4.3.2 Potential Impacts during Operation

During the operation of the wind farm, regular maintenance of the turbines will be carried out by the turbine manufacturer, the developer or service company. It is not expected that a full-time presence will be required on site. However, visits will be necessary to carry out routine inspection and preventive maintenance. It is not expected that such visits will result in any significant disturbance impact on faunal species in the area. The borrow pit, track edges and site compound will be reinstated and allowed to re-vegetate naturally post construction. No operational impact on flora is expected.

The main species of concern during operation of the wind farm are bats and birds. Potential impacts on birds is addressed in Chapter 5 Avifuana.

4.3.2.1 Potential Impacts to Bats

It is our opinion that bat foraging habitat within the general locality is not of the highest quality and large bat populations/ numbers are not expected. There will be no significant impact to bat species or abundance. Bat activity during optimal feeding (weather) conditions is expected to be low due to the lack of high quality feed habitat available. In addition bats are not expected to commute at the rotor heights, the site is elevated and exposed and any bats which may be using the area are expected to conserve their energy and fly close to the vegetation and within sheltered areas.

4.3.3 Potential Impacts on Designated Sites

There are no designated sites located within the boundaries of the proposed wind farm site. However, two designated sites are located within a 5km radius; these include Slievecallan Mountain Bog NHA and Cragnashinguan Bog NHA. These sites are important because they still contain good examples of blanket bog habitat listed as Annex I Habitat, and the hen harrier listed on Annex I of the Birds Directive. The Mid-Clare Coast SPA and the Carrowmore Point to Spanish Point and Islands SAC share much of the same boundary and are

located approximately 10km down stream of the proposed Coor Shanavogh Wind Farm on the west Clare coastline.

4.3.3.1 Slievecallan Mountain NHA

This NHA is located approximately 3km northeast of the subject site. There will **no direct impact** to the NHA during the construction or operation of the wind farm on habitats within this NHA. The only potential indirect impact which may affect the qualifying interests of this NHA is in relation to the hen harrier. Potential impacts on hen harrier are discussed in detail in Chapter 5.

4.3.3.2 Cargnashinguan Bogs NHA

This is a cluster of three discrete areas and is located approximately 3km south of the subject site. There will **no direct impact** to the NHA during the construction or operation of the wind farm on habitats within this NHA. The only potential indirect impact which may affect the qualifying interests of this NHA is in relation to the hen harrier. Potential impacts on hen harrier are discussed in detail in Chapter 5.

4.3.3.3 Mid-Clare Coast SPA

The nearest SPA is the mid-Clare coast (site code 4182) encompasses a coastal area from Spanish Point south to Doonbeg and at its nearest point is 6 km from the wind farm site (see Figure 4.1). The only potential impact on this SPA from the proposed development is water quality impacts during construction works as the small stream on site drains into this SPA. However, the SPA is located at least 10km downstream of the Coor Shanavogh Wind Farm, and given the localised nature of the works, the distance from the SPA and best management practices employed to protect water quality, the potential impact on the SPA is considered **not significant**.

4.3.3.4 Carrowmore Point to Spanish Point and Island SAC

The nearest SAC is the Carrowmore Point to Spanish Point and Island SAC (site code 1021). It is largely coincident with the Mid-Clare Coast SPA and is

designated for a number of coastal habitats that are listed under Annex I of the Habitats Directive. The only potential impact on this SAC from the proposed development is water quality impacts during construction works as the small stream on site drains into this SAC. However, the SAC is located at least 10km downstream of the Coor Shanavogh Wind Farm, and given the localised temporary nature of the works, the distance from the SAC and best management practices employed to protect water quality, the potential impact on the SAC is considered **not significant**.

4.3.4 Potential Cumulative Impact

Certain impacts in relation to biodiversity are particularly susceptible to cumulative effects. For instance, multiple small reductions in the length of hedgerow can result in long-term losses in species' populations and biodiversity. As these changes occur over long periods of time they frequently go unnoticed.
Similarly, water quality can experience large scale deterioration as a result of numerous piecemeal projects. In rural areas this can arise from effects from one-off housing and poor land management practices. In this case the impacts to water quality are of a temporary nature as there will be no permanent water abstraction or discharges from/ onto the site.

Assessing the impact of one wind farm site in isolation does not properly address the issue of cumulative impact. The effects of clusters of wind farm developments are generally additive or synergistic. Due to the nature of the (generally) upland habitats where these farms tend to be located, the issues relating to cumulative assessment are also of great importance in the both the planning and species conservation processes. Cumulative impacts when assessed can lead to the development of more effective and appropriate mitigation and ongoing monitoring measures.

The land surrounding the proposed wind farm is coniferous forestry and agricultural grassland. There are six operational/ planned wind farms in the vicinity of the proposed Coor Shanavogh wind energy development. These

include Booltiagh 1 (15 turbines operational), Booltiagh 2 (6 turbines planned), Glenmore (11 turbines planned), Cahermurphy (6 turbines planned), High Street (5 turbines planned) and Boolnagleragh (17 turbines planned). A further 31 turbines are currently in planning for Slievecallan Wind Farm.

It is possible that there may be cumulative impacts on flora and fauna at the proposed Coor Shanavogh Wind Farm due to the presence of several other existing and proposed wind farms in the surrounding area. Potential impacts of isolated wind farms in areas where extensive alternative (undisturbed) habitat are available to wildlife can generally be considered to be lower than where alternative habitats are disturbed by existing developments. This can particularly be the case where flight lines of sensitive species such as wintering waterfowl are obstructed. This is discussed in further detail in Chapter 5, Avifauna. The primary species of concern when addressing cumulative impact of operational wind farm are birds and bats. Cumulative impacts on birds is addressed in Chapter 5. Field surveys showed that the Coor Shanavogh site does not contain large populations of any bat species and it is therefore not expected that there will be any significant cumulative impacts on the local bat communities.

4.3.5 Summary of Potential Impacts

Table 4.3 below summarises the significance of potential impacts addressed in this section by combining the magnitude of the impact with the value of the ecological resource as per NRA guidelines (2006) (see Appendix 4.3 at the end of this Chapter).

Table 4.3 Summary of Impact Significance.

Impact	Significance
Habitat loss in coniferous, improved agriculture and wet grassland habitats	Minor Negative – permenant impact on large area of 'E' rating habitats.
Habitat loss in wet heath	Moderate Negative – permenant impact on small area of 'C' rating habitat
Loss of earth banks	Minor Negative – permenant impact on small areas of 'D' rating habitats.
Species mortality/disturbance in common/ widespread fauna	No Impact – temporary impacts on 'E' rating species
Species mortality/disturbance in internationally important or locally rare species	Minor Negative – temporary impact on a small area for 'C' rating species
Clearfelling	Minor-Moderate Negative – permenant impact on small part of site for 'C' and 'D' rating species
Water pollution	Not Significant – temporary impact on a 'D' rating feature
Mortality risk to Bats	No Impact – temporary impact on a 'D' rating feature

4.4 Mitigation Measures

Mitigation is required where significant negative impacts are likely to occur. The IEEM guidelines state that an impact is significant if it is 'major negative' or greater (IEEM, 2006). However, these guidelines also state that 'there is a growing body of opinion that new developments should deliver net ecological gain rather than simply being designed to achieve mere damage limitation'. This is sometimes referred to as the principle of 'no net loss' and it is considered an effective way of ensuring that sustainability is integrated into developments such as this.

4.4.1 Mitigation by Avoidance

A process of 'mitigation by avoidance' was undertaken by the EIA team during the design layout of Coor Shanavogh Wind Farm. As far as possible the existing road network and turbine layout within the site has been designed to

reduce the need for additional roads and reduce the overall impact on habitats, and where possible avoid sensitive or valuable ecological habitats.

4.4.2 General Habitat Loss and Damage Mitigation

The hard-standing area of the wind farm will be kept to a minimum, including all tree felling works, in order to minimise disturbance to habitats and flora.

No disturbance to habitats or flora outside the site boundary will occur. All works and temporary storage of material will be kept within the site boundary. The area of wet heath in the centre of the site will be fenced off for the duration of construction works and will not be impacted by the development. The area outside the immediate footprint of T6 and its hardstand will be fenced off to avoid unnecessary damage to wet heath.

All temporary structures, such as the borrow pit and site compound, will be reinstated post works. A Site Restoration Plan will be drawn up and re-vegetation of the site will be monitored by a suitably qualified ecologist.

4.4.3 Tree Felling Mitigation

The felling of trees may be subject of a licence from the Forest Service. The Forestry Service will be consulted and if required, a licence will be obtained prior to commencement of construction works.

Tree felling will be confined to the site boundary and where possible will allow for linear connection between remaining forest blocks to allow for habitat connectivity. All tree felling works will be undertaken using best management practices as outlined by the Forest Service (2000a and 2000b).

4.4.4 Species Mortality/ Disturbance Mitigation

Construction operations will take place during the hours of daylight to minimise disturbance to nocturnal mammals. A site walkover will be undertaken over the

footprint of the development prior to construction by an appropriate time of year by a suitably qualified ecologist. This will ensure any wildlife refuges may be located and managed according the NRA guidelines prior to site clearance.

No removal of uncultivated vegetation i.e. earth banks will take place from March 1st to August 31st in accordance with the provisions of the Wildlife (Amendment) Act 2000. This will avoid the breeding season for many species.

4.4.5 Water Pollution Mitigation

While this impact was assessed as not significant, pollution impacts are quite avoidable using best site management practice. The Eastern Regional Fisheries Board has produced a document 'Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites' (ERFB, unknown year). It outlines the threats to fishery habitats through the type of construction works that are likely to take place at this site. These include sedimentation; cement, grout and concrete which are toxic to fish; and oil & fuels which have direct impacts on flora and fauna.

All recommendations as outlined in the Fisheries Board document will be adhered to:

- Fuels, oils, greases and hydraulic fluids must be stored in bunded compounds well away from the watercourse. Refuelling of machinery, etc., should be carried out in bunded areas.
- Runoff from machine service and concrete mixing areas must not enter the watercourse.
- Stockpile areas for sands and gravel will be kept to minimum size, well away from the watercourse (bare soil should not be stored adjacent to the water course or on sloping ground where there is a risk to water quality).
- Runoff from the above will only be routed to the watercourse via suitably designed and sited settlement ponds/filter channels.
- Settlement ponds will be inspected daily and maintained regularly.

- Permanent water crossing will be designed as a single span bridge to avoid disturbance to the river bank or substrate.
- If culverting is unavoidable then this will be kept as short as possible and dug to a depth such that there will be 500mm of water even during low flow periods.
- Watercourse banks will be left intact if possible. If they have to be disturbed, all practicable measures should be taken to prevent soils from entering the watercourses.

The full text of this document is available at:
http://www.fishingireland.net/environment/fullconstructionanddevelopment.htm

Current best practice guidelines will be used were new site track is proposed to cross the watercourse (e.g., NRA Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes 2005, Fishery Guidelines for Local Authority Works by Department of the Marine and Natural Resources 1998 and Fisheries Protection Guidelines by the Eastern Regional Fisheries Board), in particular culvert design, in-stream works, timing of in-stream works, diversions (if required) and pollution prevention. A method statement will be prepared and supplied to Inland Fisheries Ireland in advance of any in-stream works.

Hydrological mitigation measures are outlined by HES (Hydro Environmental Services Ltd) further in Chapter 7.

4.4.6 Bat Mitigation

Fatality monitoring can be incorporated into the monitoring programme once the turbines are fully operational. Information on species, age, sex, and turbine collision or air pressure mortality can be recorded. Relevant guidance documentation will be used to help guide and produce the accounting of bat mortalities (if any) associated with the operating wing farm. These guidance documents include:

- The EUROBATS Publication Series No. 3 'Wind turbines and bats: Guidelines for the planning process and impact assessments';

- Bat Conservation Trust (BCT) Mitigation Conference Proceedings. University of Leicester, 25-26 April 2007. Sponsored by Faber Maunsell and supported by Defra and Eurobats.

4.5 Conclusion

This survey details the flora and fauna community occurring within the proposed wind farm site. The habitats on the site were dominated improved agricultural grassland, conifer plantation and wet grassland, none of which are of high conservational value. One small 1st order headwater stream flows to the south of the site.

In general the diversity of flora and fauna species on the site is low and the species and habitats recorded during field surveys are well represented in the surrounding area. With the successful application of mitigating measures and best practice construction techniques, Coor Shanavogh Wind Farm will not have any long term negative impacts on the habitats or locally occurring wildlife on the site.

With the successful application of mitigating measures the residual impacts post construction would be negligible.

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5 AVIFAUNA

5.1 Introduction

This section presents the results of an avifauna survey, which was carried out in order to determine the general nature of the avifauna present on site, and to identify any specific issues with regard to the potential significant impacts of the development of six wind turbines and associated works at Coor Shanavogh, Co. Clare. It has been compiled in compliance with the European Communities (Environmental Impact Assessment) Regulations 1989 – 2000 and follows Guidelines on the Information to be contained in Environmental Impact Statements (Environmental Protection Agency, 2002). This chapter also incorporates ornithological predicted impacts and suggested mitigations.
All survey flight line and survey result maps are given in, Appendix 4, EIS Volume III: Appendices.

5.2 Background

This document reports on the design, implementation and results of the avian surveys carried out during the winter season of 2010/2011, along with the results of a baseline avifauna survey of the site, conducted during the summer of 2010.

The current chapter includes avifauna data from a previously commissioned flora and fauna chapter for which avian surveys were carried out during the breeding season 2010. It should be noted that avifauna surveys are ongoing at the subject site with a full avifauna breeding season survey following SNH guidelines (SNH 2005) being carried out in the current calendar year.

5.3 Statement of Authority

Qualified ecologist Howard Williams CEnv CBiol MBiol MIEEM completed his B.Sc. in Biological Sciences, National University of Ireland Cork, in June 1997.

Following his degree he worked as a biologist for three years (1997-2000). Mr. Williams has acted as lead ecologist on thirty two wind farm developments in Ireland and the UK since 2000.

Mr. Williams is a full member of the Institute of Ecology and Environmental Management (IEEM). He is a Chartered Environmentalist (CEnv) with the Society for the Environment (Soc Env) and a Chartered Biologist (CBiol) with the Society of Biology. Mr. Williams is principal ecologist with INIS Environmental Consultants Ltd and currently project manager on all INIS projects in the Republic of Ireland and the UK.

Christopher Cullen AIEEM is a qualified ecologist (Dip. In Field Ecology) and a graduate of UCC. In recent years he has worked on numerous bird surveys, both voluntary and non-voluntary. He has also been employed by BirdWatch Ireland as an avian surveyor, and completed the national red grouse survey. He has worked for UCC as an avian researcher on hen harriers, and as an avian surveyor for the Environmental Research Institute. He has had work published in peer-reviewed journals such as Irish Birds and the Irish Naturalists Journal. He has also co-authored work in Irish Birds and Ringing and Migration. Mr. Cullen is the Project Manager for Bird Survey Ireland, a wholly owned subsidiary of INIS Environmental Consultants Ltd.

Stephanie Murphy B.Sc., M.Sc., MIEEM is a qualified Ecologist with a degree in Biological Sciences, National University of Ireland, Cork, received in 2002 and a Masters in Biodiversity and Conservation received from Leeds University in 2004. Stephanie has been involved in ecological surveys in Ireland since 2007, particularly in relation to the wind energy industry. She has had work published in *Irish Birds* and *Irish Naturalists' Journal*. Stephanie is senior ecologist with INIS Environmental Consultants Ltd.

5.4 Assessment Approach

The following methodologies and sources of data have been reviewed and utilized when designing the survey approach to the current project.

5.4.1 Data Sources

A preliminary desk study was carried out to collate and review ecological data from the following range of sources:

- Department of Environment Heritage and Local Government
- National Parks and Wildlife Service
- BirdWatch Ireland
- Clare County Council

For the current survey, a list was generated of bird species of conservation concern that are known or considered to be 'sensitive' to wind farm development and/or at potential collision risk. The list of species is based on an understanding of the habitat types present, desktop study, and consultation with local ornithologists.

5.4.2 Consultation

In addition to the above consultation the following statutory bodies, groups or individuals were consulted directly in relation to specific species.

- Dr. Sinead Cummins, BirdWatch Ireland
- Ms. Olivia Crowe, BirdWatch Ireland
- Dr. Barry O Donoghue, National Parks and Wildlife Service
- Dr. Marc Ruddock, Northern Ireland Raptor Study Group
- Dr. John Lusby, BirdWatch Ireland

5.4.3 Significance Criteria

The following matrix sets out the significance criteria utilized in determining individual levels of impact for the current project. This matrix is based on best practice guidelines as recommended by SNH (SNH 2009).

Table 5.1 Significance Criteria.

Level of Significance	Definition
Major	Medium to High Sensitivity of Receptor and Substantial Magnitude of change
Moderate	Low to High Sensitivity of Receptor and Moderate to Slight magnitude of change
Minor	Low to Medium Sensitivity of Receptor and Moderate to Slight Magnitude of change
Negligible	Low to High Sensitivity of Receptor and Negligible or no magnitude of change

5.5 Planning Policy Context

5.5.1 The Birds Directive

Under Article 4 of the Birds Directive (1979) it is required that in Special Protection Areas (SPAs) developers provide empirical evidence to show that any aspect of the proposed development will not adversely affect the qualifying feature of the SPA.

With regard to habitats outside SPAs, the State is required to strive to 'avoid pollution or deterioration of habitats' of all wild birds, including species listed in Annex I of the Birds Directive (Annex I refers to a list of species that require strict protection due to their populations declining seriously throughout their respective ranges).

5.5.2 The Habitats Directive

The Habitats Directive 92/43/EEC was transposed into national law through the European Communities (Natural Habitats) Regulations 1997 (S.I. 94/97). These regulations require local governments to ensure that an appropriate assessment of the impacts on Special Areas of Conservation (SACs) of any proposed development is undertaken, with regard to the SACs conservation objectives. This applies to all development proposals, irrespective of their location, or likely impact on these sites.

5.5.3 The Wildlife Act, 1976

The Third Schedule to the Wildlife Act 1976, was amended on the 6th December 1985, when the minister, in compliance with the European Communities Council Directive of 2nd April, 1979 (No. 79/409/EEC), made regulations entitled 'The European Communities (Wildlife Act, 1976) (Amendment) Regulations, 1985 (No. 397 of 1985)', removing the remaining twelve unprotected species from that schedule. The Wildlife Act 1976 is the principal national legislation providing for the protection of wildlife and the control of activities, which may adversely affect wildlife. The Act came into operation on 1st June 1977. The aims of the Act are to provide for the protection and conservation of wild fauna and flora, to conserve a representative sample of important ecosystems, to provide for the development and protection of game resources and to regulate their exploitation, and to provide the services necessary to accomplish such aims. As a consequence of the Wildlife Act all wild birds are now protected throughout the state and careful assessment of their habitats must take place before any development is allowed.

5.5.4 The Wildlife (Amendment) Act, 2000

This Act broadened the scope of the Wildlife Act to include most species, including the majority of fish and aquatic invertebrate species, which were excluded from the 1976 Act. It also strengthened the provisions relating to the cutting of hedgerows during the critical bird-nesting period. It strengthened the protective regime for Special Areas of Conservation (SACs) by removing any doubt that protection will in all cases apply from the time of notification of proposed sites. The act also gave specific statutory recognition to the Minister's responsibilities in regard to promoting the conservation of biological diversity, in light of Ireland's commitment to the UN Convention on Biological Diversity.

5.6 Existing Environment

5.6.1 Location and Setting

The subject site (central Grid Reference R110 750) is located within the town lands of Coor East, Shanavogh West and Killernan, approximately 9km east of the village of Quilty and 7km south east of Milltown Malbay. The site rises to the east where it is flanked to the north by Slieve Callan.

Habitats present within the site are primarily improved agricultural grassland, conifer plantation and wet grassland, with an additional element of wet heath.

5.6.2 Designated Sites

Candidate Special Areas of Conservation (cSAC) are protected under the European Union (EU) Habitats Directive (92/43/EEC) as implemented in Ireland by the European Communities (Natural Habitats) Regulations 1997. These are prime wildlife conservation areas in the country, considered to be important on a European as well as Irish level.

Proposed Natural Heritage Areas (pNHA) are the basic designation for wildlife in the Natural Heritage Area. Under the Wildlife Amendment Act 2000 NHAs will be legally protected from damage from the date they are formally proposed.

The EU Birds Directive (79/409/EEC) came into force in 1979 and it requires each member state to designate “Special Protection Areas” for birds. The Directive contains annexes which are lists of birds which require particular conservation measures (Annex I) and also species which may be hunted, and species which may be sold. Nearest in location to the subject site are the following designated sites:

Figure 5.6.2, overleaf, details the designated sites within 10km of the subject site.

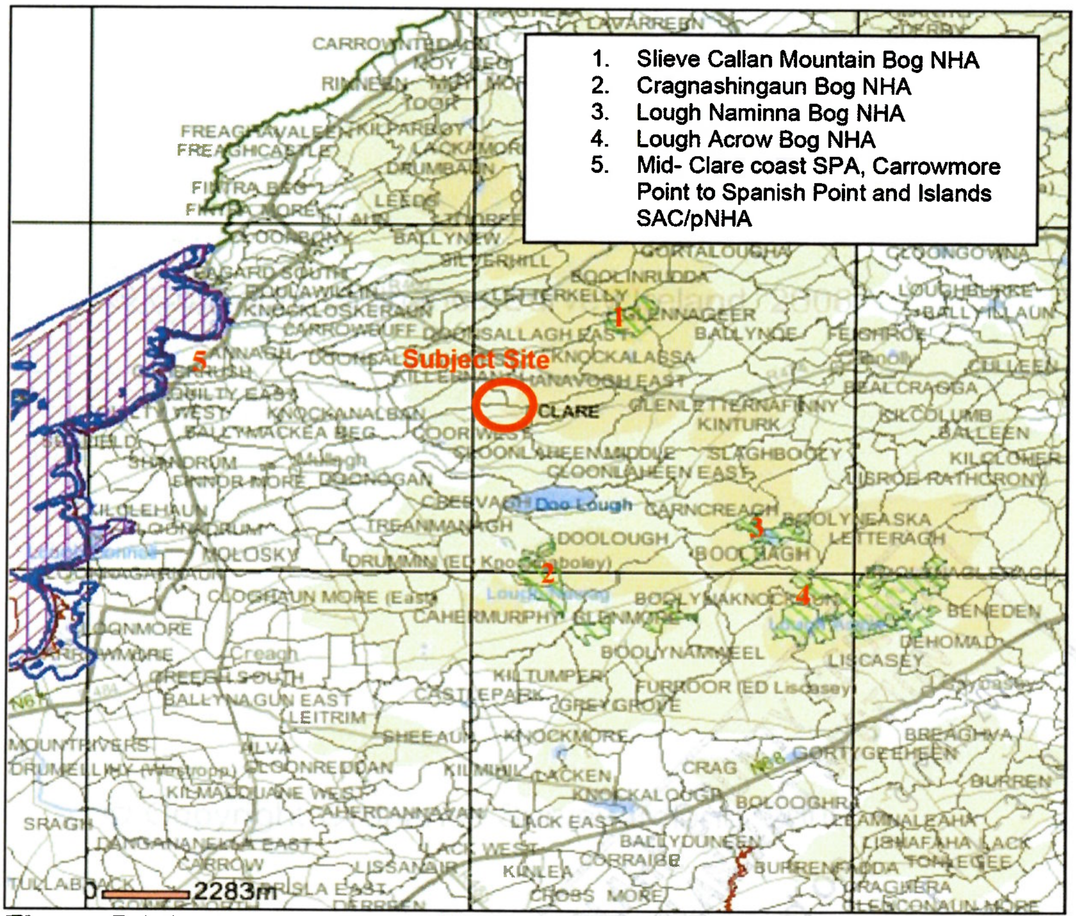

Figure 5.1 Designated sites within 10km of the subject site.

Slieve Callan Mountain Bog NHA

Slieve Callan Mountain Bog NHA is located approximately 3km NE of the subject site. The NHA is an area of upland blanket bog surrounded by forestry except on the south where it is bordered by re-vegetating cutover bog. The site is of considerable conservation value as it is a good example of an upland blanket bog. Irish Red Data Book species such as Golden Plover and Hen Harrier are known to occur on the site.

Cragnashingaun Bog NHA

Cragnashingaun Bog NHA is located approximately 5km south of the subject site. This NHA consists of a relatively large area of lowland blanket bog. This site contains both examples of lowland and upland bog and is therefore of conservation value. Hen Harrier and Red Grouse have been recorded from the site.

Lough Naminna Bog NHA

Lough Naminna Bog NHA is located approximately 6km SE of the subject site and consists of an area of upland blanket bog. The primary habitats present are areas of re-vegetated cutover, wet heath and also dry heath. Lough Naminna itself is known to be a good trout fishery and Otter has also been recorded.

Hen Harriers have been recorded hunting over the site.

Lough Acrow Bog NHA

Lough Acrow Bog NHA is located approximately 8km SE of the subject site. Habitats found at the site include upland blanket bog and also wet heath. A small, well-vegetated lake is also located within the NHA. This site is of conservation importance due to the presence of extensive blanket bog including areas of quite deep, wet bog and a well developed pool complex. The site provides both feeding and breeding habitat for a number of threatened species such as Red Grouse, Hen Harrier, Golden Plover, Irish Hare and Otter.

Mid-Clare coast SPA, Carrowmore Point to Spanish Point and Islands SAC/pNHA

This site extends along the Clare coastline in a south-southwesterly direction from Spanish Point to just west of Doonbeg Bay and includes the mainland shoreline, Mutton Island, Mattle Island and a series of rocky reefs and the open marine water of Mal Bay between the islands and the mainland.

The site is a Special Protection Area under the E.U. Birds Directive, of special conservation interest for the following species: Cormorant, Barnacle Goose, Ringed Plover, Sanderling, Purple Sandpiper, Dunlin and Turnstone.

This site is of high ornithological importance as it supports a nationally important population of wintering Barnacle Goose, as well as nationally important numbers of five wader species. In summer it has breeding colonies

of Cormorant and Great Black Backed Gull as well as a range of other seabird species.

5.6.3 The Proposed Development

The proposed development at Coor Shanavogh consists of six turbines and associated hardstands, substation, borrow pits, a temporary site compound, underground cabling and access roads. The project landholding comprises a total area of 90.7Ha. Of this, the proposed temporary and permanent windfarm infrastructure will comprise just 7.3Ha, or 8% of the total landholding.

5.6.3.1 Turbines

Four of the turbines (T3-T6) are to be located within commercial forestry of mixed age classes. Turbine 1 is located in an area of Improved Agricultural Grassland and Turbine 2 is in Wet Grassland.

5.6.3.2 Roads

A total of 12,000m^2 of new roads will be required to access the six turbines, with approximately 73m^2 of existing roads to be upgraded. The majority of new roads will be located within conifer plantation (63%), with the remainder in wet grassland (22%) and improved agricultural grassland (15%).

There is an option for an additional section of access road, from T5 to the optional northern entrance. This will not be constructed unless required by the planning authorities; it exists purely as an entrance option available if necessary. If constructed, this road will mostly require upgrading of an existing farm track and a section of new road within improved agricultural grassland.

5.6.3.3 Borrow Pits

It is proposed to excavate rock for the construction purposes at three locations within the site boundary. Borrow Pit 1 will comprise an area of 3,200m^2 and is partially located within an existing borrow pit on site and in wet grassland

habitat. Borrow Pit 2 comprises 1000m^2 and is located in an area of soil or bare ground near Turbine 5. Borrow Pit 3 is just 900m^2 and is located in improved agricultural grassland near T1. These borrow pits will be reinstated post construction.

5.7 Assessment Methodology

5.7.1 Target Species

5.7.1.1 Hen Harrier

The Hen Harrier is an Annex 1 species on the EU Birds Directive, and is currently Amber listed in Ireland (Lynas *et al.* 2007). It is a bird of open country which utilizes almost any open terrain which contains enough small mammals or birds for hunting purposes (Watson 1977). In Ireland, the preferred nesting habitat is second rotation pre-thicket forestry, followed by new pre thicket forestry, heather/bog and post thicket forestry with patches of heather or scrub (Barton *et al.* 2006). In Northern Ireland, Hen Harriers have been recorded nesting in trees (Scott & Clarke 2007).

Thompson (1849) describes the Hen Harrier as being ‘pretty generally distributed over the island’ and although no specific mention is made of North Cork/Limerick, he does quote other sources that say it is ‘occasionally met with’ in East Cork and ‘common’ in Kerry. By 1893, Usher (1893) describes the Hen Harrier as being ‘resident and common’ fifty years earlier but decreasing to the point where ‘it seems now to have almost disappeared’. In 1900, Usher & Warren (1900) state it is ‘frequently seen on the mountains south of the Mallow and Killarney line’, but ‘a straggler to other parts of the county’. By the 1950’s the Hen Harrier was considered to be ‘nowadays a rare straggler’ to Ireland (Kennedy, Ruttledge & Scroop 1954) and sufficiently rare to merit publications of individual sightings. Subsequent to this, it became known that the Hen Harrier had continued to breed in the Slieve Bloom Mountains in Co. Laois and on the Waterford/Tipperary border (Watson 1977, quoted in O’Flynn 1983).

In the early 1950's a recovery is believed to have begun (O'Flynn 1983) and Sharrock (1976) suggested that the population had risen to 200-300 pairs by 1972.

However, by the late 1970's early 1980's the population is again believed to have declined and O'Flynn (1983) says that 'since 1978' in many areas he has been 'unable to find any evidence of breeding'. From 1980 onwards however, Hen Harriers were once again breeding although numbers remained low in many areas.

In recent years a number of national Hen Harrier surveys have taken place. The first National Survey took place in 1998-2000 and identified 102-129 breeding pairs nationally (Norriss *et al.* 2002). The second National Survey took place in 2005 and identified 132-153 breeding pairs (Barton *et al.* 2005). The third National Survey took place in 2010.

5.7.1.2 Merlin

The Merlin is a small falcon which breeds over the whole Paleartic and North America, mainly in the coniferous forest belt and wooded tundra; in Britain and Ireland it is mainly found on large stretches of heather moorland but also nests in woodland as the amount of moorland with tall heather has been reduced (Gensbol 2008).

The Merlin is a widespread and locally abundant breeding bird in upland areas of Britain and Ireland (Gibbons *et. al.* 1993). In Britain and Ireland, Merlin are short distance migrants; many disperse to lower altitudes after breeding, normally within 100km of their breeding area, and smaller numbers move south into France and Iberia (Heavisides 2002).

Merlin are elusive outside the breeding season and methods of assessing their abundance at this time have not been established (Hardey *et al.,* 2009).

5.7.1.3 Barn Owl

The Barn Owl is a bird of open country and farmland which has undergone a decline in its documented range in recent times (Shawyer 1994). In Ireland it is currently red-listed due to a decline of over 50% of their population in the last 25 years (Lynas *et al.* 2007).

The causes of the decline in this species relate largely to changing agricultural practices over the last 50 years which have led to declines in prey numbers (Nagle 2007). The use of rodenticides has also been identified as a cause of decline. Other factors include the loss of potential nest sites and increasing severity of winters. There is currently approximately 140 active nesting and roosting sites in Ireland. Over 50% of these occur in Counties Cork and Kerry, making the southwest region a stronghold for Barn Owl in Ireland (J. Lusby, BirdWatch Ireland, *pers. omm.....*).

5.7.1.4 Whooper Swan

The Whooper Swan is monotypic. The majority of Whooper Swans which occur in Ireland are from the Icelandic population (Crowe 2005). In Ireland, wintering birds typically forage in and utilise habitats associated with lakes and wetland areas. Birds traditionally begin to arrive in Ireland in October and peak during mid-winter (Crowe 2005). Birds usually return to their breeding grounds in March and April (Hutchinson 1989).

5.7.1.5 Red Grouse

The Red Grouse *Lagopus lagopus scoticus* is now considered a subspecies of the Willow grouse *Lagopus lagopus* even though in the past it was considered a separate species (Murray & O'Halloran 2003). Though some authorities consider the British and Irish birds to be the same race (Cramp &Simmons 1979) ,a putative race found in Ireland and the Hebrides (*Lagopus lagopus hibernicus*) (Allen *et al.* 2005) was formerly also considered as a separate subspecies of Willow Grouse ,due to its paler colour (Hutchinson 1989).

In Ireland the Red Grouse occurs on heather moorland, blanket bogs and raised bogs (Allen et al. 2005) where it feeds on heather, which is its primary food source (Cramp & Simmons 1979). Its presence or absence within a habitat is strongly tied to the percentage cover of heather present, with studies suggesting that a minimum of 16-20% percentage cover of heather is required (Murray&O'Halloran 2003, Lance 1976).

The Red Grouse is currently Red listed in Ireland due to a population decline of over 50% in the last 25 years (Lynas *et al.* 2007).

5.7.2 Baseline Breeding Season Survey

A baseline bird survey was carried out at the subject site in May and July 2010 (OPENFIELD Ecological Services 2010) following methodologies utilised for the Countryside Bird Survey. This methodology involves walking a series of transects and identifying birds by sight and sound within specific distance bands from the observer. A modified form of this methodology was utilised to cover the subject site.

5.7.3 Winter Survey 2010/2011

A number of target species were identified prior to the commencement of this survey. Based on literature review and consultation the following survey methodologies were selected.

5.7.3.1 Crepuscular Survey

A crepuscular survey was undertaken at the subject site between the months Of November 2010 and February 2011, with the primary aim of investigating the possibility that wildfowl may be transiting over the site en route to Doo Lough to roost. This survey also aimed to note any crepuscular species such as Owls and also to determine if species such as Hen Harrier roosted proximal to the subject site. During each month the subject site was visited on at least one occasion at both dawn and dusk. A vantage point located at the centre of the subject site was utilised which afforded clear views from the subject site south towards Doo Lough.

5.7.3.2 Walkover Survey

A walkover style survey, following the Breeding Bird Survey (BBS) (Brown & Shepherd 1993) methodology was conducted at the subject site on a monthly basis from November 2010 to February 2011. This method, as recommended by SNH (SNH 2005) combines the use of shortened VP watches with a walking route between VP locations designed to maximise coverage of the study site and approach to landscape features which may be of potential ornithological importance. Periodic scanning for birds and listening for calls of birds are used to record as many species as possible. All species recorded are mapped onto a scaled map using BTO 2 letter codes. In instances where walking routes are repeated the order of VP's visited is varied between visits.in particular features or areas or varying habitat and recording all birds present on a map using standard recording codes. In the case of the subject site the direction of the route selected was also varied across visits so as to avoid introducing any bias.

5.7.3.3 Barn Owl

Given that home ranges of barn owls are not mutually exclusive the only definitive method to assess the numbers in a study area is to locate nest sites (Hardey *et al.* 2009). Barn Owls can be almost completely nocturnal but in many areas, they are crepuscular. They can be seen hunting in the early morning shortly after dawn or in the evening about an hour before sunset or even earlier in winter (Bunn *et al.* 1982).

Scottish Natural Heritage recommends that Barn Owl be surveyed within a minimum of ^{3}km from the subject site (SNH 2005). For the purposes of the current survey the following objectives were identified as essential to establishing whether there is any Barn Owl usage of the subject site:

- Establish through desktop review and consultation with both wildlife rangers and recognised Barn Owl experts whether Barn Owls are in the area.

- If Barn Owls are present in the vicinity of the subject site, then a hinterland search to establish any existing or potential breeding or roosting sites should be conducted.

Two days in January 2010 were spent searching for suitable buildings or other locations, which could in theory be utilised by Barn Owl. The hinterland distance used for this survey was ³km from the subject site. All suitable buildings or locations were noted and will be re-visited at a later date to assess presence or absence of Owls.

5.8 Results

5.8.1 Consultation

The following individuals were consulted in regard to specific species.

Dr. Sinead Cummins, BirdWatch Ireland, was consulted in February 2011 in relation to the proximity of Red Grouse to the subject site. Dr. Cummins confirmed that the nearest Red Grouse records from the recent national survey were from Slieve Callan.

Ms. Olivia Crowe, Birdwatch Ireland, was consulted in October 2010 in regard to the presence during winter of Whooper Swans at Doo Lough. The results of the most recent swan censuses were as follows:

"*None recorded in 2005 & 2010 swan censuses. Was covered once in 2002 – no birds. Four times in 95/96 peak count 38. Not to say there are no other sites nearby and that this isn't used as a key roost..*"

Dr. Barry O Donoghue, National Parks and Wildlife Service, was consulted in February 2011 in regard to Hen Harriers and other species such as Merlin and Barn Owl. In regard to Hen Harrier, Dr. O Donoghue stated that he believed the subject site was an important breeding and foraging site and that he had confirmed breeding in the past.

Dr. Marc Ruddock, Northern Ireland Raptor Study Group, was consulted in regard to Hen Harriers. Dr. Ruddock confirmed that the nearest confirmed breeding in 2010 was circa 2.5km from the subject site.

Dr. John Lusby, BirdWatch Ireland, was consulted in regard to Barn Owls in the vicinity of the subject site. Dr. Lusby was unaware of any breeding birds in the area.

5.8.2 Baseline Breeding Season Survey

5.8.2.1 Breeding Birds

Table 5.2.overleaf, details the results of the preliminary breeding bird survey undertaken in 2010 (from OPENFIELD Ecological Services 2010).

A total of 19 species were recorded from the subject site. Two Amber listed species were recorded, Skylark and Starling. Skylark was recorded in song and it can be assumed therefore that breeding takes place at the subject site. Starlings were only recorded in flight over the subject site but most likely breed at nearby farm buildings. Four species of Corvid, including Raven, were recorded. No raptors were found on site. Cuckoo was also recorded along with some of the commoner summer migrants such as Swallow and Willow Warbler. No Red Grouse were recorded on site.

Table 5.2 Results of 2010 Breeding Bird Survey.

Coor Wind Farm Preliminary Breeding Bird Survey 2010				
Species #	Name	Latin Name	Activity	Conservation Status
1	Blackbird	*Turdus merula*	Singing	Green
2	Meadow Pipit	*Anthus pratensis*	Singing	Green
3	Chaffinch	*Fringilla coelebs*	Singing	Green
4	Robin	*Erithacus rubecula*	Singing	Green
5	Magpie	*Pica pica*	Flying	Green
6	Raven	*Corvus corax*	Roosting	Green
7	Pied Wagtail	*Motacilla alba*	Perched	Green
8	Pheasant	*Phasianus colchicus*	Singing	Green
9	Rook	*Corvus frugilegus*	Flying	Green
10	Starling	*Sturnus Vulgaris*	Flying	Amber
11	Jackdaw	*Corvus monedula*	Flying	Green
12	Hooded Crow	*Corvus cornix*	Perched	Green
13	Lesser Redpoll	*Carduelis cabaret*	Feeding	Green
14	Woodpigeon	*Columba palumbus*	Flying	Green
15	Skylark	*Alauda arvensis*	Singing	Amber
16	Cuckoo	*Cuculus canorus*	Singing	Green
17	Willow Warbler	*Phylloscopus trochilus*	Singing	Green
18	Swallow	*Hirundo rustica*	Feeding	Green
19	Stonechat	*Saxicola torquata*	Singing	Green

5.8.3 Winter Survey 2010/2011

5.8.3.1 Walkover Survey

Table 5.3. overleaf, details the results of the walkover survey conducted from November 2010 to February 2011.

A total of 37 species were recorded from the subject site over the winter months. Of these, a total of 7 species listed as Amber were recorded (see Table 5.8.3.1, overleaf). Amber listed species included raptors (Hen Harrier and Kestrel) in addition to passerine species (House Sparrow, Starling and Skylark). Snipe and Woodcock (both Amber) were also recorded.

Table 5.3 Results of the walkover survey conducted from November 2010 to February 2011.

Coor Wind Farm Walkover Results Winter 2010/2011							
Species	Name	Latin Name	November	December	January	February	Conservation Status
1	Blackbird	*Turdus merula*	20	8	12	4	Green
2	Wren	*Troglodytes troglodytes*	9	3	4	7	Green
3	Meadow Pipit	*Anthus pratensis*	47	3	2	0	Green
4	Chaffinch	*Fringilla coelebs*	17	5	4	6	Green
5	Robin	*Erithacus rubecula*	9	1	8	7	Green
6	Magpie	*Pica pica*	10	12	12	5	Green
7	Raven	*Corvus corax*	2	1	2	0	Green
8	Pied Wagtail	*Motacilla alba*	2	2	3	1	Green
9	Pheasant	*Phasianus colchicus*	2	0	0	2	Green
10	Fieldfare	*Turdus pilaris*	5	1	1	40	Green
11	Redwing	*Turdus iliacus*	4	0	15	40	Green
12	Dunnock	*Prunella modularis*	3	0	5	6	Green
13	Reed Bunting	*Emberiza schoeniclus*	4	0	1	0	Green
14	Rook	*Corvus frugilegus*	8	5	27	13	Green
15	Coal Tit	*Parus ater*	1	0	6	5	Green
16	Blue Tit	*Parus caeruleus*	5	2	3	1	Green
17	Great Tit	*Parus major*	1	0	3	2	Green
18	Long Tailed Tit	*Aegithalos caudatus*	2	0	3	0	Green
19	House Sparrow	*Passer domesticus*	1	0	0	0	Amber
20	Starling	*Sturnus Vulgaris*	9	100	85	58	Amber
21	Song Thrush	*Turdus philomelos*	9	0	3	1	Green
22	Jackdaw	*Corvus monedula*	2	6	10	4	Green
23	Hooded Crow	*Corvus cornix*	2	11	9	9	Green
24	Lesser Redpoll	*Carduelis cabaret*	4	0	0	0	Green
25	Goldcrest	*Regulus regulus*	2	0	1	0	Green
26	Sparrowhawk	*Accipiter nisus*	1	0	0	0	Green
27	Snipe	*Gallinago gallinago*	4	10	0	0	Amber
28	Kestrel	*Falco tinnunculus*	1	0	1	0	Amber
29	Hen Harrier	*Circus cyaneus*	1	0	0	0	Amber
30	Dipper	*Cinclus cinclus*	0	1	0	0	Green
31	Goldfinch	*Carduelis carduelis*	0	0	21	0	Green
32	Bullfinch	*Pyrrhula pyrrhula*	0	0	1	0	Green
33	Woodpigeon	*Columba palumbus*	0	0	1	2	Green
34	Linnet	*Carduelis cannabinna*	0	0	1	0	Green
35	Mallard	*Anas platyrhynchos*	0	4	0	0	Green
36	Skylark	*Alauda arvensis*	0	0	0	1	Amber
37	Woodcock	*Scolopax rusticola*	0	0	0	1	Amber

The highest number of overall species was recorded in November (n=29). December had the lowest number of species recorded (n=17), possibly a reflection of the cold weather at the time. The mean number of species recorded per month was 23.5 (range 17-29).

The most abundant species recorded from the subject site were generally flocking species such as Starling, Fieldfare and Redwing. In addition to these,

Corvid species were recorded in good numbers apart from Raven where a maximum of one pair was recorded per single visit.

A notable peak of 47 Meadow Pipits were recorded during the November visit, this does include a flock flushed from feeding in wet grassland and therefore may be more indicative of a throughput of birds during the winter months. Many of the small passerine species were either absent or recorded in low numbers in December and January; this is without doubt attributable to the extremely cold weather experienced.

A single Skylark was recorded in February, as well as a single Woodcock.

In terms of raptors; Kestrel and Sparrowhawk were both recorded, though frequency of occurrence was low. Hen Harrier was recorded both flying through and foraging on site in November. These sightings are attributed to an individual male bird which was also noted during dawn and dusk surveys prior to the walkover. Hen Harrier was not recorded from the subject site after November and the cold weather in December/January most likely dispersed any birds in the general area.

5.8.3.2 Crepuscular Survey

Table 5.8.3.2, Overleaf, details the dates and times of dawn and dusk watches conducted between November 2010 and February 2011.

The primary observation of note was that of a male Hen Harrier flying through the site on November 11, 2010 (see Table 5.5). This bird was observed for 47s at a height interval of 10-100m. The bird flew through the site from the north and continued south (see Figure 3 for flight lines, Appendix 4, EIS Volume III).

No other sightings of note were recorded. Mallard were recorded on one occasion (see Table 5.6 and Appendix 5.1). No other wildfowl, or crepuscular species such as Owls were noted.

Table 5.4 Dates, Times and Conditions for Crepuscular Survey Vantage Point Watches.

Coor Winter Survey 2010/2011 Watch Information									
VP	**Grid Reference**	**Date**	**Start-Finish**	**Survey**	**Visibility**	**Cloud Cover**	**Wind Speed/Direction**	**Precipitation**	**Temperature**
1	10959 74496	11/11/2010	15.00-17.30	Dusk	Good	75%	SW F3 plus gusts	Dry	Cool
1	10959 74496	12/11/2010	07.00-09.00	Dawn	Good	0%	W F1	Dry	Cool
1	10959 74496	15/12/2010	15.00-17.00	Dusk	Good	80%	N F1	Dry	Cool
1	10959 74496	16/12/2010	07.15-09.15	Dawn	Good	90%	W F1-2	Occ. Mist	Cool
1	10959 74496	24/01/2011	15.00-17.45	Dusk	Good	80%	W F1	Dry	Cold
1	10959 74496	25/01/2011	07.00-09.00	Dawn	Good	100%	E F1-2	Occ. Mist	Cool
1	10959 74496	22/02/2011	17.00-19.00	Dusk	Moderate	100%	W F1	Dry	Cool
1	10959 74496	23/02/2011	06.50-08.20	Dawn	Good	80%	SW F2	Dry	Cool

Table 5.5 Raptor Flight Activity November 2010 to February 2011.

Coor Wind Farm Raptor Flight Activity Winter 2010/2011												
Bout	**Date**	**Survey**	**Flightline number**	**Period**	**Species**	**Sex**	**Start Time**	**Total time**	**<10**	**10-100**	**>100**	**Notes**
1	11/11/2010	Dusk	1	15.00-17.30	Hen Harrier	Male	15.42	47s		47		Flythrough
2	12/11/2010	B&S	2	09.20-10.00	Hen Harrier	Male	9.31	30s		30		Flythrough
3	12/11/2010	B&S	3	12.20-13.00	Hen Harrier	Male	12.27	20s	20			Hunting Male
4	12/11/2010	B&S	4	n/a	Kestrel	n/a	10.3	30s		30s		Ad hoc sighting-Mobbed by HC
5	12/11/2010	n/a	5	n/a	Sparrowhawk	n/a	14.3	10s	10			Ad hoc sighting when leaving
6	24/01/2011	Dusk	6	15.00-17.45	Kestrel	n/a	17.3	10s	10			Brief view of bird at dusk
7	24/01/2011	B&S	7	n/a	Kestrel	n/a	13.4	10s		10		Ad hoc sighting walking to car

Table 5.6 Wildfowl Flight Activity from November 2010 to February 2011.

Coor Wind Farm Wildfowl Flight Activity Winter 2010/2011												
Bout	**Date**	**Survey**	**Flightline number**	**Period**	**Species**	**Sex**	**Start Time**	**Total time**	**<10**	**10-100**	**>100**	**Notes**
1	16/12/2010	Dawn	1	07.00-09.15	Mallard	n/a	8.2	20s	20			4 MA from SE

5.8.3.3 Barn Owl

Over a two day period in January 2011, approximately 60 buildings within ^{3}km radius of the subject site were investigated as to their suitability for Barn Owl, either as roosts or potential nest sites. Very few buildings were deemed suitable for occupancy by Barn Owl. A total of 3 buildings were identified as candidate sites for Barn Owls however these were not optimum in most cases and no evidence in the form of droppings, whitewash or pellets were found.

The most suitable building located was outside the ^{3}km hinterland employed for the search; this shall also be re-visited during the summer months to re-check for occupancy.

5.8.3.4 Raptors

Table 5.8.3.4, overleaf, details all recorded flight activity for raptors within the study period.

Total flight duration recorded for raptors was 157s. This included flying bouts by three species, Hen Harrier, Kestrel and Sparrowhawk. Total flight duration was highest for Hen Harrier (t=97s) followed by Kestrel (t=50s) and then Sparrowhawk (t=10s). Flight activity was primarily recorded at height intervals of 10-100m. For Hen Harrier, total flight activity was highest at 10-100m (t=77s), with the remainder (t=20s) at <10m.

Flight activity for Kestrel was also divided between height intervals, with flight duration highest at 10-100m (t=30s) followed by <10m (t=10s). Only one flying bout was recorded for Sparrowhawk, this was at a height interval of <10m (t=10s), which is typical for this species.

A walkover survey was conducted in January 2011 for Merlin following recommended methodologies. No birds were recorded.

5.8.3.5 Wildfowl

Table 5.6 details flight activity for wildfowl from November 2010 to February 2011.

The only recorded wildfowl from the subject site were 4 Mallard which were recorded in December 2010. Total flight duration for the single recorded bout was 20s, at a height interval of <10m.

In addition to the subject site, visits were also made on a monthly basis to nearby lakes such as Doonogan Lough (2km SW of site), Doo Lough (3km S of site) and Lough Naminna (c.5km SE of site) to check for wintering wildfowl such as Whooper Swans which may have been present in the area.

No wildfowl of note were recorded on any of these visits with only small numbers of species such as Tufted Duck (peak =4), Mallard (peak =3) and Mute Swan recorded at Doo Lough (peak =3.)

5.8.3.6 Other Species of Conservation Concern

No additional species of conservation concern were recorded from the subject site. No Red Grouse were recorded and it is believed the habitat present is too marginal and poorly degraded for potential breeding.

5.9 Assessment of Impacts

5.9.1 Potential Impact on Hen Harrier

Hen Harriers are known to favour nest sites in tall stands of mature heather in upland habitat, or areas of early second-rotation clear fell forestry which border areas of heather moorland (or heather and rough grassland mosaic) (Wilson *et al.* 2009). Whilst there is young conifer plantation within the subject site boundary, only a small amount of what could be classed as heather moorland (in the form of wet heath) is present. This is further degraded in the southern section of the site and is unlikely to attract nesting Harriers as there

large expanses of suitable habitat to the east and north of the subject site. Parts of the subject site containing wet heath and wet grassland may be utilised by foraging Harriers from territories proximal to the subject site.

Ongoing survey work at the subject site, including full Breeding Season Hen Harrier Surveys as per SNH guidelines will provide information into levels of usage of the proposed site for both foraging and breeding.

Consultation with local experts and with Dr. Marc Ruddock of the Northern Ireland Raptor Study Group indicates that the nearest known breeding attempt to the subject site in 2010 was c.2.5km south of the subject site. As typical foraging rates for harriers can be up to 3-4km from the nest site (Arroyo *et al.,* 2006), this clearly puts the subject site within the foraging range of this territory.

In a study of wind farms in the United Kingdom (Pearce-Higgins *et al.,* 2009), hereafter referred to as Pearce-Higgins 2009, it was found that critical distances exist within which birds may be adversely affected by developments such as wind farms. In the case of the Hen Harrier the distance within which breeding bird density seemed to be adversely affected by turbines was 500m whilst it was also found that, in the case of wind farm infrastructure such as tracks there was no significant effect on Hen Harrier distribution due to proximity. As there is no known nest site within 500m of the subject site then we believe that the proposed development will have no significant impact on breeding bird density in the area.

With regard to any potential impact on foraging breeding hen harrier which are nesting outside the subject site, according to research (Arroyo *et al.,* 2006) the maximum foraging range for a breeding male Hen Harrier is between 3 and 4 km, however approximately 75% of foraging occurs within 2km of the nest (the same research reports that females forage almost entirely within 2km of the nest).

One Irish case study which has been published refers to the Derrybrien Wind Farm, Co. Galway (Madden & Porter 2007), which continued to see usage by Hen Harrier post construction. INIS surveyors have also personally observed Hen Harriers utilizing wind farm sites for foraging.

The next potential impact is on non-breeding birds, including juveniles dispersing following fledging and wintering birds. The current study has found usage of the site in November 2010 by a single Harrier- further usage may have been curtailed by the extremely cold conditions prevalent from December 2010 through to January 2011. However this may also be reflective of typical winter usage of the site.

In regard to collision risk, given the fact that the site to date exhibits very low usage by foraging Hen Harrier and also that there has been only one documented case of collision in Ireland (Scott & McHaffie 2008) we believe the chance of collision on this site is low, INIS has compiled numerous CRM models on sites with very high activity which showed no collisions in the 25 year lifetime of the wind farm in every case (INIS Environmental Consultants Ltd. 2008).

5.9.2 Potential impact on Breeding Birds

5.9.2.1 General Breeding Birds

The preliminary breeding bird study carried out in 2010 found only 19 species present, with only 2 species classified as Amber, namely Skylark and Starling.

In the case of Skylark, there is suitable habitat on site for a number of pairs. Pearce-Higgins 2009 found that while some species were significantly affected by wind farms, Skylark is largely unaffected. The following is quoted from same; *"the effects of turbine proximity on skylark were of marginal significance"*. It is therefore thought unlikely that the number of breeding pairs of this species will be affected by development.

Starlings were only recorded flying through the site; however it is likely that birds breed at nearby farm buildings. Meadow Pipits were also recorded in song. However Pearce-Higgins 2009 states that there is little evidence of any effect of wind turbine proximity on passerines. Given the amount of suitable habitat for both these species in the vicinity of the subject site we foresee no significant impact as a result of the proposed development.

5.9.2.2 Barn Owl

Given the low number of potential breeding sites found within the hinterland of the subject site during searches in January 2011, we foresee that the likelihood of breeding Barn Owl being in the area and therefore affected by the proposed development is low. Ongoing studies will provide additional information on occupancy levels of buildings identified as potential nest/roost sites.

5.9.2.3 Red Grouse

No Red Grouse were recorded from the subject site during the preliminary breeding survey in 2010 or the winter survey in 2010/2011. Though small amounts of wet heath are present it is unlikely to attract breeding birds and therefore the only likelihood of occurrence would be of dispersing birds from nearby natal areas.

In the case of Red Grouse, Pearce-Higgins 2009, found no evidence of turbine avoidance by Red Grouse however the study found that the only significant effect of proximity of wind farm infrastructure on Red Grouse distribution was that there was a greater occurrence of Red Grouse (analysed at the large scale) close to tracks. Red Grouse naturally eat available grit to aid in the physical digestion of heather. They regularly pass out grit and replace it on a daily basis. This demand for grit could explain the slightly higher occurrence close to tracks. We believe that the probability of long-term disturbance as a result of the construction of the proposed development on this species is low.

5.9.3 Potential Impact on Wintering Birds

5.9.3.1 Hen Harrier

Due to the low number of recorded flying bouts over the winter period 2010/2011 and total recorded flight time of just 97s we believe that there is no significant impact on hen harrier in the area during this period.

5.9.3.2 Wildfowl

Due to the low frequency of occurrence of any wildfowl species during the winter 2010/2011 season (total flight duration 20s at height interval of <10m) we believe that there is no significant impact on wildfowl as a result of the proposed development.

The low numbers of wildfowl found at surrounding water bodies also support this.

5.9.3.3 Wintering Raptors

The primary species of raptor present during the winter months is the Kestrel. As the total flight duration for this species was only 50s, we foresee no significant impact on this species during the winter period as a result of the proposed development.

5.9.3.4 Barn Owl

No observations were made of Barn Owl during dawn and dusk surveys conducted over the winter months. In addition, a hinterland search found no evidence of occupied sites within 1km of the subject site. Based on these findings we foresee no significant impact during the winter period on this species.

5.9.3.5 Merlin

No Merlin were recorded from the subject site during the dedicated Merlin survey conducted in January 2011. In addition no casual sightings were

obtained from any of the visits between November 2010 and February 2011. We therefore foresee no significant impact on this species during the winter period as a result of the proposed development.

5.10 Mitigation

The overall footprint of the development has been minimised to reduce potential habitat loss. The layout of turbines and access tracks maximise the use of existing tracks in order to minimise habitat loss and disturbance to streams and known breeding areas. Important areas of heath/bog have been protected and the layout minimises loss of habitat that is important to species such as snipe and skylark.

Construction work for the turbines and access roads should be conducted outside the main breeding season (April to July) where possible. Where construction work is required in the breeding season, this should be undertaken following prior consultation with NPWS. Should works need to proceed during the breeding season a breeding bird survey should be conducted for ground nesting species on any area proposed for works and all nests identified and protected.

Construction works will be confined to the least area possible and off-road vehicle activity will be kept to a minimum.

The potential effects and mitigation measures are summarised in the Table 5.10.1. In all cases, provided the mitigation strategies are followed, the residual effects show no significant negative impacts.

Table 5.5 Summary of Potential Effects and Mitigation Measures.

Potential Effect	Mitigation Strategy	Residual Effect
Construction Effects		
Habitat loss	Maximise use of existing tracks for access roads Minimise disturbance to streams, hedgerows and tree lines around site Minimise removal of vegetation Access tracks should follow contours of slopes Avoid disturbance to wet grassland areas onsite. Minimise "footprint" of wind farm and associated infrastructure Implement approved management schemes to benefit birds that use the site throughout the year	No significant negative impacts
Disturbance to birds	Conduct construction outside main breeding season (April to July)	No significant negative impacts
Operational Effects		
Disturbance	Minimise site maintenance visits	No significant negative impacts
Collision risk to birds	Appropriate wind turbine design, considering turbine height, number of turbines and positioning Guy wires on wind anemometers marked with flags or marker-balls Use underground cables	No significant negative impacts
Decommissioning Effects		
Disturbance to mammals	Conduct decommissioning outside main breeding season (April to July)	No significant negative impacts

After construction of the wind farm, the majority of the habitat within the site will remain intact, with the added presence of turbines and associated access roads.

5.11 Conclusions

The results of the 2010/2011 winter survey and the preliminary 2010 breeding season survey indicate that there are likely to be no significant impacts from the proposed development of this site on any birds of conservation concern.

Ongoing surveys following SNH recommended methodologies will further investigate levels of usage by species such as Hen Harrier (during the breeding season), Merlin, Barn Owl and Red Grouse, in addition to an assessment of hinterland usage by Hen Harrier. The results of these surveys shall also be reviewed in the context of recent literature, in particular, Pearce-Higgins 2009.

As part of an environmentally-responsible development scheme, the mitigation measures outlined in the current ES should be undertaken as part of a Construction and Environmental Management Plan (CEMP), including phased construction to avoid on-site works during the bird breeding season.

In conclusion the size and scale of the proposed works and (provisional) low frequency of occurrence of the conservation interest of the SPA (i.e. Hen Harrier), in addition to the implementation of meaningful mitigation measures will ensure that the proposed development will not have any significant impacts affecting the SPA or the conservation interest of the SPA.

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6 LANDSCAPE AND VISUAL

6.1 Introduction

This chapter describes the landscape context of a proposed wind farm at Coor and Shanavogh, County Clare and assesses the likely landscape and visual impacts of the scheme using a semi-quantitative analysis. This analysis is based on scale of magnitude judgements for a set of criteria including landscape sensitivity, the visual presence of the scheme and also its aesthetic impact. Potential cumulative landscape and visual impacts in relation to other existing and permitted wind farms within the Study Area are also addressed.

The key objectives of this chapter are to assess the landscape and visual impacts of the proposed wind farm development at Coor and Shanavogh from a variety of receptor types, viewing angles and viewing distances. The following visual receptors are addressed:

- *Key views* from sites of national or international importance;
- *Designated scenic routes and views* as set out in the relevant Local Authority developments plans;
- *Local community views* taking consideration of those people that live or work in close proximity to the proposed wind farm;
- *Centres of population;*
- *Major routes;*
- *Amenity and heritage features;*

All Photomontages and Zone of theoretical Visibility Maps are presented in Volume IV of the EIS.

6.2 Statement of Authority

This assessment report was prepared by Richard Barker, Senior Landscape Architect, MosArt Landscape Architects, Wicklow. MosArt have extensive

experience at project level and at the level of strategic planning for wind farms in Ireland. A summary of relevant experience is included below:

- Assisted the Department of Environment, Heritage and Local Government (DoEHLG) in drafting the Landscape Section of the revised Wind Energy Development Guidelines (2006);
- Responsible for the landscape section of the national attitude survey to wind farms commissioned by Sustainable Energy Ireland (2003);
- Drafted the DoEHLG Landscape and Landscape Assessment Guidelines (2000);
- Completed a Wind Energy Strategy for Waterford County Council (2004);
- Landscape character and sensitivity classification of County Cork for wind farm planning for Cork County Council (2003);
- Involved in landscape impact assessment of over 80 on-shore wind farm projects;
- Prepared the landscape impact assessment reports for the Arklow Bank, Codling Bank and Oriel offshore wind farm projects; and
- Presented papers at numerous national conferences concerning landscape assessment for strategic planning and also for the planning and design of wind farms.

6.3 Assessment Methodology

Production of this Landscape and Visual Impact Assessment involved desk studies and fieldwork comprising professional evaluation by landscape consultants. This entailed the following, reflecting the format of this report:

- Establishing a Study Area to reflect the potential visibility of the proposed development;
- Preparation of a Zone of Theoretical Visibility (ZTV) map to indicate areas from which the development is potentially visible in relation to terrain within the Study Area;

- Selection of potential Viewshed Reference Points (VRP) to be investigated during fieldwork for actual visibility and sensitivity (VRP's are the representative locations used as the basis for the landscape and visual assessment);
- Preparation of a VRP Selection Report to provide justification for the inclusion or exclusion of potential VRP's and to guide the visualisation specialist with regard to image capture for photomontages. The VRP Seklection Report was finalised in consultation with Clare County Council to ensure VRP where selected following the considerations of the Local Authority;
- Description of proposed development and ancillary/ associated structures;
- Description of the geographic location and landscape context of the proposed wind farm site;
- General landscape description concerning essential 'Landscape Character' and salient features of the Study Area, discussed with respect to landform, vegetation, land use and structures;
- Consideration of design guidance, the planning context and relevant landscape designations.
- Semi-quantitative assessment of landscape sensitivity;
- Detailed assessment of photomontages produced by Macroworks Ltd;
- Estimation of the likely degree of impact on landscape; and
- Recommendation of mitigation measures where appropriate and possible.

6.4 Description of Proposed Development

The developer proposes to locate a wind farm in the foothills of the Slievecallan Uplands, approximately 6km to the southeast of Miltown Malbay in County Clare. It is proposed that the development comprise of the following main elements:

- Six turbines at 85m hub height; 82m rotor diameter; 126m overall height to tip;
- Substation compound and associated areas of hard standing;
- Access tracks – 5m wide; and
- Underground electric cabling.

6.5 Existing Environment

6.5.1 Definition of Study Area

The Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government specify different radii for examining the zone of theoretical visibility of proposed wind farm projects (ZTV). The extent of this search area is influenced by turbine height, on the basis that taller turbines would be visible at greater distances, as follows:

- 15km radius for blade tips up to 100m; and
- 20km radius for blade tips greater than 100m.

In the case of this project, the blade tips are 126m high and, thus, the ZTV radius required is 20km. This 20km radius, therefore, defines the extent of the Study Area for this project.

6.5.2 Description of Landscape Context

A description of the landscape encompassing the context of the proposed wind farm site is provided below under the headings of landform and drainage, vegetation and land use, centres of population and houses, transport routes and public amenities and facilities. The selection of Viewshed Reference Points (VRP's) for assessment purposes (see section 6.7.2) is largely determined by their relevance and association with the features described below. Additional descriptions of the landscape are also provided later under the detailed assessments.

6.5.2.1 Landform and Drainage

The proposed site is located within the western foothills of the Slievecallan Uplands in County Clare. The Slievecallan Uplands divide the central Study Area in two, rising between the coast and the River Shannon in a northwest – southeast direction. Slievecallan itself is the highest point in the Study Area at 391m a.s.l. and rises immediately to the northeast of the proposal site. The eastern portion of the Study Area comprises of drumlin terrain, interspersed with occasional small lakes and winding watercourses. To the west a more planar strip of terrain occupies the area between the Slievecallan Uplands and the coast. The Inagh/ Cullenagh River drains the northern half of the Study Area as it flows in a northwesterly direction towards Liscannor Bay. This is fed by several smaller tributaries, which run southwesterly before joining with the Inagh River at Ennistimon and Liscannor Bay. There are also a number of other smaller rivers spread across the coastal plains that drain directly from the Slievecallan Uplands to the sea. In the northern section of the Study Area the landform rises gently before dropping dramatically to the Atlantic Ocean at the Cliffs of Moher.

6.5.2.2 Vegetation and Land Use

The lowland landscape of the Study Area is largely in pasture with the fields lined by low windblown hedgerows and stone walls. This landscape is fringed with a narrow dune complex as it meets with the Atlantic Ocean. On the upper slopes of the Slievecallan Uplands there are broad areas of marginal farmland, moorland and coniferous forestry. Within this zone a natural succession of native and naturalized plants is visible where previously fields would have been grazed for pasture. Further rough pasture exists towards the northern limit of the Study Area where the land slopes gently inland from the Cliffs of Moher.

6.5.2.3 Centres of Population and Houses

The largest settlement contained within the Study Area is Lahinch in County Clare. This is located some 13km to the north of the proposed site where the Inagh River meets Liscannor Bay. Approximately three kilometers inland from

Lahinch is the Town of Ennistimon and approximately two kilometers to the northwest of Lahinch is the coastal settlement of Liscannor. Closer and to the east of the proposed development site are the settlements of Milltown Malbay and Spanish Point at distances of five and six kilometers respectively. The coastal village of Doonbeg occurs 15km to the southwest of the site. The remaining centers of population contained within the Study Area are fairly small crossroad settlements, the most substantial of which tend to occur to the southwest of the site. These include Creegh, Cooraclare and Kilmihil. Otherwise the area around the site has a dispersed population that includes holiday homes, rural dwellings and farmsteads. In the immediate vicinity of the site and throughout the Slievecallan Uplands there is a noticeably less frequent distribution of houses.

6.5.2.4 Transport Routes

The principle transport route contained within the Study Area is the N67 national secondary road, which runs in a north easterly direction along the coast from Doonbeg to Lahinch before turning inland towards Ennistimon, where it carries on in a northerly direction. The N85 national secondary route, which connects Lahinch and Ennis also crosses the Study Area, however, this road is not contained within ZTV coverage. The N68 national secondary route also enters the Study Area as it joins the towns of Kilrush and Ennis running in a north easterly direction. This road is also not contained within ZTV coverage.

Five Regional Routes emanate from within, or cross, the Study Area. These include; the R478 which follows a north-south course and runs parallel to the Cliffs of Moher; the R474, which runs between Miltown Malbay and Ennis; the R460, which connects the villages of Inagh and Miltown Malbay; the R484, which connects the settlement of Creagh with the N68; the R483 which connects the settlements of Kilrush and Creagh and; the R482 as it follows the headland at Spanish Point. The nearest of these to the site is the R474, which passes approximately 1.5km to the north at its nearest point.

6.5.2.5 Public Amenities and Facilities

The principle public amenities contained within the Study Area are the beaches of County Clare particularly at Doonbeg and Doughmore bay, the beaches at Spanish Point and also the beach at Lahinch. These beaches and associated surf breaks are key attractions in the local and national landscape. With respect to the surfing breaks, this stretch of coastline has recently begun to attract significant international interest owing to the size and quality of the waves. Due to the location of the narrow coastal dune system inland from the beaches many of the views towards the proposed development will be obscured.

The Cliffs of Moher are a significant tourist attraction within the curtilage of the Study Area and are located to the north of the site, although the cliffs themselves are not within ZTV coverage the approach roads and immediate context are.

The Burren Way is a 123km walking route that begins at Lahinch in County Clare and sweeps to the north and west before turning east inland towards Corofin. In the immediate vicinity of the cliffs of Moher a 2.5km section of this waymarked route is within the ZTV. The Mid Clare Way is another waymarked walking route contained within the Study Area. It passes in and out of the eastern portion of the Study Area and remains to the east of the Slievecallan Uplands.

The Golf Club at Doonbeg is a significant amenity feature within the Study Area and is located approximately 11km to the south west of the proposed development. This course was designed by Greg Norman and opened in 2002. This club also includes a five star hotel, spa and self catering accommodation.

The West Clare Cycleway is a 70km long cycle route that stretches from the Shannon estuary to the town of Lahinch. This route largely follows the Clare coastline and traverses the Study Area in a northerly direction.

6.6 Design Guidance and Planning Context

6.6.1 Department of the Environment, Heritage and Local Government Wind Energy Development Guidelines (2006)

The Wind Energy Development Guidelines (2006) published by the Department of the Environment, Heritage and Local Government are supportive of Government Policy on Renewable Energy. The current guidelines are thus much more proactive regarding wind farms in the landscape than the previous 1996 guidelines. The current document does not preclude wind farm development at any particular location or within certain landscape types. Instead, it provides a basis for Local Authorities in preparing policies with respect to wind farm development as well as siting and design guidance for developers. Under these guidelines the site may be characterised by a combination of two landscape specific landscape types. Considering that the proposed wind farm site comprises of characteristics of both a "Transitional Marginal Landscape" and a "Mountain Moorland" landscape, design guidance from both of these character types will be examined in respect of this proposed wind farm.

6.6.1.1 Location

Transitional Marginal Landscapes

"In these situations it is important to minimize visual confusion such as the crossing by blade sets of skylines, buildings, utility lines and varied landcover".

Mountain Moorland

"An acceptable location is lower down on sweeping mountainsides"

6.6.1.2 Spatial extent

Transitional Marginal Landscapes

"Wind energy developments in these landscapes should be relatively small in terms of spatial extent".

Mountain Moorland

"The spatial extent of a wind energy development would need to be reduced where a suggestion of smaller scale is provided by nearby landscape features".

6.6.1.3 Spacing

Transitional Marginal Landscapes

"Irregular spacing is likely to be most appropriate, given the complexity of landform and land cover typical of these landscapes".

Mountain Moorland

"All spacing options are usually acceptable".

6.6.1.4 Layout

Transitional Marginal Landscapes

Wind energy developments on broader hilltops "could be linear or clustered".

Mountain Moorland

"Where a wind energy development is close to a linear element, such as a river, road or long escarpment, a corresponding linear layout or staggered line might be most desirable".

6.6.1.5 Height

Transitional Marginal Landscapes

"Where the upper ground is relatively open and visually extensive, taller turbines may be more appropriate"

Mountain Moorland

"There would generally be no height restrictions on mountain moorlands as the scale of landscape is so great".

6.6.1.6 Cumulative Effect

Transitional Marginal Landscapes

"This would have to be evaluated on a case by case basis, but great caution should be exercised".

Mountain Moorland

"The open expanse of such landscapes can absorb a number of wind energy developments, depending on their proximity".

6.6.2 County Development Plans

6.6.2.1 Clare County Development Plan (2005 – 2011)

A number of scenic routes are identified in Appendix 9 of this Development Plan and shown on the relevant maps. Scenic Route 15 (R474 from Connolly to Milltown Malbay) is the most relevant to this proposal skirting just to the north of the site. Scenic Route 1 (Coast Road from County Boundary to Quilty) also affords potential views of the development albeit from a considerable distance to the north of the site.

As the current Clare County Development Plan is due to be replaced during this year a draft version of the 2011 – 2017 Development Plan is currently being prepared. The current development plan does incorporate a 'Landscape Appraisal' document and broad wind energy objectives for the County. The former is a classification of landscape types and their inherent sensitivities to development, thus providing a framework for the latter. However, the Clare County Development Plan for the period 2005 – 2011 has been appended with "Variation Two" that includes a separate Wind Energy Strategy. Broad policy guidelines that are outlined in Chapter 5, state that "It is the policy of the Planning Authority to seek the development of wind energy infrastructure sufficient for the production of 50MW of electricity by the year 2010 through the identification of suitable areas", and that the Planning Authority "wishes to see the sustainable exploitation of those natural resources where it is for the benefit of the county, country and globally".

6.6.2.1.1 Variation No. 2 (Wind Energy Strategy) to the Clare County Development Plan 2005 – 2011

Variation No.2 to the Clare County Development Plan 2005 – 2011 includes the current wind energy strategy which was completed during 2009. A key priority, of the Plan "given the wind resource in County Clare, is to identify sites, of strategic, national and regional importance, that have the potential to accommodate wind energy development". The map in Figure E graphically identifies "Strategic Wind Farm Development Areas" within the County. Also identified on the same map are areas that are "Acceptable in Principle", areas that are "Open to Consideration" and areas that are "Not Normally Permissible". The location of the proposed wind farm development occurs within an area identified as "Acceptable in Principle".

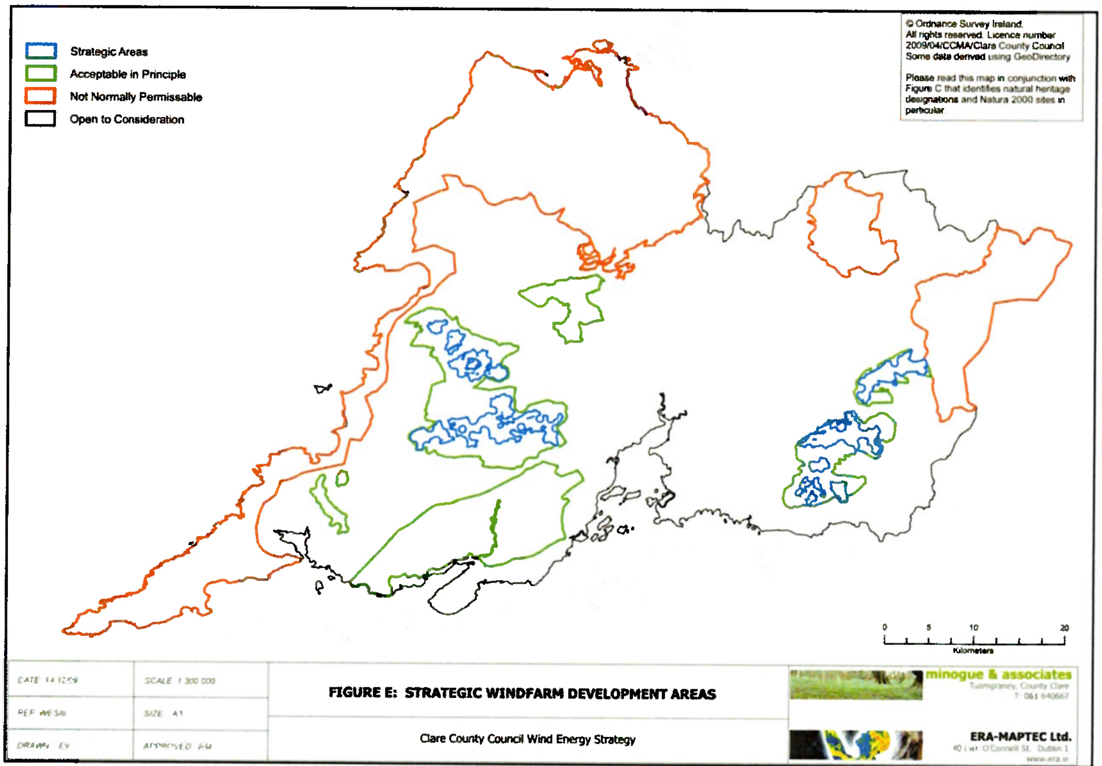

Figure 6.1 Wind Energy Strategy map – Clare County Development Plan 2005 – 2011.

The basis for these determinations is explained in "Section Four: Advice on Landscape Capacity for Wind energy developments based on Landscape Character Areas (LCAs)" and are further detailed in Annex C of the Wind Energy Strategy. These sections provide guidance on the capacity of landscapes in the County "in terms of key landscape and visual characteristics and features" with regard to overall sensitivity to wind farm developments and include a capacity assessment of the landscape under consideration. According to this classification "The rolling hills, low settlement, extensive plantations reduce the overall sensitivity of this LCA to Wind Farm development. The area could accommodate large or medium wind farms subject to careful siting to avoid significant impacts on skylines". Regarding medium sized wind farm developments Chapter 4 identifies medium sized wind farms as having between 5 and 11 turbines which is in accord with the 6 turbines currently being proposed.

The Clare County Development Plan (2005 – 2011) includes a Wind Energy Strategy as part of variation number 2.

6.6.2.2 Draft Clare County Development Plan (2011 – 2017)

The same scenic routes appear to have been carried over from the previous 2005 County Development Plan. Again, Scenic Route 15 (R474 from Connolly to Milltown Malbay) and Scenic Route 1 (Coast Road from County Boundary to Quilty) remain the most relevant to this proposal.

The new "Draft Clare County Development Plan (2011 – 2017) includes a revised Draft Wind Energy Strategy as part of Section 5. The content of this Draft Strategy has not altered significantly from the current "Wind Energy Strategy" particularly with regard to the "Wind Energy Designations" map included as part of Chapter 8 Annex C. This map also classifies the proposed site as within an area where such proposals are "Acceptable in Principle", based on similar criteria to those already outlined in the current "Clare County Development Plan (2005 – 2011)".

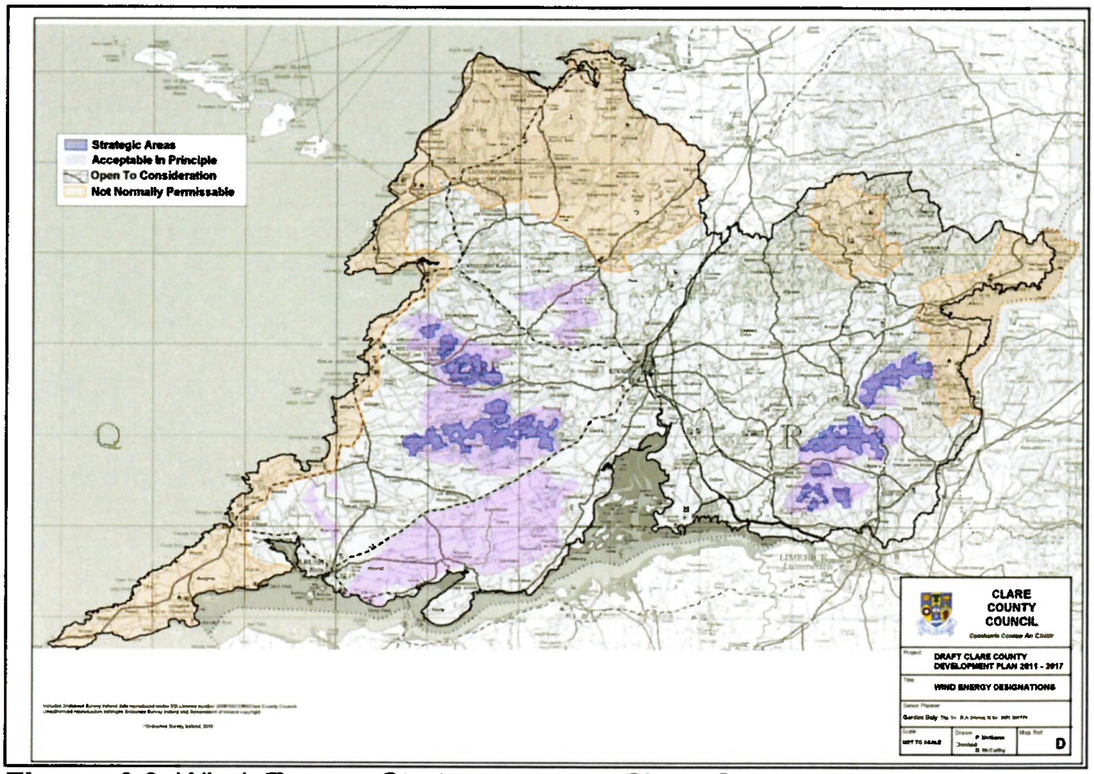

Figure 6.2 Wind Energy Strategy map – Clare County Development Plan 2005 – 2011

6.7 Landscape Analysis

6.7.1 Zone of Theoretical Visibility (ZTV)

Macroworks Ltd. carried out a computer automated study of the zone of theoretical visibility (ZTVs are given in EIS Volume IV). The purpose of this exercise is to identify the 'theoretical' extent and degree of visibility of turbines. This is a theoretical exercise because it is based on topography only at 10m contour intervals and does not allow for intermittent screening provided by, for example, hedgerows, forests or buildings and does not involve the actual height of crests (but using the nearest 10m contour below). Thus the ZTV map, assuming no screening, represents a worse than 'worse-case-scenario' with respect to viewing exposure. For the purposes of this project a radius of 20km was used for the ZTV as discussed earlier. A cumulative ZTV was also prepared, which indicates the intervisibility of other existing and permitted wind farms in conjunction with proposed scheme.

The following key points should be noted from the ZTV studies:

- The ZTV map indicates that the proposed wind farm will not be seen from the majority of the eastern half of the Study Area beyond the Slievecallan Uplands due to the screening effect of this landscape feature.
- The ZTV pattern covering much of the western half of the Study Area is fairly comprehensive indicating that this is a flat or only mildly undulating landscape that offers little in the way of terrain screening of the proposal.
- The ZTV map indicates that the beaches of Clare have a very limited view of the proposed scheme due to the immediate screening of the coastal dunes.
- The cumulative ZTV map indicates that there are no locations within the Study Area that would have a view of only the proposed Coor Wind Farm and no other wind farms.
- Only 15% of the Study Area has no theoretical view of any of the proposed, permitted or existing wind farms contained within the Study Area.
- 39% of the Study Area, predominantly within the coastal plains to the west of the Slievecallan uplands, would have a view of the proposed scheme in conjunction with other existing and permitted wind farms.

6.7.2 Identification of Viewshed Reference Points as a Basis for Assessment

The results of the ZTV analysis provide the basis for selection of Viewshed Reference Points (VRP's), which are the locations used to study the landscape and visual impact of the proposed wind farm in detail. It is not warranted to include each and every single location that provides a view of this development as this would result in an unwieldy report and make it extremely difficult to draw out the key impacts arising from the project. Instead, the assessors endeavoured to select a variety of location types that would provide views of the proposed wind farm from different distances, different angles and

different contexts. This involves desk study analysis using the ZTV map and fieldwork to establish likely visibility and the relative sensitivity of the VRP locations as well as the grid coordinates of positions from which photomontages can be prepared.

The impact of the proposed development upon landscape is assessed using 6 distinct categories of receptor type as listed below;

- **Key Views -** from features of national or regional importance;
- **Designated Scenic Routes and Views;**
- **Local Community views;**
- **Centres of Population;**
- **Major Routes; and**
- **Amenity and Heritage Features.**

In the interests of providing a clear and concise report that focuses on the fundamental landscape and visual issues of the proposal, the VRP's will be grouped for assessment in relation to the above receptor types. Where a VRP might have been initially selected for more than one reason it will be assessed according to the primary criteria for which it was chosen, or alternatively, considered as a 'key view' due to its increased relevance. The characteristics of each VRP receptor type are described below. The MacroWorks Ltd., VRP photomontages and visibility maps are available for viewing in EIS Volume IV.

6.7.2.1 Key Views

These VRP's are at features or locations that are significant at the regional or national or even international level, typically in terms of heritage, recreation or tourism. They are locations that attract a significant number of viewers who are likely to be in a reflective or recreational frame of mind possibly increasing their appreciation of the landscape around them. The location of this receptor type is usually quite specific. A VRP may also be placed in the key view category if it is applicable to several selection criteria and likely to be a pivotal view in the context of the assessment.

6.7.2.2 Designated Scenic Routes and Views

Due to their identification in the County Development Plan this type of VRP location represents a general policy consensus on locations of high scenic value within the Study Area. These are commonly elevated, long distance, panoramic views and may or may not be mapped from precise locations. They are more likely to be experienced by static viewers than the previous category as people are more inclined to stop and take in such vistas. Views from important walking routes or canals are included within this category as they are likely to be of high scenic value and are experienced at low speeds unlike the Major Routes category.

6.7.2.3 Local Community Views

This type of VRP represents those people that live and/ or work in the locality of the wind farm, usually within a 5km radius of the site. Although the VRP's are generally located on local level roads they also represent similar views that may be available from adjacent houses. The precise location of this VRP type is not critical, however, clear elevated views are preferred, particularly when closely associated with a cluster of houses. Coverage of a range of viewing angles using several VRP's is necessary in order to sample the spectrum of views that would be available from surrounding dwellings.

6.7.2.4 Centres of Population

VRP's are selected at centres of population primarily due to the number of viewers that are likely to experience that view. The relevance of the settlement is based on the significance of its size in terms of the Study Area or its proximity to the site. The VRP may be selected from any location in the public domain that provides a clear view either within the settlement or in close proximity to it.

6.7.2.5 Major Routes

These include national and regional level roads and rail lines and are relevant VRP locations due to the number of viewers potentially impacted by the proposed development. The precise location of this category of VRP is not

critical and might be chosen anywhere along the route that provides clear views towards the proposal site, but with a preference towards close and/ or elevated views. Major routes typically provide views experienced whilst in motion and these may be fleeting and intermittent depending on screening by intervening vegetation or buildings.

6.7.2.6 Amenity and Heritage Features

These views are often one and the same given that heritage locations are often important tourist and visitor destinations and amenity areas or walking routes are commonly designed to incorporate heritage features. Such locations or routes tend to be sensitive to development within the landscape as viewers are likely to be in a receptive frame of mind with respect to the landscape around them. The sensitivity of this type of visual receptor is strongly related to the number of visitors they might attract and, in the case of heritage features, whether these are discerning experts or lay tourists. Sensitivity is also heavily influenced by the experience of the viewer at a heritage site as distinct from simply the view of it. This is a complex phenomenon that is likely to be different for every site. Experiential considerations might relate to the sequential approach to a castle from the car park or the view from a hilltop monument reached after a demanding climb. It might also relate to the influence of contemporary features within a key view and whether these detract from a sense of past times. It must also be noted that the sensitivity rating attributed to a heritage feature for the purposes of a landscape and visual assessment is not synonymous with its importance to the Archaeological or Architectural Heritage record.

6.7.3 Final VRP Set

Having undertaken the desk study and field work stages of VRP selection MosArt prepared a VRP Selection Report. This report provides a rationale for the VRP's that are to be used for assessment purposes. Importantly, it also provides a rationale for why some of the initially selected VRP locations will not be used, usually for reasons of poor visibility in the direction the proposed scheme. This report was used in pre-planning discussions with Clare County

Council Planning Authority, the original VRP selection document used for consultation with the Council is provided in Appendix 5, EIS Volume V. Outline agreement was reached as to the location and number of VRP's to be used in the landscape and visual assessment. In this instance Clare County Council elected to refine the VRP set from 17 down to 11 VRP's for the final assessment. These are outlined in Table 1 below.

Table 6.1 Outline Description of Viewshed Reference Points (VRP).

KEY VIEWS		
No Key Views have been included for assessment with regard to this development. It should be noted that the 'Cliffs of Moher' definitely fall within the 'Key View' definition, however, there is no intervisibility between the proposed wind farm and this iconic natural feature. A proposed VRP location at the car park for the Cliffs of Moher was considered unnecessary by Clare County Council, presumably because of the likely Imperceptible nature of any impacts on this distant location.		
DESIGNATED ROUTES AND VIEWS		
VRP No.	Location	Direction of view
DR1	R474 at Drehidenagh	S
LOCAL COMMUNITY VIEWS		
VRP No.	Location	Direction of view
LC1	Local Road to north west of site	SE
LC2	Local Road at Coor	N
LC3	Mullagh village	NE
CENTRES OF POPULATION		
VRP No.	Location	Direction of view
CP1	Milltown Malbay	SE
CP2	Spanish Point	SE
CP3	Quilty	E

MAJOR ROUTES		
VRP No.	Location	Direction of view

MR1	N67 at Craggaknock	NE
MR2	N68 at Knockaderren	N
	AMENITY AND HERITAGE FEATURES	
VRP No.	Location	Direction of view
AF1	Doonbeg Golf Club	NE
AF2	Killard Beach west of Doonbeg	NE

6.8 Estimation of Impact on Landscape from VRPs

This part of the study is concerned with a detailed assessment of the impact of the proposed development on the landscape. This comprises the production of photomontages or visual simulations of the proposal as viewed from the VRPs as well as an estimation of the impact from each one.
Estimation of landscape and visual impacts is reached using both quantitative and qualitative factors. It comprises four parts, as follows:

- Landscape sensitivity of each VRP location;
- Visual presence of the wind farm;
- Aesthetic impact of the wind farm on its landscape context; and
- Significance of the impact.

These factors are explained in outline below.

6.8.1 Sensitivity of VRP's

Sensitivity in this study is concerned with the acceptability of change to the landscape in respect of various attributes and features to which values might be attached for both the landscape itself and the people who view and/ or use it. Values might be due, for instance, to the attractiveness, use and/or importance of these attributes and features in the public mind. The Study Area is assessed for sensitivity of the context of specific VRP locations, taking into account views of the surrounding landscape. The evaluation is based on

common sense, observation and professional knowledge. Sensitivity plays a major part in the later determination of the significance of impact.

A five-point scale is used by landscape consultants to indicate the degree of landscape sensitivity of VRP's from Very Low, Low, Medium, High and Very High. This process is similar to that proposed by the Department of the Environment and Local Government in their Landscape Guidelines issued for consultation (Anon., 2000). This exercise is important as an indication of the relative sensitivity of a location. No systematic aggregation of the results for the different criteria is used to indicate sensitivity.

The criteria used by MosArt to estimate the sensitivity of VRPs include those listed below (no relative importance is inferred by the order of listing):

- Intensity of use, popularity (number of viewers);
- Likely mental disposition of viewers (eg. commuters hurriedly driving on busy national route versus golfers enjoying panoramic views in a leisure mode);
- Recreational facility;
- Provision of elevated panoramic views;
- Sense of remoteness and/or tranquillity;
- Presence of water (river, lake, sea);
- Mountains present;
- Ruggedness of landform / exposure of rock outcrops;
- Degree of perceived naturalness;
- Presence of striking or noteworthy features (distinctiveness and memorability);
- Historical, cultural and / or spiritual significance evident or sensed;
- Rarity or uniqueness (including noteworthy representativeness of a landscape type);
- Integrity of character (condition / intactness);
- Sense of place (special sense of wholeness and harmony); and
- Sense of awe.

Those locations which are deemed to satisfy many of the above criteria (for example, popular recreational places providing distinctive and highly memorable views from elevated positions involving say, rugged mountains and water, wild and remote in character) tend to be higher in terms of sensitivity than those which do not (eg. non-recreational areas of strongly anthropogenic character without striking features and no sense of place). MosArt considered each of the above criteria at every VRP and this is addressed under the 'Character and Sensitivity of the Existing Landscape' section for each VRP receptor type.

A five-point scale is typically used by landscape consultants to indicate the degree of landscape sensitivity of VRPs as shown below. This process is similar to that proposed by the Department of the Environment and Local Government in their Landscape and Landscape Assessment Draft Guidelines (2000). This exercise is important as an indication of the relative sensitivity of a location.

Very Low	Low	Medium	High	Very High

6.8.2 Visual Presence of the Wind Turbines

This concerns how visually dominant the wind turbine is on the landscape and is synonymous with the concept of magnitude. Note that a strong visual presence is not synonymous with adverse impact. It is assessed using the following five-point scale:

Minimal	Sub-dominant	Co-dominant	Dominant	Highly dominant

6.8.3 Aesthetic Impact of the Wind Turbines on the Landscape

This concerns the aesthetic relationship of the wind turbines to their context and whether it results in a negative or positive change. The aesthetic impact of wind turbines will be classified from each of the selected VRPs using the following seven-point scale:

Positive				Adverse		
Major	Moderate	Minor	Neutral	Minor	Moderate	Major

6.8.4 Significance of Impact

The significance of the impact of the development is determined by the following:

- Sensitivity of VRPs, as previously estimated; and
- Visual presence of the wind turbine, as previously estimated.
- Aesthetic impact on the landscape, as previously estimated;

Significance of impact is summarised on the following scale:

Level of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences
Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate	An impact that changes the character of the environment in a manner that is consistent with existing and emerging trends.
Significant	An impact, which by its character, magnitude duration or intensity alters a sensitive aspect of the environment
Profound	An impact which obliterates sensitive characteristics

The method for assessing the development involves a description of the views and an estimation of landscape sensitivity. This is followed by an evaluation of

the visual presence and the landscape aesthetic impact of the proposed wind farm and, finally, an estimation of the significance of impact.

6.8.5 Cumulative Effect

There are ten other existing or permitted wind farms within the 20km radius Study Area of the Coor wind farm. The majority of these are contained within the Slievecallan uplands to the southeast of the proposal site and the remainder are in the extreme southwest of the Study Area. These schemes are summarised in the table below and a cumulative impact assessment is provided under section 10.14 using the same impact scale as for 'significance of impact';

Table 6.2 Other Existing or permitted Wind Farms within the Study Area.

Wind Farm name	Status	Number of turbines	Approximate location in relation to the proposed Coor Wind Farm
Booltiagh	Existing	13	8km southeast
Booltiagh Extension	Permitted	6	8km southeast
West Clare Renewables	Permitted	30	1km northeast
Boolynagleragh	Permitted	9	13km southeast
Glenmore	Permitted	14	9km southeast
Gortaheera	Permitted	6	5km south
High Street	Permitted	5	11km southeast
Kiltumper	Permitted	2	9km south
Tullabrack	Existing	6	18km southwest
Moanmore	Existing	7	19km southwest

6.9 Designated Scenic Routes and Views

Applicable VRP's:		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR1	R474 at Drehidenagh	S	14km	6

6.9.1 Character and Sensitivity of the Existing Views

This is an elevated and broadly panoramic southerly view from near the base of Slievecallan. The view afforded is over a mildly undulating landscape of pastoral farmland interspersed with occasional farmsteads. Although a pattern of hedgerows is apparent many of the field boundaries are formed by low dry stone walls and overall the character of the landscape is fairly open. In terms of sensitivity this VRP is located on a relatively busy regional level road that is also designated as a scenic route in the County Development Plan due to the relatively extensive nature of the views from it. For these reasons the sensitivity of DR1 is deemed to be **High**.

6.2.2 Impact Assessment

6.9.2.1 Visual Presence

In such close proximity to the wind farm the turbines would become the defining element of the view and they also occupy a considerable portion of the available vista. Although the scheme is oblique to the road this route is designated in terms of the scenic views it affords. A viewers attention is, therefore, likely to be drawn across the wider landscape, within which, the wind farm draws immediate attention. For these reasons the visual presence of the development from DR1 is deemed to be **Dominant**.

6.2.2.2 Aesthetic Impact

In compositional terms the proposed wind farm is well displayed at this location. The turbines are all seen fully in silhouette above the near horizon with a generous and relatively even spacing. The profile of the scheme also

reflects the underlying ridge and the flat nature of the planar landscape beyond. Even though this is a designated view the turbines are not considered to unduly detract from the character of this working rural landscape. They also do not obstruct or intrude on the view of any particularly sensitive landscape features or aspects of this vista. Overall it is considered that the aesthetic impact of the scheme at DR1 is **Minor Adverse**.

6.9.2.3 Significance of Impact

Both the landscape sensitivity of DR1 and the visual presence of the proposed Coor Wind Farm when viewed from here are in the higher order of magnitude. The aesthetic impact of the scheme on the other hand is in the lower order of magnitude. On balance therefore the significance of impact is deemed to be **Moderate** at **DR1**.

Summary Impact Table

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
DR1	R474 at Drehidenagh	High	Dominant	Minor Adverse	Moderate

6.10 Local Community Views

Applicable VRP's:		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC1	Local Road to northwest of site	SE	2.7km	6
LC2	LC2 Local Road at Coor	N	0.4km	6
LC3	LC4 Mullagh Village	NE	5.7km	6

6.10.1 Character and Sensitivity of the Existing Views

All of these Local Community views afford slightly elevated and broadly panoramic vistas across the mildly undulating landscape that lies between the Slievecallan uplands and the sea. This is a rural landscape of both good and marginal pasture. The geometric fields are defined by dry stone walls and low windswept hedgerows and hence the landscape has a very open character. Slievecallan itself is a prominent landform in this otherwise planar landscape. This is a relatively unique landscape and thus it has a distinct sense of place along with an integrity of character and a sense of tranquillity. The views afforded are also vast in their extent. The area is, however, sparsely populated and these VRP's are all located on minor local roads. On balance of these reasons the sensitivity rating of LC1, LC2 and LC3 is deemed to be **Medium**.

6.10.2 Impact Assessment

6.10.2.1 Visual Presence

From LC1 the turbines are seen at a noticeable scale just to the right hand side of Slievecallan and together these features would draw the eye in this fairly flat landscape. Counteracting this somewhat is the vast nature of the vista in all directions and the fact that the proposed turbines would only occupy a small portion of this vista. As a result the visual presence of the scheme at **LC1** is considered to be **Co-Dominant**.

LC2 is the closest of all of the VRP's to the proposed Wind Farm and as such the turbines are seen at a considerable scale. The scheme also stretches

across much of the northerly vista due to its close proximity. Even within the context of the long distance, 360° vista afforded from here the proposed wind farm is considered to be **Highly Dominant**.

The proposed turbines are seen at a much smaller scale from LC3 than they are from either LC1 or LC2. Although they are seen in the context of a very broad and long distance vista their close lateral association with the prominent form of Slievecallan makes them more noticeable than they might otherwise be. On balance the visual presence of the wind farm at **LC3** is deemed to be **Sub-Dominant**.

6.10.2.2 Aesthetic Impact

From the precise location of LC1 the turbines are positioned directly above a cluster of rural dwellings and sheds, which causes a degree of visual clutter in this section of the view. Other than this the turbines have a fairly harmonious composition. They are viewed almost fully in silhouette above the skyline with an even profile that reflects the underlying terrain. The turbines are also evenly spaced and avoid overlapping with each other for the most part. For these reasons the aesthetic impact at **LC1** is considered to be **Minor Adverse**.

At LC2 the turbines are seen at a dramatic scale in a fairly random linear layout and with a degree of perspective between the nearest and furthest turbines. Although this is a rural zone it has the open and expansive character of an upland landscape and thus the large scale of the turbines is not inappropriate. There are also few dwellings within close proximity to the scheme that might be visually dominated by the turbines. The wind farm does intrude on the view of Slievecallan, which is a locally prominent landscape feature, but overall the aesthetic impact is deemed to be **Minor Adverse** at **LC2**.

From LC3 the lower halves of the turbines are seen against a backdrop of terrain and the upper halves against the sky. This is not detraction in itself but the blades will rotate against the skyline and when passing across the

contrasting tones of the backdrop and this may cause a degree of visual confusion. There are also two instances of turbine overlap, which add to visual clutter and confusion. These effects are diluted somewhat by the fact that there are only six turbines and this is a reasonable viewing distance. Overall it is considered that the aesthetic impact is **Minor Adverse** at **LC3**.

6.10.2.3 Significance of Impact

For LC1 and LC3 the mid to lower order judgements across all three assessment criteria are deemed to result in a Slight significance of impact. For LC2 the Highly Dominant visual presence of the scheme is considered to lift the significance of impact judgement to Moderate despite it having the same level of sensitivity and aesthetic impact as for the other two locations.

Summary Impact Table

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
LC1	Local Road to northwest of site	Medium	Co-Dominant	Minor Adverse	Slight
LC2	LC2 Local Road at Coor	Medium	Highly Dominant	Minor Adverse	Moderate
LC3	LC4 Mullagh Village	Medium	Sub-Dominant	Minor Adverse	Slight

6.11 Centres of Population

Applicable VRP's:		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP1	Milltown Malbay	SE	6.4	6
CP2	Spanish Point	SE	7.5	6
CP3	Quilty	E	8.2	6

6.11.1 Character and Sensitivity of the Existing Views

The settlements subject of this VRP set are all located in close proximity to each other on, or near, the coast to the northwest of the proposal site. The zone between the coast and the Slievecallan uplands is a vast planar landscape of marginal farmland and this is typified in each of these views. Indeed, the farmland in such close proximity to the coast is perhaps more marginal than further inland and the hedgerows are lower and more windswept. Clusters of houses, many of which are holiday homes, can be seen from each of these locations, which tend to be at the outskirts of the settlements in question in the interests of obtaining an unobstructed view. The mixture of landuses at these locations results in a relatively low integrity of landscape character. These VRP locations are not elevated above the surrounding landscape, but nonetheless, the inland views are broadly panoramic and relatively long distance. When coupled with the number of receptors represented by these Centre of Population VRP's as well as their coastal locations the sensitivity of **CP1, CP2 and CP3** is deemed to be **Medium**.

6.11.2 Impact Assessment

6.11.2.1 Visual Presence

Given the similar viewing distances and landscape contexts of each of these VRP's, the turbines are seen at a comparable scale. They are also seen within broad panoramic vistas with relatively complex foregrounds. The lateral extent of the scheme appears somewhat reduced from CP3 as the six turbines are seen in two overlapped clusters. They are also seen at a slightly smaller scale as this VRP is marginally further away from the wind farm than CP1 and CP2. The tangling of the blade sets at CP3 will be fairly eye catching and as such the scheme is likely to be as noticeable from CP3 as it is from CP1 and CP2. The level of visual presence from all of these locations is deemed to be **Sub-Dominant**.

6.11.2.2 Aesthetic Impact

At CP1 and CP2 the turbines are seen fully in silhouette above the horizon in an uncomplicated arrangement of relatively even spacing and with a flat profile. There is a minor degree of visual clutter generated between the proposed scheme and intervening utility poles in both cases. There is also an instance of turbine overlap when viewed from CP2. These are not critical aesthetic issues and overall the aesthetic impact is deemed to be **Minor Adverse** from **CP1 and CP2**.

As mentioned above, the six turbine wind farm is seen as two heavily overlapped clusters when viewed from CP3. This would generate a tangle of rotating turbine blades and cause visual clutter and confusion, which is further exacerbated by intervening utility poles that overlap with the scheme in perspective. The turbines blades do at least avoid cutting against any ridgelines or other landscape features and another ameliorating factor is the considerable viewing distance. For these reasons the aesthetic impact at **CP3** is considered to be **Moderate Adverse**.

6.11.2.3 Significance of Impact

The landscape sensitivity of each of these Centre of Population VRP's is deemed to be Medium and the proposed wind farm is considered to have a Sub-Dominant visual presence from all of them. The aesthetic impact of the scheme from CP1 and CP2 is considered to be Minor Adverse and as a result of this set of judgements the significance of impact is deemed to be Slight at both of these locations. As the aesthetic impact is Moderate Adverse at CP3 the significance of impact at this location is increased to Moderate.

Summary Impact Table

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
CP1	Milltown Malbay	Medium	Sub-Dominant	Minor Adverse	Slight
CP2	Spanish Point	Medium	Sub-Dominant	Minor Adverse	Slight
CP3	Quilty	Medium	Sub-Dominant	Moderate Adverse	Moderate

6.12 Major Routes

Applicable VRP's:		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR1	N67 at Craggaknock	NE	9.3km	6
MR2	N68 at Knockaderren	N	15.7	6

6.12.1 Character and Sensitivity of the Existing Views

MR1 is contained within the flat, open landscape between the Slievecallan uplands and the coast. This is an area of rough grazing, low hedgerows and occasional farmsteads. The views afforded from the N67 are fairly expansive despite not being elevated above the surrounding landscape. Slievecallan is the most prominent landscape feature within the north-easterly view and the terrain is seen to rise gradually towards it. The main aspects of sensitivity at MR1 are the quantum of traffic on this national secondary route and the relatively expansive nature of the vista. These factors are not considered to render it overly sensitive to development and, thus, the sensitivity of **MR1** is deemed to be **Low**.

The view from MR2 is slightly more elevated than from MR1 and the landscape is more undulating at a macro scale. This location is further inland than the other VRP's and is the only VRP that is not contained within the flat coastal plains or the Slievecallan uplands. The land use in this area is a

combination of good quality pastoral grazing and commercial forest plantations, which creates a more classical rural patchwork pattern than at MR1. This is a vast yet strongly anthropogenic vista and not only because it is located on a busy transport route. Overall it is considered that the sensitivity of **MR2** is **Medium**.

6.12.2 Impact Assessment

6.12.2.1 Visual Presence

The view of the proposed turbines is oblique to the road at MR1, but nonetheless they are seen at a noticeable scale from this distance. Furthermore, the light toned turbines are contrasted against the darker backdrop of Slievecallan, a landform that is a prominent feature of this vista and this serves to highlight the location of the wind farm. For these reasons the wind farm is considered to have a **Co-Dominant** visual presence when viewed from **MR1**.

At MR2 only the upper portions of the turbines can be seen above an intervening ridgeline and at this considerable distance they are barely discernable. This is a vast, panoramic vista and the proposed scheme occupies only a very small portion of the horizon at an oblique angle to the road. As a result of these factors the visual presence of the proposed wind farm is deemed to be **Minimal** from **MR2**.

6.12.2.2 Aesthetic Impact

When viewed from MR1 the proposed turbines have a near perfect spacing and their full height is visible against the backdrop of Slievecallan a short distance beyond in what is an uncomplicated view of the scheme. There is some visual tension generated, however, by the flat profile of the scheme contrasting against the undulating skyline beyond. This also results in the blades of the easternmost turbine cutting against this ridge in silhouette. There is, however, a sense that the scheme is anchored within the more planar landscape at the foot of Slievecallan, which makes the flat profile marginally

more acceptable. On balance of these factors the aesthetic impact of the wind farm at **MR1** is considered to be **Minor Adverse**.

Due to its low order visual presence from MR2 the proposed scheme has little influence on the vista, which has an anthropogenic character in any event. The partial view of the scheme may cause a minor degree of visual confusion but this effect is strongly diluted by the viewing distance. The aesthetic impact of the Coor Wind farm proposal is, therefore, deemed to be **Neutral** at **MR2**.

6.12.2.3 Significance of Impact

Although the proposed wind farm is relatively noticeable from MR1 the sensitivity of the location is in the lower order of magnitude as is the aesthetic impact of the wind farm. This combination of judgements is considered to result in a Slight significance of impact. The sensitivity rating of MR2 is higher than for MR1, but the visual presence and aesthetic impact judgements are at the lowest end of the scale due to the considerable viewing distance and partial screening of the scheme. As a result the significance of impact is deemed to be Imperceptible.

Summary Impact Table

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
MR1	N67 at Craggaknock	Low	Co-Dominant	Minor Adverse	Slight
MR2	N68 at Knockaderren	Medium	Minimal	Neutral	Imperceptible

6.13 Amenity and Heritage Features

Applicable VRP's:		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
AF1	Doonbeg Golf Club	NE	14km	6
AF2	Killard Beach west of Doonbeg	NE	16.7km	6

6.13.1 Character and Sensitivity of the Existing Views

AF1 is a coastal location but the relevant view in this instance is inland. The landscape is open and expansive with few trees and thus the afforded views are extensive. The dune landscape in the immediate vicinity is utilised as a 'links' golf course. Links courses by their nature tend to be far less manicured in appearance than their 'parkland' counterparts and they are also knitted more gently into existing landscape contours. Holiday houses can be seen throughout the foreground and the frequency of these is likely to be closely related to the proximity to the renowned Doonbeg Golf Club. The sensitivity of this location relates primarily to its attraction for tourists as an internationally renowned golf course and also due to the views of the coast. The surrounding landscape to the east is not of a high quality or integrity, but nonetheless the sensitivity of the location is deemed to be **High**.

Killard Beach, the location of AF2 is a deeply incised cove. Small cliffs of about 8 – 10m in height separate the beach from the surrounding farmland and give it a sense of enclosure and shelter. The shape of the cove focuses the viewer towards the County Clare Coastline and Slievecallan can be seen as a distinctive bulge on the distant horizon. There is a strong degree of tranquillity and sense of place at this location. The views afforded are long distance and of a picturesque nature and for all of these reasons AF2 is deemed to be of High sensitivity.

6.13.2 Impact Assessment

6.13.2.1 Visual Presence

The proposed wind farm appears almost identical from these two VRP's as they are from a very similar angle and comparable distance. In both instances the turbines would be seen in direct alignment with Slievecallan fully contained below its ridgeline. At these considerable viewing distances the turbines are a small scale feature within the broader views. The similarities between AF1 and AF2 end here, however, as the viewing context is markedly different for each. At AF1 the scheme is seen between foreground housing developments within

an easterly, inland vista that struggles to compete for a viewer's attention in comparison to Doonbeg Golf course and the coast to the west. As a result the visual presence of the wind farm is deemed to be **Sub-Dominant** from **AF1**.

At AF2 the view of Killard Beach is aligned with the view of Slievecallan and the proposed wind farm across the bay. Rather than being distinctly background features, as they are from AF1, the wind farm and the mountain are a distant focal point in the confined vista afforded from AF2. There is also little foreground complexity and few other prominent man made features across the bay to compete for a viewers attention at AF2. Even though it is slightly further away from the scheme than AF1 the visual presence at **AF2** is deemed to be **Co-Dominant**.

6.13.2.2 Aesthetic Impact

As the scheme is seen from a similar angle and viewing distance its compositional traits are almost identical from both AF1 and AF2. The turbines are fully exposed to the viewer with a relatively even spacing and a flat profile. At AF2 the blades of the two easternmost turbines will rotate in silhouette against the skyline, whereas from AF1 the turbines are more desirably contained below the skyline. This 'cutting' effect at AF2 is strongly diluted by the viewing distance and the low tonal contrast between the hills and the sky.
The landscape character at AF1 is relatively mixed and complex and the scheme is seen as a background element between foreground housing developments that cause a degree of visual clutter. The wind farm does not detract from the anthropogenic landscape character at this location especially given its low order visual presence. For these reasons the aesthetic impact at **AF1** is considered to be **Minor Adverse**.

At a macro level the scheme is seen within an uncomplicated vista from AF2 and although it intrudes slightly upon the view of Slievecallan it remains subordinate to this feature and highlights its location. The turbines will be the most distinctive manmade feature within the view, but within a context of coastal housing so that there is not a sense that they detract from a

naturalistic landscape character. For all of these reasons the aesthetic impact of the scheme at **AF2** is deemed to be **Minor Adverse**.

6.13.2.3 Significance of Impact

Both AF1 and AF2 are considered to be of equally high sensitivity, but for quite different reasons. Again, for a balance of different reasons the aesthetic impact is deemed to be in the lower order of magnitude from both locations. The only difference in terms of impact level occurs in relation to visual presence where the scheme is deemed to be more noticeable from AF2 than from the closer AF1 on the basis of viewing context. This is considered to result in a Moderate significance of impact from AF2 and a Slight significance of impact at AF1.

Summary Impact Table

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
AF1	Doonbeg Golf Club	High	Sub-Dominant	Minor Adverse	Slight
AF2	Killard Beach west of Doonbeg	High	Co-Dominant	Minor Adverse	Moderate

6.14 Cumulative Impact Assessment

As detailed earlier under section 10.8.5 there are ten other existing or permitted wind farms within the Study Area. This cumulative impact assessment is largely a theoretical exercise as any number of the currently permitted schemes may not ever be constructed.

Other than for the two existing schemes at the extreme southwest of the Study Area (Tullabrack and Moanmore) all of the developments are located in the Slievecallan upland area. It is the wind farms within the Slievecallan area that are of most relevance in terms of potential cumulative impacts so the Tullabrack and Moanmore Wind Farms will not be considered further in this assessment.

Given that this is such an open and expansive landscape, almost all of the VRP's used in this assessment afford clear views of the other existing and permitted wind farms within the Slievecallan uplands. If all of these developments were constructed there would undoubtedly be a sense of proliferation in this area. This effect is likely to be as strong from the distant views such as AF1, AF2 and MR2 as it is from the remaining closer VRP's on the basis that the Slievecallan uplands occupy a narrower portion of the overall vista when viewed from a distance. The various schemes are, therefore, seen within more or less the same viewing angle from a distance. Whilst the more disparate viewing angles of the schemes from many of the closer VRP's mitigates the cumulative impact slightly this is counteracted by the greater visual presence of each scheme within a closer proximity.

The closest development to the proposed Coor Wind Farm will be the permitted West Clare Renewables scheme. This is a large scale (30 turbines) and expansive wind farm that spreads across Slievecallan's southern faces. The permitted turbines have a loose spacing and a random layout. Given their proximity the proposed Coor Wind Farm and the West Clare Renewables Wind Farm will appear as a singular extensive development. This is appropriate in terms of the Wind Energy Guidelines (2006), which acknowledge under the cumulative impact section that *'different wind energy developments can appear as a single collective unit if located near each other'*. The guidelines also state in this section that; *'Similarity in the siting and design approach is preferred where a number of wind energy developments are located in the same landscape character area, particularly within the same viewshed'*. In this respect the proposed scheme has slightly larger turbines a more regular layout and a tighter spacing between units than the permitted scheme. These variant design characteristics are not obvious, however, from any of the VRP's and it is considered that the proposed scheme is successfully assimilated within the context of the larger permitted scheme. Together these combined developments are approximately the scale of the cluster formed by the existing Bootilagh Wind Farm, its permitted extension and the permitted Glenmore Wind Farm, which occur some 8km to the southeast.

Overall it is considered that the cumulative impact of existing and permitted wind farms (including the permitted West Clare Renewables scheme – Slieve callan) in the Slievecallan upland area is currently Moderate, but approaching Significant. **Given its close association and visual assimilation with the more extensive West Clare Renewables Wind Farm, the proposed Coor Wind Farm is considered to represent only a Slight incremental cumulative impact.**

The earlier assessment of impacts for the Coor Wind Farm in isolation utilised judgements relating to 'landscape sensitivity' along with the 'visual presence' and 'aesthetic impact' of the scheme. **If the currently permitted wind farms are constructed it is considered that the landscape sensitivity ratings would likely be reduced at each VRP location.** The visual presence judgements for the proposed Coor Wind Farm would also reduce on the basis that the proposed turbines represent such a small proportion of the number of turbines visible on the Slievcallan uplands skyline. There may be some aesthetic issues associated with the stacking of the proposed turbines in perspective against the turbines of other schemes. Such effects would likely be counteracted by the minimal impact of the scheme on the character of a landscape where turbines are prevalent. **The aesthetic impact of the Coor Wind Farm would therefore likely remain at the same modest level.** On the basis of these reasons the significance of impact of the proposed Coor Wind Farm would reduce in the context of the current level of permitted wind farm development in the vicinity should the majority of it be constructed.

6.15 Discussion and Conclusion

A summary table is provided below which collates the assessments of landscape sensitivity, visual presence, aesthetic impact and overall significance of impact of the proposed Coor Wind Farm from each of the 11 viewshed reference points used. A discussion of these results is provided thereafter, followed by a general conclusion on anticipated overall impact.

Imperceptible		Slight		Moderate		Significant		Profound

Table 6.3: Summary Impact Assessment

Key Views

Applicable VRP's:	Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
No Key Views have been included for assessment with regard to this development				

Designated Scenic Routes and Views

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
DR1	R474 at Drehidenagh	High	Dominant	Minor Adverse	**Moderate**

Local Community Views

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
LC1	Local Road to northwest of site	Medium	Co-Dominant	Minor Adverse	**Slight**
LC2	LC2 Local Road at Coor	Medium	Highly Dominant	Minor Adverse	**Moderate**
LC3	LC4 Mullagh Village	Medium	Sub-Dominant	Minor Adverse	**Slight**

Centres of Population

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
CP1	Milltown Malbay	Medium	Sub-Dominant	Minor Adverse	**Slight**
CP2	Spanish Point	Medium	Sub-Dominant	Minor Adverse	**Slight**
CP3	Quilty	Medium	Sub-Dominant	Moderate Adverse	**Moderate**

Major Routes

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
MR1	N67 at Craggaknock	Low	Co-Dominant	Minor Adverse	**Slight**
MR2	N68 at Knockaderren	Medium	Minimal	Neutral	**Imperceptible**

Amenity and Heritage Features

Applicable VRP's:		Sensitivity	Visual Presence	Aesthetic Impact	Significance of Impact
AF1	Doonbeg Golf Club	High	Sub-Dominant	Minor Adverse	**Slight**
AF2	Killard Beach west of Doonbeg	High	Co-Dominant	Minor Adverse	**Moderate**

6.15.1 Landscape Sensitivity

In this instance the landscape sensitivity judgements are generally in the higher order of magnitude with three of the VRP's registering High sensitivity and all but one of the remainder registering Medium sensitivity. This reflects the vast open nature of the views in this planar landscape as well as the coastal location of some of the VRP's and the elevated location of many of the others. The three High ranking VRP's were DR1, AF1 and AF2. In the case of DR1 the sensitivity level relates to the elevated panoramic views afforded as

well as its location on a regional road. For AF1 the sensitivity is related, primarily, to Doonbeg Golf Club's value as a tourist attraction as well as the coastal views that are afforded from this location, albeit in the opposite direction to the proposal site. AF2 is considered highly sensitive in relation to the picturesque, long distance views afforded and the tranquil coastal location.

6.15.2 Visual Presence of the Wind Farm

As clear visibility of the scheme is afforded from most of the VRP locations due to the absence of screening elements in this open landscape, visual presence in this instance is strongly related to viewing distance. One exception to this is AF2, which has a simple surrounding context and a focussed view towards the proposed wind farm and Slievecallan on the same alignment. In this instance a Co-Dominant visual presence was attributed to the scheme despite it being considerably further away than from some VRP's where lower visual presence judgments are made. Except for AF2 the principle views from the other VRP's located along the coast tend to be focussed away from the inland proposal site.

6.15.3 Aesthetic Impact of the Wind Farm

The aesthetic impacts tend to be in the lower order of magnitude (Minor Adverse or Neutral) for the vast majority of the VRPs. This reflects the simple linear arrangement and the modest scale of the scheme. The full height of the turbines also tends to be seen from most locations as they are slightly elevated in relation to the surrounding plain. This makes for an uncomplicated and generally uncluttered view of the scheme. Only at CP3 is the aesthetic impact considered to be Moderate Adverse. In this instance the viewing angle is such that the proposed turbines are heavily overlapped in perspective generating visual clutter and confusion.

6.15.4 Cumulative Impact

It is considered that the Slievecallan uplands area is currently at a Moderate to Significant level of cumulative impact taking into account all existing and

permitted schemes. **The proposed Coor Wind Farm is a modest scale scheme that would be visually assimilated with the more extensive, adjacent West Clare Renewables Wind Farm when viewed from most locations. The contribution of the proposal to cumulative impact is, therefore, deemed to be Slight.**

6.15.5 Overall Significance of Impact

On the basis of the judgements made in relation to landscape sensitivity, visual presence and aesthetic impact the majority of VRP's (6 out of 11) are attributed a Slight significance of impact. A Moderate significance of impact is applied to four of the VRP locations, but for slightly different reasons. In the case of DR1, LC2 and AF2, this results from the higher order of magnitude judgements that are made with respect to the sensitivity of the VRP location and the visual presence of the scheme. At CP3 a middling sensitivity rating and a Moderate Adverse aesthetic impact are responsible for the Moderate significance of impact judgement.

As the highest level of summary impact across the selection of VRP's is Moderate, the overall significance of impact for the proposed Coor Wind Farm is also considered to be **Moderate**. This is the median of five levels of impact significance available to the assessors and is defined earlier as '*An impact that changes the character of the environment in a manner that is consistent with existing and emerging trends'.* If the majority of the currently permitted wind farms in the vicinity are constructed the significance of impact of the proposed Coor Wind Farm is likely to be diminished.

6.16 Proposed Mitigation Measures

A number of other general mitigation measures are included below:

- Matt non-reflective finishes should be used on all turbine components.
- Powerlines between individual turbines and the substation should be placed underground.

- Counter rotation of blade sets should be avoided.
- The number and extent of new track roads should be kept to a minimum and properly landscaped immediately following completion of works. Such landscaping would include reinstating original vegetation along verges and repairing any wheel ruts. In addition, the colour of road material should be such as to minimise contrast with the surrounding landcover and include chippings coloured to match those in the immediate context.
- Special care should be taken to preserve any features which contribute to the landscape character of the Study Area. Any damage to existing hedgerows from transporting the turbines should be made good.
- The proposed development should, in so far as possible, not detract from the enjoyment of amenities, both visual and physical, within or adjacent to the site.
- A high standard of design should be applied to all structures associated with the substation considering not only its function but also the aesthetic quality, in order to minimise any sense of intrusion. The development should provide colour harmony and adequate screening of the substation using berms covered with scrub and ground vegetation in order to mitigate its impact. It is the intention of the developer to plant appropriate screening trees surrounding the substation compound.

7 SOILS AND GEOLOGY

7.1 Introduction

7.1.1 Background

Applied Ground Engineering Consultants (AGEC) were engaged by INIS Environmental Ltd to carry out an assessment of the impact of the proposed wind farm at Coor, County Clare on the soils and geology aspect of the environment. The AGEC Ltd., Soils and Geology investigation was carried out in conjuction with the AGEC Peat Stability Assessment for the site. In addition this work was also carried out in conjucnction with a HYDRO Environmental Services Hydrolgy and Hydrogeology Assessment. Figures for this Gouls and Geology Chapter are provided in Appendix 6 of Volume III, EIS Appendices. The Peat Stability Assessment is provided in Appendix 7 of EIS Volume III Appendices. Control Surveys worked with both AGEC and HYDRO re topgraphical survey and mapping of the site for all assessment work incluudeing borrow pit design.

7.1.2 Relevant Legislation

The EIS is carried out in accordance with the following legislation:

S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No.30 of 2000 the Planning and Development Act, 2000 and S.I. 600 of 2001 Planning and Development Regulations and subsequent amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment.
Under the above legislation, other legislation which is relevant to assessing the effects of projects on the environment is invoked. For the soils and geology environment these may include, S.I. No. 4 of 1995, The Heritage Act 1995.

7.1.3 Schedule of Works

A site walkover and trial pitting was carried out by AGEC during March 2011.

7.2 Methodology

7.2.1 Desk Study

A desk study of the study area was largely completed in advance of the study area visits, and all relevant geological, subsoils and soils related designations data was gathered and collated. This included the following:

Acquisition of available data regarding the proposed windfarm development;
Acquisition of map data O.S.I. 1:2,500 scale, O.S.I. 1:50,000 scale, orthophotographs and site contour survey;
Consultation of geological, sub-soils and soils associated data sources comprising:

- Geological Survey of Ireland (GSI) 1:100,000 bedrock scale map series Sheet 17: Geology of the Shannon Estuary (1999);
- Geological Survey of Ireland borehole/depth to bedrock data from Exploration and Mining Division Minerals open file data and geotechnical databases (www.gsi.ie);
- Environmental Protection Agency/Teagasc 1:50,000 scale soils and subsoils maps and associated documentation;
- Geological Survey of Ireland Database of Geological Heritage Sites

7.2.2 Site Investigations

Site investigations were carried out during March 2011. The works covered:

- Geological mapping of exposed faces (soils, geology and subsoils) to validate desk study information;

- Walk over inspection of the study area with recording of salient geomorphological features.
- Peat depth probing at and adjacent to proposed development footprint and at various locations across the study area.
- Trial pitting and logging of subsoils to BS5930 standard at turbine locations.
- In-situ shear vane testing at selected locations to provide representative site coverage.

7.2.3 Impact Assessment Methodology

- Baseline soils, subsoils and geological site characteristics of the receiving environment are derived from the desk study information and site investigations;
- Potential hazards arising from the development are identified;
- Receptors in the receiving environment to which these hazards may represent a risk are identified in the course of the study area characterisation;
- The potential impacts on receptors are identified, in terms of quality, significance, duration and type;
- Measures to mitigate potential impacts on given receptors from the proposed development are identified;
- Residual impacts are stated.

7.2.4 Characteristics of the Development

The proposed Coor development consists of 6 wind turbines with an approximate diameter of 85m and an approximate hub height of 85m, hardstanding areas, control building, electrical compound, approximately 2 km of new site roads, 3 no. borrow areas and associated works. All roads constructed on site are to be founded on suitable founding stratum, Less than

100 m of existing road needs to be upgraded. None require floated road construction.

7.3 Receiving Environment

The receiving environment comprises the existing soils, subsoils and bedrock geological environment in which the proposed development will take place.

7.3.1 Bedrock Geology

The study area and surrounding area comprises rocks of Namurian age, belonging to the Central Clare Group, as shown in Figure 7.2, Bedrock Geology, below. The Central Clare Group comprises cyclothemic sequences of sandstones, siltstone and shale, interpreted to be the result of delta progradation with main channels and point bar deposits and sub-deltaic minor cycle units. A typical cyclothem sequence consists of a laminated shale unit with a fossil bearing (goniatite) marine band at the base, a thick laminated to massive grey siltstone unit in the middle and a thick upper unit, usually dominated by laminated sandstone (GSI 1999).

No major faults occur within or in the vicinity of the study area. An east-north east to west-southwest fault occurs to the northwest at a distance of approximately 4 km from the study area.

Rock exposures inspected in borrow pits in the study area comprised dark grey shale and siltstone bedrock. Mudstone bedrock was observed at the base of trial holes where bedrock was reached (TP B2, TP B3, TP B4, TP T1, see Appendix B Site Investigation Logs of AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm, Appendix 7 of Volume III, Appendices to this EIS).

There are no geological heritage sites recorded in the Geological Survey of Ireland Database of Geological Heritage Sites within the study area.

7.3.2 Soils and Subsoils Geology

Soils

Soils in the study area comprise of a number of different types. The main types include deep well drained material from acid brown earths & brown podzolics, deep poorly drained material from surface water gleys & ground water gleys, blanket peat and poorly drained mineral soils with peaty topsoil. Figures are provided in Appendix 6 of Volume III Appendices to this EIS

Subsoils

The subsoils on the study area are of Quaternary age. Subsoils as mapped on Environmental Protection Agency/Teagasc 1:50,000 subsoils maps (EPA/Teagasc) indicate the presence of bedrock close to surface, along with shale and sandstone derived till and peat as shown in Figure 7.1, Subsoils Geology. Figures are provided in Appendix 6 of Volume III Appendices to this EIS

Peat Stability

This section summarises the Report on Assessment of Peat Stability for Proposed Coor Wind Farm by AGEC, included as Appendix 7 of Volume III Appendices to this EIS.

Previous Failures

No previous peat failures have been recorded at Coor (Geological Survey of Ireland (GSI), 2006). The nearest recorded peat failure is located some 20km to the north of the site within an upland area called Ballaghline. The failure recorded by Geological Survey of Ireland (GSI) occurred in 1900 however no description of the failure is given.

Other failures recorded by GSI that occurred in County Clare are at Corbehagh and Derryulk. The failure at Corbehagh occurred in 1934 and was described as a peat flow. The failure at Derryulk occurred in 2005 and was described as an earth slide (unspecified).

Site Reconnaisance

Site reconnaissance was carried out in March 2011 by AGEC Ltd. The conclusions of the study area reconnaissance are summarised below

1) The turbines are located in areas of relatively shallow peat and as such are not considered to be at risk from peat failure.
2) Numerous exposures of mineral soil and outcrops of rock are evident across the site.
3) Slope angles range from 1 to 5 degrees at turbine locations.
4) No evidence of past failures or signs of instability were noted on site.

Site Investigations

Site Investigations comprised peat depth probing at and adjacent to proposed development footprint and at various locations across the study area. In situ peat strength measurements were also made.

Summary of Peat Depths and Distribution

Peat depths were contoured to create a peat depth map for the study area. See Figure 2 (Peat Thickness Zonation Plan) of Appendix 7 of Volume III Appendices to this EIS (Report on Assessment of Peat Stability for Proposed Coor Wind Farm). Peat depths were recorded at each turbine location and along access tracks. At turbine locations peat depth varied from 0.4m (T6) to 0.7m (T3).

Table 7.1 Peat Depths at Proposed Turbine Locations.

Turbine	Easting	Northing	Peat Depth (m)
T1	111091	175077	0.5
T2	110736	175045	0.5
T3	111217	174826	0.7
T4	110939	174812	0.5
T5	110247	174861	0.6
T6	110538	174836	0.4

Subsoils Undrained Shear Strengths

In–situ peat strength was recorded by shear vane testing at selected locations across the study area to provide a representative coverage of indicative peat strengths. The results indicate undrained shear strengths in the range 28 to 100kPa, with an average of about 60kPa. These strengths would be considered typical of shallow, more fibrous peat deposits. When compared with the shear strengths back-calculated for the well characterised and reported Derrybrien wind farm site (AGEC, 2004), the shear strengths for the study area are well in excess of those at Derrybrien (estimated at 2.5kPa), indicating that there is notably less likelihood of failure at this site.

Peat Stability Assessment – Factor of Safety Analysis for Peat Slopes

Stability of a peat slope is dependent on several factors in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above mentioned factors alone is unlikely to result in peat failure. To assess the factor of safety for a peat slide, an undrained and drained analysis has been undertaken to determine the stability of the peat slopes. The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide which is a reasonable representation of the dominant mode of movement for peat failures.

The purpose of the analysis is to determine the Factor of Safety (FoS) of peat slopes. The analysis was carried out at the turbine locations and at various shear vane test locations across the study area.

For the stability analysis two load conditions were examined, namely:

Condition (1): no surcharge loading
Condition (2): surcharge of 10kPa, equivalent to 1m of stockpiled peat, assumed as worst case.

Results of Factor of Safety Analysis for Peat Slopes

The minimum required FoS is 1.3 based on BS6031:1981: Code of Practise for Earthworks (BSI, 1981). The assigned probability of instability associated with a given FoS value is described in Table 7.2 below.

Table 7.2 Probability Scale for FoS.

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.11	Likely
4	1.01 to 1.10	Probable
5	≤1.0	Very Likely

The results of the drained and undrained analysis are presented in Appendix D of AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm, included as Appendix 7 of Volume III (Appendices) to this EIS.

In summary, the results of the undrained analysis for the study area are as follows:

i) Calculated FoS for load condition (1) is in excess of 1.3 for each location analysed with a range of FoS of 29 to in excess of 100 across the study area.

ii) Calculated FoS for load condition (2) is in excess of 1.3 for each location analysed, with a range of FoS of 15 to in excess of 10.

In summary, the results of the drained analysis for the study area are as follows:

i) Calculated FoS for load condition (1) is in excess of 1.30 for each location analysed, with a range of FoS of 2.4 to in excess of 10.

ii) Calculated FoS for load condition (2) is in excess of 1.3 for each location analysed, with a range of FoS of 2.1 to in excess of 10.

Peat slope Factors of Safety (FoS) Undrained for Condition 1, are mapped and have been contoured to create a FoS map for the area of the study area. See Figure 3 (Factor of Safety Plan) of AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm included as Appendix 7 of Volume III (Appendices) to this EIS.

7.4 Do Nothing Impact

In the absence of the wind farm development current land use practises will continue. Coniferous forestry will be felled as forestry compartments reach maturity. Re-planting of these areas with coniferous plantation is likely to occur.

7.5 Potential Impacts of the Development

7.5.1 Construction Phase

The potential impacts of the development are summarised in Table 7.3 below, in terms of the hazard, the characteristics of that hazard which may result in an impact and the receptor which will be impacted by that hazard.

Table 7.3 Summary of Hazards and Potential Impacts on Receptors.

Hazard	Characteristics of the hazard which may result in impact	Receptor 1	Receptor 2	Receptor 3
Construction Phase				
Turbine base, hardstanding, and road construction	Peat, subsoils and bedrock removal	Peat, Subsoils	Bedrock	Geological Heritage
	Vehicular Movement	Peat, Subsoils	Blanket Bog Habitat	Water Environment
	Emplacement of materials	Site geochemistry and hydrochemistry	Water Environment	
	Storage and Stockpiles	Peat Stability	Water Environment	
Waste	Waste Generation and Management	Peat Stability	Water Environment	
Construction in peat environment	Peat Instability	Surface Waters	Property	Human beings

Hazard: Peat, Subsoils and Bedrock removal

Implementation of the site infrastructure will require the removal of soil to a competent subsoil or bedrock foundation, in order to facilitate construction of roads and turbine bases. Material will also be excavated from borrow pits, to provide material for road and general hardstanding construction. All material required for road and general hardstanding construction purposes is to be sourced on site. Removal of peat represents a direct impact on the peat and a risk to dependent peat habitats. However the ecological assessment work indicates that any natural peatland habitat which may once have been present on site is now highly compromised as a result of afforestation. Habitats on site have been modified though farming practices such as fertilisation and grazing and forestry practices such as land drainage. The ecological value of the peat on site has therefore been reduced.

Table 7.4 Excavation Volumes at Infrastructure Locations.

Infrastructure	**Average depth m**	**Area m^2**	**Volume m^3**
Turbine Bases	2	1,350	3,525
Hardstands	2	5,750	11,500
Construction compound	1	1,350	1,350
Electrical substation	0.5	2,250	1,125
New access roads	0.75	12,000	9,000
Infrastructure Total			26,500

There are no geological heritage sites recorded in the Geological Survey of Ireland Database of Geological Heritage Sites within the study area, therefore no geological heritage is at risk.

Three small borrow pits (BPs) exist on the site. The material in these pits consists of a weathered mudstone at/close to the surface with the degree of weathering reducing with depth. This material is considered to be suitable for construction of new access roads (Figure 7.3).

Table 7.5 Bedrock Excavation Volumes at Borrow Pits.

Name	**Estimated Rock Extraction m^3**
BORROW PIT 1	21,600
BORROW PIT 2	3,500
BORROW PIT 3	4,950
Total	**30,050**

Some excavation of the till sub-soil will be required due to the shallow depth of peat at some turbine bases, and across the area of associated infrastructure. See Tables 7.4 and 7.5 above. Generally most excavation works will be restricted to 1 – 1.5m. However, at turbine bases, excavation of up to 3m below ground level (i.e. into bedrock) will be required for suitable foundations for turbine bases. The depth of sub-soil beneath the peat/ peaty soils is variable, and reduces to zero close to where rock is exposed at the surface.

Based on the volume of rock to be excavated and the plan area of the borrow pits, it is estimated that bedrock will be excavated to a depth of 6.75m at BP1, 3.5m at BP2 and 5.5m at BP3. Groundwater strikes were recorded between 0.4 and 3.0m based on the trial pit logs. These are not considered representative of the groundwater levels within the bedrock. Extraction of the bedrock is not expected to adversely impact upon the groundwater in the bedrock.

No areas of instability were recorded during the site visits. Given the shallow depth to bedrock in the area, there is unlikely to be any risk of instability during the construction phase.

The removal of peat constitutes a negative, moderate permanent residual impact on the peat subsoil.

The removal of bedrock constitutes a negative, moderate permanent residual impact on the bedrock.

Hazard: Vehicular Movement

During the construction phase of the development, vehicles will cross over and excavate into peat and supported habitats, in order to construct new access roads and to gain access to the proposed development areas. This can result in damage to the vegetated peat surface, exposing it to erosion and also damage to the supported habitat.

Hazard: Emplacement of Material

The emplacement of construction materials, used to construct roads, turbine bases and hardstands, of different mineralogical composition to that of the study area can result in changes in site geochemistry with potential impacts on site hydro-chemistry and supported habitats.

Hazard: Storage and Stockpiles

Handling, storage and re-use of excavated materials are considered significant elements of the construction phase. There is potential for direct impact on slope stability, due to loading.

Hazard: Waste Generation/Management

Waste is generated as a by-product of development. In this case solid waste will be generated by the excavation of peat and subsoils, which is not suitable for use in construction works other than the construction of verges, and reinstatement of the proposed borrow pits. A volume of bedrock will be excavated from the turbine, hardstanding and road areas, but these materials may be suitable for reuse in construction. The redistribution of the peat and subsoils has the potential for causing ground instability and providing a source of sediment which could impact negatively on the water environment. However all excavated peat and subsoils will be placed in borrow pits for permanent reinstatement. The borrow pits will be designed to provide complete stability and containment of in-filled peat and sub-soils. Mitgation will also be provided to ensure any run off is minimised and contained.

Waste can also be generated as a function of introduced construction materials (e.g. cement based products). Depending on how inert these materials are, and how different in chemistry to that of the study area, they can cause local change in geochemistry, which can in turn impact on hydrochemistry and thus on water dependent habitats. This is not considered an isuue here as only one small 1st order watercourse exists on-site, drainage towards this watercourse will be easily controlled and managed.

Hazard: Peat Instability

This section summarises AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm included as Appendix 7 of Volume III (Appendices) to this EIS of this EIS.

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on proposed wind farm development and the surrounding environment. Peat failure excludes localised movement of peat that would occur (say) below an access road, creep movement or erosion type events.

The consequence of peat failure at the study area may result in:

I. Death or injury to site personnel;
II. Damage to machinery;
III. Damage or loss of access tracks;
IV. Drainage disrupted;
V. Site works damaged or unstable;
VI. Contamination of watercourses, water supplies by particulates;
VII. Degradation of the environment.

7.5.2 Operational Phase

No new impacts will occur during the operational phase. Risk and impacts related to peat stability and the construction and maintenance of infrastructure in the peat environment are described in Construction Phase Impacts above.

Table 7.6 Summary of Hazards and Potential Impacts on Receptors.

Hazard	**Characteristics of the hazard which may result in impact**	**Receptor 1**	**Receptor 2**	**Receptor 3**
Operational Phase				
Infrastructure in peat environment	Peat Instability	Surface Waters	Property	Human beings

7.6 Mitigation Measures

7.6.1 Construction Phase Mitigation

Mitigation by Avoidance

Peat, Subsoils and Bedrock removal

Placement of turbines and infrastructure in areas of low peat depth and avoidance of deep peat areas. All of the turbine base locations are located at peat depths of less than 1m.

Vehicular Movement

Vehicular movement will be confined to the proposed footprint of the development. New and upgraded road construction, will take place from the existing roadway. All other development will take place progressively from these roads.

Emplacement of Material

Materials of similar local mineralogical composition will be used for construction of roads, turbine bases or hardstandings or sub-station compound hardstanding. These will be sourced from the borrow pits within the site. Bedrock within the study areas comprises Namurian rocks of the Central Clare Group, which comprises sequences of sandstones, siltstone and shale, i.e. siliceous rocks. Where importation is unavoidable, locally sourced materials form the Clare Shale Formation, or similar mineralogical composition, will be used.

Storage and Stockpiles

Restriction of stockpiling to areas of appropriate FoS (i.e. $\geq$1.3) and restricted stockpile heights will reduce the risk of slope instability as a result of stockpiling to negligible. No temporary storage of excavated material is

proposed across the site. All excavated material will be removed to the borrow pits.

Adherence to the control measures are set out in Appendix A and Section 10 of AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm (Appendix 7 of Volume III EIS Appendices).

Pre-construction planning and construction management of stockpiling to be carried out by appropriately qualified geotechnical personnel.

Waste Generation/Management

It is proposed that peat and subsoils excavated on the site will be stored in excavated bedrock borrow pits. Geotechnical assessment of the placed soil (peat and sub-soils) in the borrow pits is to be carried out, and an appropriate capping design implemented. Appropriate operational phase drainage to attenuate drainage water from the stored peat in order to prevent impacts on the water environment will be implemented.

Mitigation by Reduction

None anticipated

Mitigation by Remediation

None anticipated

7.6.2 Operational Phase Mitigation

Mitigation by Avoidance

Peat Instability

Turbine locations have been restricted to areas with a high level of slope stability, as defined by the Factor of Safety (FoS) assessment.

Control measures as set out in Appendix A of Appendix 7 of Volume III EIS Appendices of this EIS relating to individual turbine locations and adjacent road infrastructure. General control measures as set out in Section 10 of Appendix 7 (Volume III EIS Appendices) of this EIS.

Mitigation by Reduction

None anticipated

Mitigation by Remediation

None anticipated

7.7 Residual Impacts of the Development

Following construction, the residual impacts of the development on the soils and bedrock of the site are considered minimal.

7.8 Monitoring

In relation to the geological and geotechnical impacts identified the following recommendations are made in terms of site monitoring:

AGEC's Report on Assessment of Peat Stability for Proposed Coor Wind Farm shows that the site is naturally at low risk of slope failure or mass movements. However, the construction contractor selected for the detailed design phase should provide details of environmental safety methodology outlining best practice procedures to manage construction activities. This methodology statement should be reviewed and critiqued by a qualified geotechnical engineer.

Monitoring and management of the site will be carried out in accordance with Section 10.3 Construction Risk Management Guidelines of Appendix 7 of Volume III EIS Appendices of this EIS.

An independent, qualified geotechnical engineer is to be contracted for the detailed design stage of the project and geotechnical services to be retained throughout the construction phase, including monitoring and supervision of construction activities on a regular frequency.

7.9 Conclusion

The following conclusions are given.

(1) The Coor site comprises 6 wind turbines and associated infrastructure.

(2) Peat depth across the site ranged from 0 to 1.6m based on probe results which indicate that peat depths are shallow.

(3) Slope angles recorded for the site ranged from 1 to 14 degrees.

(4) Based on ground investigation and walk-over the ground conditions were recorded as typically peaty topsoil over bedrock. The bedrock was Namurian Siltstone and Shale.

(5) Undrained shear strengths in the range 28 to 100 kPa were recorded in the Peat which would be typical of well drained Peat.

(6) An analysis of peat sliding instability was carried out for each of the turbine and structure locations across the site for both the drained and undrained conditions. The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes and the mineral soil below the peat.

(7) For the undrained condition for the peat, the calculated FoS for load conditions (1) & (2) are in excess of 1.30 for each location analysed with a FoS of 2 or greater at all locations.

(8) For the drained condition for the peat, the calculated FoS for load conditions (1) & (2) are in excess of 1.30 for each location analysed with a FoS of 2 or greater at all locations.

(9) The risk assessment at each turbine (and structure locations) identified a number of control measures, see Appendix A of the Report on Assessment of Peat Stability for Proposed Coor Wind Farm by AGEC, included as Appendix 7 of Volume III EIS Appendices, to reduce the potential risk of peat failure. Access

roads to turbines should be subject to the same control measures that apply to the nearest turbine.

(10) In summary, the stability analysis results show that the FoS's for the Coor site are acceptable and are greater than the required minimum value of 1.3 from the code of practice for earthworks BS 6031:1981 (BSI, 1981). The high FoS determined for the peat slopes at the proposed site indicates that there is minimal potential for peat failure.

7.10 Matrix of Impacts / Mitigation / Residual Impacts

Impact	Mitigation	Residual Impact
Peat Instability	Restrict Turbine locations to areas of shallow peat.	Minimal
Waste Generated	Material store in appropriate locations or removed from site.	Minimal
Storage/Stockpiles	Restrict location and size of stockpiles.	Minimal

7.11 Non-Technical Summary

The proposed development comprises 6 turbines, new access roads, borrow pits, and an associated site drainage system. Temporary infrastructure includes a site compound and a temporary hard-standing area.

Study Area Baseline Characteristics

The study area is located at Coor, Co. Clare. The study area ranges in height from 100m O.D. to 150m O.D. Slope angles across the site generally vary from flat to 14 degrees.

Bedrock geology underlying the study area comprises the Namurian Central Clare Group, which consists of sandstone, siltstone and shale.

Soils and subsoils are dominated by siltstone derived till and peat. Recorded peaty topsoil and peat depths vary from 0m to 1.6m (bgl).

Potential Significant Impacts

The assessment indicates that the potential significant impacts of the proposed development are:

Construction Phase

Peat, subsoils and bedrock removal: Implementation of the site infrastructure will require the removal of soil to competent subsoil or bedrock foundation and excavation from borrow pits, to provide material for road and general hard-standing construction. Removal of peat represents a direct impact on the peat and a risk to dependent peat habitats. However the ecological assessment work carried out by Openfield Ecology and INIS Environmental consultants Ltd., indicates that the peat dependant habitats on-site are degraded due to conifer plantation and are not of any significant conservation status.

Storage and Stockpiles: Handling, storage and re-use of excavated materials is a significant element of the construction phase. There is minimal potential for direct impacts on slope stability due to loading, and minimal potential impact on the water surface environment resulting from stockpiling as a source of suspended sediment.

Measures to mitigate impacts on slope stability by avoidance comprising; a) Adherence to the peat stability design risk controls and construction risk controls, b) Pre-construction planning and construction management of stockpiling and c) Restriction of stock piling to areas of appropriate factors of safety (i.e. ≥1.3) and restricted stockpile height. Adoption of these mitigation measures will reduce the risk of peat instability as a result of stockpiling to negligible and will reduce this impact to neutral, slight, short-term residual impact.

Construction and Operational Phase

Construction activity and infrastructure location resulting in peat instability: Peat instability represents a risk to the water environment, material assets and human beings. Peat stability was assessed using a factor of safety analysis for peat slopes. For undrained conditions the factor of safety indicated a negligible/no risk of peat instability (factor of safety ≥ 1.3) for all turbine locations and along access roads. For drained conditions a negligible/no risk of peat instability was calculated for all turbine locations. These analyses included for loading equivalent to 1m of stockpiling on existing peat during excavation works or roads of standard construction.

A combined peat stability and risk assessment was carried out for each proposed turbine location in the study area. Environmental impact (in the case of peat failure) on watercourses was assessed. Impact on watercourses in the case of peat failure, is assessed as low at all of the turbine locations. Mitigation measure to minimise the potential impacts comprise a range of design risk controls and construction risk controls.

Monitoring

Monitoring of ground conditions during the construction phase and regular monitoring through the operational phase is required to ensure that mitigation design and control structures operate to stated purpose.

References

Applied Ground Engineering Consultants (AGEC), 2004. Derrybrien Wind Farm Final Report on Landslide of October 2003.

British Standards Institution (BSI), 1981. BS6031:1981: Code of Practice for Earthworks. HMSO, London.

British Standards Institution (BSI), 1999. BS5930: 1999: Code of Practice for Site Investigations. HMSO, London.

Geological Survey of Ireland, 2006. Landslides in Ireland. Geological Survey of Ireland – Irish landslides Group. July 2006.

Geological Survey of Ireland, 1999, Geology of the Shannon Estuary

8 HYDROLOGY AND HYDROGEOLOGY

8.1 Introduction

8.1.1 Background & Objectives

Hydro-Environmental Services (HES) was engaged by INIS Environmental Consultants Ltd to carry out an assessment of the potential impacts of a proposed wind farm at Coor/ Shanavogh, Co. Clare on water aspects (hydrology and hydrogeology) of the receiving environment. A site location map is shown as Figure 8.1.

The primary objectives of the assessment includes:

- Produce a study of the existing water environment (surface and groundwater) in the area of the proposed wind farm development;
- Identify likely positive and negative impacts of the proposed development on surface water and groundwater during construction and operational phases of the development; and,
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts.

8.1.2 Relevant Legislation

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on

the assessment of the effects of certain public and private projects on the environment;

- S.I. No. 600 of 2001 Planning and Development Regulations, 2001;
- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988 Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WDF). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;
- S.I. No. 41 of 1999 Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);

- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);
- S.I. No. 439 of 2000 Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations; and,
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010.

8.1.3 Relevant Guidance

The water section of the EIS is carried out in accordance with guidance contained in the following:

- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;
- Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes; and,
- Wind Farm Development Guidelines for Planning Authorities (September, 1996).

8.2 Methodology

8.2.1 Desk Study

A desk study of the site and the surrounding area was completed in advance of undertaking the walkover survey. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency database (**www.epa.ie**):
- Geological Survey of Ireland – National Draft Bedrock Aquifer map;
- Geological Survey of Ireland – Groundwater Database (**www.gsi.ie**);
- The Department of Communications Marine and Natural Resources – Exploration and Mining Division website (**www.minerex.ie**);
- Met Eireann Meteorological Databases (**www.met.ie**);
- National Parks & Wildlife Services Public Map Viewer (**www.npws.ie**);
- Water Framework Directive Status Reports (**www.wfdireland.ie**);
- Geological Survey of Ireland (GSI) [3]:100,000 bedrock scale map series Sheet 17: Geology of the Shannon Estuary (Sleeman, A. G. and Pracht, M., 1999);
- Geological Survey of Ireland – Milltown Malbay Groundwater Body Initial Characterisation Report (2003);
- Report on Assessment of Peat Stability for Proposed Coor East Wind Farm, Co. Clare (AGEC, 2011); and,
- OPW Indicative Flood Maps (**www.flooding.ie**).

8.2.2 Site Investigations

Drainage mapping and hydrological baseline monitoring was undertaken by HES on 25^{th} March 2011. Site investigations and a geotechnical assessment were undertaken by Irish Drilling Ltd and AGEC Ltd on 24^{th} & 25^{th} March 2011. Data used to address the Water Section of the EIS included the following:

- A walkover survey and hydrological mapping of the site and the surrounding area were undertaken by HES whereby water flow directions and drainage patterns were recorded;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken by HES at 9 no. locations to determine the origin and characteristics and indicative quality status of surface water flows;
- A peat stability assessment by AGEC Ltd to determine the distribution, depth and stability of peat overlying the site; and,
- A site investigation by Irish Drilling Ltd whereby a total of 6 no. trial pits was undertaken at the site.

8.2.3 Impact Assessment Methodology

The statutory criteria (EPA, 2002 and EPA, 2003) for the assessment of impacts require that likely impacts are described with respect to their extent, magnitude, complexity, probability, duration, frequency, reversibility and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment are those set out in EPA (2002) *Glossary of Impacts* and are as follows in Table 8.1. In addition the two impact characteristics proximity and probability are described for each impact and these are defined in Table 8.2. Examples of potential impacts on the hydrology, hydrogeology and morphology of the existing environment are shown in Table 8.3.

In addition to the above methodology the sensitivity of the water environment receptors were assessed on completion of the desk study and baseline assessment. Levels of sensitivity which are defined in Table 8.4 are then used to assess the potential impact that the proposed development may have on them.

Table 8.1 Impact Descriptors as per EPA, 2003.

IMPACT CHARACTERISTIC	DEGREE/NATURE	DESCRIPTION
Quality	Positive	A change which improves the quality of the Environment.
	Neutral	A change which does not affect the quality of the Environment.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An impact capable of measurement but without noticeable consequences.
	Slight	An impact which causes noticeable changes in the character of the environment without affecting its' sensitivities.
	Moderate	An impact that alters the character of the environment in a manner consistent with existing and emerging trends.
	Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
	Profound	An impact which obliterates sensitive characteristics.
Duration	Temporary	Impact lasting for one year or less.
	Short-term	Impact lasting one to seven years.
	Medium-term	Impact lasting seven to fifteen years.
	Long-term	Impact lasting fifteen to sixty years.
	Permanent	Impact lasting over sixty years.
Type	Do Nothing	The environment as it would be in the future should no development of any kind be carried out.
	Cumulative	The addition of many small impacts to create one larger, more significant impact.
	Indeterminable	When the full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity, or reproductive capacity of an environment is permanently lost.

IMPACT CHARACTERISTIC	DEGREE/NATURE	DESCRIPTION
	Synergistic	Where the resultant impact is of greater significance than the sum of its constituents.
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect.
	Worst Case	The impacts arising from a development in the case where mitigation measures substantially fail.

Table 8.2 Additional Impact Characteristics.

IMPACT CHARACTERISTIC	DEGREE/NATURE	DESCRIPTION
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 8.3 Impact Descriptors Related to the Receiving Environment.

IMPACT CHARACTERISTICS		POTENTIAL HYDROLOGICAL IMPACTS
QUALITY	**SIGNIFICANCE**	
Negative only	Profound	Widespread permanent impact on: - The extent or morphology of a cSAC. - Regionally important aquifers. - Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time dependent impacts on: -The extent or morphology of a cSAC / ecologically important area. -A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). -Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area, Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time dependent impacts on: - The extent or morphology of a cSAC / NHA / ecologically important area. - A minor hydrogeological feature. - Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

Table 8.4 Receptor Sensitivity Criteria (Adapted from **www.sepa.org.uk**)

Sensitivity Receptor:

- **Not sensitive**: Receptor is of low environmental importance (*e.g.* surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability "Low" – "Medium" classification and "Poor" aquifer importance.

- **Sensitive**: Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability "High" classification and "Locally" important aquifer.

- **Very sensitive**: Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A^3 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability "Extreme" classification and "Regionally" important aquifer.

8.2.4 Characteristics of the Development

The proposed development at Coor/ Shanavogh will comprise 6 no. turbines, a sub-station, temporary compound and approximately 2.06km of additional internal access roads (5m width) along with a site access bridge and 3 no. borrow pits (which are already existing and are to be extended). The hardstanding area at each turbine location will take up a footprint of approximately 1,099 m^2 with and additional 400m^2 of ground left soft but levelled. It is proposed that the peat/ subsoil and stony matter excavated (26,500m^3) during the construction phase will be permanently stored in the 3 no. borrow pits, a quantity of this will also be relaid at excavation trences and along access roads and hardstanding verges no greater than 0.5 m in height. The site layout is shown as Figure 8.2.

8.3 Receiving Environment

8.3.1 Site Description

The project landholding is located in the townlands of Coor East, Coor West, Shanavogh West, Shanavogh East, Shanavogh West and Killernan. Site central co-ordinates are E110610, N174920 approximately 6km southeast of the town of Milltown Malbay in Co. Clare. The total site area is approximately 90 hectares and ranges in elevation from 90m to 160mOD (Ordnance Datum Malin Head). A topographic divide, which runs in a southwest-northeast orientation on the northern section of the site, means the site drains into two surface water catchments. A small stream which drains one of the catchments flows through the southern section of the site. The southern section of the site; and predominately the southwest facing slopes is dominated by a dense covering of commercially planted coniferous trees. The northern section of the site is predominately agricultural land. There are 3 no. existing small borrow pits which have previously been used to extract bedrock. The site is overlain by poorly drained peaty soil.

8.3.2 Runoff and Recharge

Long term rainfall and evaporation data was sourced from Met Éireann. The annual average rainfall (AAR) recorded at Milltown Malbay, 6km northwest of the site, are presented in Table 8.5.

Table 8.5 Long term Average Rainfall Data (Data taken Meteorological Service)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Milltown Malbay		106100		179800		55		1943		1984		
Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***	
127	89	92	65	72	79	79	104	108	135	128	129	**1207**

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Shannon Airport, approximately 40km southeast of the site. The long term average PE for this station is 540mm/yr. This value is

used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 513mm/yr (0.95 PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE
= 1207mm/yr – 513mm/yr
ER = 694mm/yr

The proportion of precipitation that reaches the water table is referred to as the recharge coefficient. The recharge coefficient depends on the hydrogeological characteristics of the site and the average precipitation levels. A summary of the geology of the site is described below. A more detailed description of the site geology is dealt with in the Soils & Geology Section (Chapter 7).

The mapped soils (**www.epa.ie**) within the site are poorly drained mineral soils (AminPD). Peat stability investigations at the Coor Shanavogh site encountered little or no peat cover (AGEC, 2011). Where peat was recorded it was essentially peaty topsoil, with pockets of black soft fibrous peat. Depths of 0 to 1.0m were recorded for the peat (AGEC, 2011). The peat was typically described as firm brown fibrous peat. A site investigation map is shown as Figure 8.3.

The mapped subsoils (**www.gsi.ie**) are Namurian sandstone and shale derived tills. Subsoils encountered by Irish Drilling Ltd (2011) during trial pitting were predominately gravelly SILT or gravelly SILT/CLAY with cobbles and boulders. Depth to bedrock was reported to be between 0.5m and 3.4m. Depth top bedrock at each turbine location was between 0.4 – 0.7 m, Depth to bedrock does not exceed 1 m bgl at any infrastructural location.

Based on the site geological setting a recharge coefficient (GSI, 2004) estimate of 15% recharge is taken for the site as an overall average. This

value is for “Till overlain by poorly drained (gley) soil” with an “Extreme” vulnerability rating (*i.e.* subsoils < 3m). The lowest value in the available range was chosen to reflect the dominant coverage of conifer trees on the site which would increase evapotranspiration rates. Therefore, annual recharge and runoff rates for the site are calculated to be approximately 105mm/yr and 589mm/yr respectively.

8.3.3 Local and Regional Hydrology

A regional hydrology map is shown as Figure 8.4. The site is situated in two surface water catchments. The majority of the site drains into the Annagh River which flows in a south-westerly direction to the north of the site before entering the sea 1km south of Spanish Point (*i.e.* 6.3km down-gradient of the site). The Annagh catchment makes up approximately 57% of the total site area. There is no long term flow data available for this river which has a catchment area of approximately 9.8km^2 up-gradient of the site.

The southern section of the site (and most of the development area) drains into a small unnamed first order stream (S1) which flows in a westerly direction along the southern boundary of the site for much of its length before entering the sea 2km south of Quilty Town (*i.e.* 8.7km down-gradient of the site). The stream briefly flows through the site on the south-eastern section before forming the sites southern boundary. The stream flows within a deeply incised channel with a depth and width of 1.5m and 1m respectively. The stream channel is within mineral substrate subsoil and has bedrock bedding. The stream catchment makes up approximately 43% of the total site area. The stream catchment area up-gradient of the site is estimated to be 1.5km^2.

Proposed turbine locations T1, T2 and T5 and existing borrow pit no. 3 are located within the Annagh surface water catchment. Proposed turbines locations T3, T4, and T6 and existing borrow pits no. 1 and no. 2 are located within stream S1 surface water catchment.

8.3.4 Site Drainage

The only natural drainage feature within the site boundary is stream (S1) which briefly flows through the south-eastern section of the site prior to forming the sites southern boundary. Stream S1 is a small first order stream. Otherwise, the majority of the southern section of the site (with the exception of the area to the south of stream S1) has shallow land drains present which are associated with the existing conifer plantation. The area to the south of stream S1 is poorly drained grassland. The conifer plantations are present predominately on the southern facing slopes of the catchment divide and therefore drain into stream (S1) along the southern boundary of the site. These shallow drains, which were noted to be dry on the day of the survey (25/03/2011), run 45^{o} degrees to the topographic contours and are spaced approximately every 15m. The northern section of the site, which predominately slopes north towards the Annagh River, generally comprises agricultural land and therefore extensive drain networks are generally absent in this part of the site.

8.3.5 Flood Risk Assessment

OPW's indicative river and coastal flood map was consulted to identify those areas as being at risk of flooding. No areas within the site boundary were identified from the maps. A number of recurring flood incidents associated with tidal flooding are mapped on coastal areas downstream of the site. The available OPW flood report for this location is shown on www.flooding.ie.

8.3.6 Surface Water Hydrochemistry

Surface water Q-rating[1] data is available for the Annagh River and stream (S1). Most recent data (2009) show that the upstream and downstream EPA monitoring stations on the Annagh River were given a Q3

[1] The Q value system describes the relationship between water quality and the macroinvertebrate community in numerical terms. Q5 waters have high diversity of macroinvertebrates and good water quality, while q1 have little or no macroinvertebrate diversity and bad water quality. Intermediate values, q1-2, 2-3, 3-4 etc denote transitional conditions. (refer to **www.epa.ie**).

and Q4 rating respectively in 2009. The downstream station on stream S1 was given Q4 rating in 2009.

The Annagh River has moderate status (Q3-4) at site 200 (bridge at Drehide) and good status (Q4) at site 900 (Bealaclugga Bridge). The upper reaches of the Annagh are mainly forestry and agricultural pressures. Quality improves in the middle reaches to satisfactory but drops downstream due to localised pressures and/or because it is affected by seawater (www.wfdireland.ie).
Field chemistry measurements of unstable parameters, electrical conductivity E.C. (µs/cm), pH (pH units) and temperature (°C), were taken at 9 no. locations in surface watercourses at the site on 25th March 2011. The weather on the day of the site visit was dry and sunny. The week preceding the visit was also dry and therefore the streams were observed in low flow conditions. The results are listed in Table 8.6 below. The locations where field measurements were taken are shown in Figure 8.3.

Table: 8.6 Summary of Field Parameter Measurements.

Location ID	Easting	Northing	Electrical Conductivity (µs/cm)	pH	Temp °C
FP1	111161	174720	109	7.3	7.6
FP2	111420	174721	113	7.1	7.3
FP3	110987	174757	108	6.9	7.2
FP4	110845	174784	110	7.0	7.2
FP5	110209	174888	259	7.6	9.0
FP6	110240	174863	502	7.7	9.0
FP7	110544	174820	115	7.1	7.3
FP8	110914	175516	110	7.2	7.2
FP9	110423	175504	106	7.5	7.3

The Annagh River (FP8 & FP9) is characterised by relatively low E.C. values (106-110µS/cm) and a slightly alkaline pH (7.2-7.5). The values for pH and E.C. are typical of water derived from Namurian rocks or tills which is the parent material type of the catchment.

Stream S1 (FP1, FP2, FP3, FP4 and FP7) is also characterised by relatively low E.C. values (108-115µS/cm) and a slightly alkaline pH

(7.3-7.9). The values for pH and E.C. are also typical of water derived from Namurian rocks or tills.

Field parameters FP5 and FP6 were taken in a forestry drain in close proximity to proposed turbine T5. Relatively high E.C. values in the range of 259-502μS/cm indicates the presence of a groundwater seepage in this area. The pH was between 7.6 and 7.7.

8.3.6 Hydrogeology

The rocks of the Central Central Clare Group, which underlie the site are classified by the GSI (**www.gsi.ie**) as a Locally Important Aquifer, having bedrock which is generally unproductive except for local zones (LI). The Namurian rocks of the Central Clare Group which comprises sequences of sandstones, siltstone and shale are generally devoid of intergranular permeability. Groundwater flow occurs only in fractures, joints and faults, except for the top few metres of the rock where the rocks are likely to be more fractured and/ or weathered. Bedrock fissures are generally poorly connected, with fissure permeability reducing rapidly with depth (GSI, 2003). Most flow is therefore expected to occur in the top 5 to 15m of the bedrock. Due to the low bedrock permeability, and low infiltration rates, a high proportion of the rainwater will leave the site as surface runoff. Surface waters are therefore more at risk of contamination from any localised groundwater contamination. Base flow contribution to streams tends to be low, particularly in summer as the groundwater regime cannot sustain summer base flows due to low storativity with the aquifer. The stream hydrochemistry (*Section 8.3.6*) would indicate water which has a low residence time within the catchment. In winter, low permeabilities will lead to a high water table and potential water logging of soils which is consistent with the mapped soil type of the site (*i.e.* poorly drained mineral soil). Local groundwater flow directions will mimic topography whereby flow paths will be from topographic high points to lower elevated discharge areas at streams and rivers. Therefore, the anticipated local groundwater flow direction in the northern section of the site will be towards the Annagh River (*i.e.* northwest). The anticipated local groundwater

flow direction in the southern section of the site will be towards stream S1 (*i.e.* south – southwest). The regional bedrock groundwater flow direction is likely to be to the southwest. The regional aquifer map is shown as Figure 8.5.

No wells are recorded in the GSI wells database (**www.gsi.ie**) within the site boundary. Three wells are recorded in the GSI wells database within ^{3}km of the site boundary. The two closest are at a distance of approximately 300 and 470m from the north-eastern boundary of the site. The third mapped well is located 780m to the south of the site. These are likely to be wells which serve single houses or farms within the area, but well yields would be expected to be small. None of these mapped wells are located hydraulically down-gradient of the proposed development (refer to Figure 8.5). Consequently the development does not have the potential to impact on the water supply of these wells. In addition no public supply wells or source protection zones occur within 5km of the study area.

8.3.8 Groundwater Vulnerability

The GSI groundwater vulnerability rating for the site ranges from Extreme (*i.e.* <3m subsoils) to Extreme X (*i.e.* rock near or at the surface). The groundwater vulnerability rating is consistent with depths to bedrock recorded at the site (Irish Drilling, 2011). Depth to bedrock was reported to be between 0.5m and 3.4m, with most being less than 3m. The higher land on the topographic divide were noted to have areas of outcropping rock.

8.3.9 Groundwater hydrochemistry

Due to the absence of any wells on or near the study area, no direct measurements of groundwater hydrochemistry were made. Namurian bedrock aquifers (including the Central Clare Group) have predominantly $Ca\text{-}HCO_3$ hydrochemical signatures.

8.3.10 Designated Sites

Designated sites include National Heritage Areas (NHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). The proposed wind farm development area is not located within any designated conservation-sites.

The Mid-Clare Coast is the nearest pSPA (site code 4182). It encompasses a coastal area from Spanish Point south to Doonbeg and at its nearest point is 6km from the wind farm site (see Ecology, Chapter 4). The largely coincindent Carrowmore Point to Spanish Point and Islands cSAC (site code 1021) is designated for a number of coastal habitats that are listed under Annex I of the Habitats Directive. Surface waters in the vicinity of the site enter the sea in the vicinity of Spanish Point which is approximately 9km down-gradient of the site. From a hydrological perspective there will be no impact on this marine designated site.

8.3.11 Receptor Sensitivity

Refer to Table 8.4 for sensitivity criteria. Groundwater at the site can be classed as Sensitive to pollution because the Namurian bedrock is classified as a Locally Important Aquifer (LI). However, the majority of the site is covered in peaty poorly draining topsoil which acts as a protective cover to the underlying aquifer. Any contaminants which may be accidently released on-site are more likely to travel to nearby streams within surface runoff. The low permeability of the bedrock means that any contaminant that may reach the bedrock would not disperse and would remain localised to the source or would be removed as runoff during wet periods. Also, there are no mapped public or private groundwater supplies down-gradient of the development site. Nevertheless, measures will be put in place to protect groundwater at the site.

Surface waters such as the Annagh River and stream S1 are very sensitive to potential contamination. Stream S1 is not known to be of salmonid quality but it can be considered to be of salmonid potential (see Ecology, Chapter 4). The

Annagh River however which flows to the north of the site is a significant river and may have fish stocks present.

Mitigation measures will ensure that surface runoff from the developed areas of the site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the site. Drainage mitigation is outlined below.

8.4 Potential Impacts of the Development

8.4.1 Assessment of Changes in Site Runoff

The following water balance assessment gives a preliminary indication of the highest monthly average volume of surface water runoff expected from the site. The calculations are carried out for the month (October) with the highest average recorded rainfall versus evapotranspiration, for the current baseline site conditions, in terms of subsoil and bedrock exposure (Table 8.7). It represents therefore, the wettest annual scenario in terms of volumes of surface water runoff from the site area pre-development. The groundwater recharge co-efficient for the site is estimated to be a conservative 15%, based on the predominant coverage of poorly drained soils at the site.

Milltown Malbay rainfall station (E106100, N179800) is the closest station with long term rainfall records. The highest long term average (30 year) monthly rainfall occurred in October, at 135mm. The average monthly evapotranspiration for the synoptic station at Shannon Airport over the same period in October was 24.4mm. Actual evapotranspiration (AE) for the site is taken to be 23.2mm/yr (0.95 PE). The calculation is carried out for the catchment areas of the Annagh River and stream S1 within the site boundary. The balance indicates that a conservative estimate of surface water runoff for the total site area during the highest rainfall month is 85,500m^3/month, which equates to an average of 2,758m^3/day, as outlined in Table 8.8.

Table 8.7 Water Balance and Baseline Runoff Estimates for Wettest Month.

Water Balance Component	**Depth (m)**
Average October Rainfall ®	0.135m
Average October Potential Evapotranspiration (PE)	0.0244m
Average October Actual Evapotranspiration (AE = PE x 0.95)	0.0232m
Effective Rainfall October(ER = R – AE)	0.112m
Recharge co-efficient (% of ER)	15%
Runoff (% of ER)	85%
Runoff/m /month (depth)	0.095m

Table 8.8 Baseline Runoff to Annagh River and Stream S1 Catchments.

Catchment	**Approx Area m^2**	**Baseline Runoff/ month (m^3)**	**Baseline Runoff/day(m^3)**
Annagh	513,000	48,735	1,572
S1	387,000	36,765	1,186
Totals	900,000	85,500	2,758

The proposed hardstanding footprint within the Annagh River catchment will be approximately 8,600m^2 which would account for only 1.5% of the catchment area within the site boundary. The emplacement of hardstanding (assuming emplacement of impermeable materials) could result in a maximum total site increase in surface water runoff of 146m^3/month, for the month of highest average recorded rainfall. This equates to a maximum increase of 4.7m^3/day. This represents a 0.3% increase in the maximum daily volume of runoff from the site in comparison to the baseline pre-development site runoff conditions. Refer to Table 8.9.

The proposed development footprint within the S1 catchment will be approximately 16,700m^2 which would account for only 3.8% of the catchment area within the site boundary. The emplacement of hardstanding (assuming

emplacement of impermeable materials) could result in a maximum total site increase in surface water runoff of 284m^3/month, for the month of highest average recorded rainfall. This equates to a maximum increase of 9.2m^3/day. This represents a 0.77% increase in the maximum daily volume of runoff from the site in comparison to the baseline pre-development site runoff conditions.

In both catchments there would be a negligible increase in maximum runoff and this can be attributed to the relatively small area of the overall site being developed.

Table 8.9 Water Balance and Estimated Development Runoff Volumes.

Site Sub-catchment	Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Hardstanding Area m^2	Development Area 100% Runoff (m^3)	Development Area 85% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
Annagh	48,735	1,572	8,600	963	817	146	4.7	0.30
StreamS1	36,765	1,186	16,700	1,870	1,587	284	9.2	0.77
Totals	85,500	2,758	25,300	2,834	2,404	430	13.9	1.07

8.4.2 Do nothing scenario

The site would remain exclusively as conifer plantation and agricultural land. Harvesting, clear felling and replanting of conifer plantations would continue as normal. Drainage at the site would remain in its present state which is heavily engineered in places due to forestry drainage.

8.4.3 Worst Case Scenario

Local contamination of the underlying aquifer and on-site surface water features during the construction and operational phases, which in turn could affect the water quality and ecology of the Annagh River, stream S1 and other downstream water bodies.

8.4.4 Potential Impacts and Mitigation Measures – Construction Phase

1. Physical changes to surface watercourses and drainage patterns.

Diversion or culverting of surface watercourses can result in changes to drainage patterns and alteration of aquatic habitats. Construction of bridges over water courses has the potential to significantly interfere with water quality and flows during the construction phase. A new stream crossing is required over stream S1 leading from borrow pit no. 1 to the turbine locations. Minor alternations (including ditch crossings and culverting, and possible minor realignment of forestry drains) of on-site drainage networks will be required to allow for the proposed development footprint.

Pathway:	Surface water discharge routes.
Receptor:	Surface waters and associated dependant ecosystems.
Potential Impact:	Direct, negative, slight, short term, high probability impact.
Proposed Mitigation Measures:	Stream S1 is a small first order stream and is unlikely to be a suitable habitat for spawning by salmonid species. Therefore, there is no risk near the site itself of direct impact on these species or their habitat due to culvert or bridge construction. However, it is likely that downstream water bodies will contain fish stocks and therefore mitigation measures will be put in place to protect all water courses influenced by the site. Mitigation by design: Any mitigation measures proposed by the Western Regional Fisheries Board will be incorporated into the design of the proposed development and design of elements referred to in Fisheries Boards guidance (Eastern Regional Fisheries Board, not dated), will be carried out in accordance with this reference. In stream construction works (culverts, bridges etc.) and construction of the site drainage systems will only be carried out during the period permitted by the Fisheries Boards for in-stream works according to Fisheries Boards guidance (Eastern Regional Fisheries Board, not dated), that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

	The proposed bridge over stream S1 will be single span, open bottomed and be such as to include no in-stream elements or construction plant crossing of the channel. Silt curtains will be emplaced immediately downstream of the construction area for the duration of the construction phase. Minor adjustments to the forestry drain network may be required to allow for the development footprint. These on-site drains, which are mainly associated with the forestry plantation, are only minor in nature and they do not transmit significant volumes of water, if any. All main forestry drains on the day of the site survey (25/03/2011) were noted to be dry. Natural routes of all watercourses will be maintained, with no diversion of existing watercourses. Also, there is no planned development in close proximity to the Annagh River to the north of the site. The closest turbine to the Annagh River is T1, which is at a distance of 320m from the water course.
Residual Impact:	Direct, negative, imperceptible, short term, medium probability impact.

2. Earthworks (removal of vegetation cover, excavations and stock piling) resulting in suspended solids entrainment in surface waters.

Construction phase activities including access road and turbine base construction will require earthworks resulting in removal of vegetation cover and excavation of peaty topsoil and mineral subsoil. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from road and turbine base excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of access road culverts resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies.

Pathway:	Drainage networks.
Receptor:	Down-gradient rivers and dependant ecosystems.
Potential Impact:	Direct, negative, significant, short term, medium probability impact.
Proposed Mitigation Measures:	Mitigation by avoidance: The majority of the proposed development will be located outside of the Annagh River surface water catchment. Only proposed turbines

	T1, T2 and T5 and 1 no. borrow pit are to be located in this catchment. The closest turbine to the Annagh River is T1, which will be located at a distance of approximately 320m. A 20m wide watercourse buffer zone will be in place for stream S1 (with the exception of the bridge crossing). The proposed buffer zone will: • Avoid physical damage to watercourses, and associated release of sediment; • Avoid tree felling within close proximity to surface water courses; • Avoid the entry of suspended sediment from earthworks into watercourses; and, • Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone; Mitigation by Design: • Interceptor drains will be installed up-gradient of works areas to collect surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground as overland flow; • Swales will be used to intercept and collect runoff from works areas of the site, likely to have entrained suspended sediment, and channel it to stilling ponds for sediment settling; • Check dams will be installed at regular intervals along interceptor drains and swales in order to reduce flow velocities and therefore minimise erosion within the system during storm rainfall events; • Stilling ponds, emplaced as pairs in series, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses. Stilling ponds will be designed to retain the volume associated with a 1 in 100 year 24 hour return period rainfall event for 6 hours. Stilling ponds are designed to reduce the flow velocity of discharge water; and, • Vegetation filters, that is areas of existing vegetation, accepting drainage water issuing from level spreaders as overland flow, will remove any suspended sediment from water channelled via interceptor drains. <u>Water Treatment Train:</u> If the discharge water from construction areas fails to be of a high quality then a filtration treatment system (such as a 'siltbuster' or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase. All concrete wash down at the site should be

	completed in a dedicated RCW concrete wash unit (http://www.siltbuster.com/sheets/RCW.pdf). This unit catches the solid concrete and filters and holds wash liquid for pH adjustment and further solids separation. The residual liquids and solids can be disposed of off-site at an appropriate waste facility. Silt fences: Silt fences will be emplaced within forestry drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. *Pre-emptive Site Drainage Management:* The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of peat/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast. The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities: **General Forecasts:** Available on a national, regional and county level from the Met Eireann website (**www.met.ie/forecasts**). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates; **MeteoAlarm:** Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale; **3 hour Rainfall Maps:** Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events; **Rainfall Radar Images:** Images covering the entire country are freely available from the Met Eireann website (**www.met.ie/latest/rainfall_radar.asp**). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and, **Consultancy Service:** Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

	Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event. Works should be suspended if forecasting suggests either of the following is likely to occur: >10 mm/hr (*i.e.* high intensity local rainfall events); >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or, >half monthly average rainfall in any 7 days. Prior to works being suspended the following control measures should be completed: • Secure all open excavations; • Provide temporary or emergency drainage to prevent back-up of surface runoff; and, • Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded. <u>Management of runoff from peat and subsoil storage areas:</u> During the initial placement of peat and subsoil within borrow pits, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from the repository areas. 'Siltbuster' treatment trains will be employed if previous treatment is not to a high quality. Drainage from repositories will ultimately be routed to an oversized swale and a number of stilling ponds pond and a 'Siltbuster' with appropriate storage and settlement designed for a 1 in 100 year 24 hour return period rainfall event for 6 hours before being discharged to the on-site drains. Peat/subsoil repository areas will be vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised peat/subsoil storages areas will no longer be a potential source of silt laden runoff. Timing of site construction works: Construction of the site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.
<u>Residual Impact:</u>	Negative, imperceptible, short term, low probability impact.
<u>Monitoring:</u>	An inspection and maintenance plan for the on-site drainage system will be prepared in advance of commencement of any works. Regular

	inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended. Any excess build up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed. During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each watercourse, and specifically following heavy rainfall events (*i.e.* weekly, monthly and event based). The will be done in consultation with the Fisheries Board.

3. Felling of Coniferous Plantation Forestry.

Approximately 11.56 acres (4.67 hectares) of existing plantation forestry will be felled to allow for development of the proposed windfarm infrastructure *i.e.* turbine hardstandings and access roads and turbulence felling (that is trees in the vicinity of turbines which have to be removed as their height results in turbulence which impacts negatively on turbine performance and longevity. The total existing forested area on the site is 24.68ha.

Potential impacts during tree felling occurs mainly from:

- Exposure of soil and subsoils due to vehicle tracking, and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

Pathway:	Drainage and surface water discharge routes.
Receptor:	Surface waters and associated dependant ecosystems.
Potential Impact:	Direct, negative, moderate, short term, high probability impact.
Proposed Mitigation Measures:	Best practise methods related to water incorporated into the forestry management and mitigation measures have been derived from: • Forestry Commission (2003) Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;

	• Coillte (2009) Forest Operations & Water Protection Guidelines; and, • Coillte (2009) Methodology for Clear Felling Harvesting Operations. Mitigation measures which will reduce the risk of entrainment of suspended solids in surface watercourses during tree felling include the following: • Machine combinations will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soils disturbance. Consideration should be given to the use of cable-crane extraction, to reduce soil disturbance. • Checking and maintenance of roads and culverts will be on-going through the felling operation; • No tracking of vehicles through watercourses will occur, as vehicles will use road infrastructure and watercourse crossing points; • Drains which flow from the area to be felled towards surface watercourses will be blocked, and temporary sediment settlement ponds and silt fences will be used; • Brash mats should be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding will occur; • Timber should be stacked in dry areas away from surface water courses. Straw bales to be emplaced on the down-gradient side of timber processing areas; and, • Works should be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water runoff. <u>Drain Inspection and maintenance during and after tree felling</u> The following items shall be carried out during inspection pre-felling and after: • Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines; • Inspection of all areas reported as having unusual conditions. • Inspection of main drainage ditches and outfalls. During pre-felling inspection the main drainage ditches shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall; • Following tree felling all main drains shall be inspected to ensure that they are functioning; • Extraction tracks nears streams need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground; • Culverts on drains exiting the site must be unblocked; and, • All silt removed from drains, culverts and silt traps must be deposited away from water courses to ensure that it will not be carried back into the trap or stream during subsequent rainfall;
<u>Residual</u>	Direct, negative, slight, short term, low probability impact.

Impact:	

4. Excavation Seepage. Excavation seepage may occur in turbine base excavations, road excavations, and in borrow pit excavations and can potentially result in a localised flow of groundwater into the excavation. This can create additional volumes of water to be treated by the runoff management system.	
Pathway:	Drainage networks.
Receptor:	Down-gradient rivers and dependant ecosystems
Potential Impact:	Direct, negative, slight, short term, low probability impact.
Proposed Mitigation Measures:	During the site investigation by Irish Drilling Ltd, Stiff damp brown bluish grey slightly sandy gravelly SILT/CLAY was the most common subsoil encountered. Minor groundwater seepages from the subsoil and subsoil/bedrock interface were noted during the excavations. Based on the initial borrow extraction estimates by AGEC Ltd , it is likely that bedrock will be excavated to a maximum depth of approximately 8 metres below ground level. Given the elevation of the site and poor aquifer type of the bedrock, seepage rates will be very low. Any inflows into the excavations will likely to be near surface runoff/through flow during wet periods. During dry periods it is very likely that there will be no seepages into excavations. Due to the elevation of the site it is not anticipated that any groundwater table will be intercepted. Design and Control Measures include: • Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations and borrow pits will be put in place; • If required, pumping of excavation seepage will prevent build up of seepage water in the excavation; • The interceptor drainage will be discharged to the site constructed drainage system and not directly to surface waters; • The pumped water volumes will be discharged via volume and sediment attenuation ponds; • There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading; • The drainage system is reactive, and has been designed so as to have the capability to increase storage volumes; and, • Daily monitoring of excavations by a suitably qualified person should occur during the construction phase. If high levels of seepage inflow occur, excavation work should immediately be stopped and a geotechnical assessment undertaken. A mobile 'Siltbuster' or similar equivalent treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur.

	Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites.
Residual Impact:	Negative, imperceptible, short term, low probability impact.

4. Potential Impacts on groundwater levels and local well supplies during excavation of borrow pits. Dewatering of excavations and especially borrow pits have the potential to impact on local groundwater levels and local supply wells during the construction phase.	
Pathway:	Fractures and other groundwater flow paths.
Receptor:	Down-gradient water supply wells and springs.
Potential Impact:	Direct, negative, imperceptible, short term, low probability impact.
Proposed Mitigation Measures:	The rocks of the Central Central Clare Group are generally a poor bedrock aquifer. Due to their low permeability the Central Clare Group aquifers have low recharge characteristics and have generally short flow paths. Flow paths are estimated at a minimum of 30m to a maximum of 300m for aquifers in this groundwater body (GSI, 2003). The flow path is the distance and direction from the aquifer recharge area to where groundwater is discharged as surface water in rivers, seeps or springs. Therefore, it is unlikely that groundwater flow volumes and direction will be impacted by any activity that is at a distance of greater than 300m from a given point in the aquifer. In addition, neither can any pollutant potentially released in the borrow pits impact on the quality of water to any supply well that is at a distance of greater than 300m from a given point in the aquifer as there is no transport pathway. Proposed turbine T3, T4 and T6 and borrow pit no.1 and no.2 are located in the catchment to stream S1 which is located directly down-gradient of these proposed construction areas. The groundwater discharge zone from these proposed development areas is therefore stream S1. There are no private wells located down-gradient of the proposed development areas within the S1 catchment (*i.e.* there are no wells located in the groundwater flow path from recharge to discharge zones). Proposed turbines T1, T2 and T5 and proposed borrow pit no. 3 are located in the catchment to the Annagh River. There are no mapped wells down-gradient of any of the proposed development areas within the Annagh catchment. In summary, the borrow pits do not intersect any flow paths which are contributing groundwater to local water supply wells. The borrow pits cannot therefore impact on yields from any local water supply wells. Neither can any pollutants accidently generated in the borrow pits impact on the quality of water to any local water supply wells.
Residual	No impact

Impact:	

6. Accidental Spillages of Hydrocarbons

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway:	Groundwater flow paths and site drainage network.
Receptor:	Aquifer and down-gradient streams and dependant ecosystems.
Potential Impact:	Direct, negative, significant, temporary, medium probability impact to surface water ecology. Direct, negative, slight, temporary, medium probability impact to groundwater quality.
Mitigation Measures:	The following mitigation measures are proposed: • Refuelling will be completed off-site wherever possible. This will be the case for regular, road-going vehicles and will reduce the volume of fuel to be stored on-site; • Plant and vehicles must be inspected regularly for leaks and fitness for purpose as part of the construction phase Environmental Management Plan; • The incident management plan of the construction phase EMP must include an approved, certified clean-up consultancy, nominated by the contractor and available on 24 hour notice to commence a clean-up in the event of a hydrocarbon spillage from plant or vehicles; and, • The use of a 4x4 jeep which will transport a double skinned bowser to large immobile plant such as cranes etc. The jeep will also carry spill kits.
Residual Impact:	Direct, negative, imperceptible, short, low probability impact.

7. Groundwater & surface water contamination from on-site wastewater disposal.

Release of treated effluent from site services have the potential to impact on groundwater and surface water bodies during the construction phase of the development.

Pathway:	Groundwater and surface water flow paths.
Receptor:	Groundwater and surface water.
Potential Impact:	Direct, negative, significant, medium probability impact.

Mitigation Measures:	There will be no discharge of wastewater on-site. All wastewater will be stored in a tank and will be pumped out and removed off-site by tanker for treatment at an appropriate wastewater treatment facility.
Residual Impact:	No residual impact.

8.4.5 Potential Impacts and Mitigation Measures – Operational Phase

1. Changes in site runoff and drainage patterns.

Changes to the natural drainage distribution of a site by emplacement of artificial drainage could impact on the natural site hydrology. The function of artificial drainage is to remove natural surface water runoff volumes and additional surface runoff caused by the emplacement of impermeable surfaces, from a specific area, and to distribute it at a location where it will not interfere with the functioning of the development. Potential impacts are changes to the natural hydrology by diversion of water from, and to, new locations, and changes in the volumes of water present at any given location, as well as an increase in water velocities with the possible result of hydraulic loading of surface watercourses.

Pathway:	Site drainage network.
Receptor:	Surface water and downstream aquatic habitats.
Potential Impact:	Direct, negative, medium, long term, medium probability impact on surface water. Direct, negative, slight, long term, low probability impact on groundwater.
Mitigation Measures:	Due to the low permeability of the poorly drained soils which overlie much of the site, the natural runoff coefficient is estimated to be as high as 85%. The post development water balance undertaken for the site shows that the increase in runoff due to the emplacement of the foot print will be negligible (*i.e.* 0.3% for the Annagh catchment and 0.77% for the S1 catchment within the site boundary). The existing drainage network will remain mostly the same post development. The majority of drainage works will only require management of localised surface runoff within the vegetation layer. However, in order to mitigate the impacts of slightly increased runoff during the construction and operational phases, and of re-distribution of natural surface water runoff, drainage design measures, intended to mimic natural drainage and retain surface water runoff close to its source, will be emplaced as construction proceeds and retained through the operational phase. Specific elements designed to mimic the natural hydrology are the emplacement of swales discharging via a large number of drainage outfalls along their length by diffuse discharge (across the watercourse buffer zones) to surface watercourses or into appropriate wetland habitats. Final discharge is

	via stilling ponds designed to buffer storm runoff volumes, level spreaders to convert channel flow into overland flow and vegetation filters which promote percolation across the natural vegetation surface.
Residual Impact:	Direct, negative, imperceptible, long term, low probability impact on surface waters. Neutral impact on groundwater flows.

2. Suspended sediment in site runoff.

Runoff during the operational phase of the development has the potential to cause erosion of peat/subsoil repository areas, drainage ditches and gullies which may pose a risk to the surface water quality and aquatic habitats.

Pathway:	Site drainage network.
Receptor:	Surface water and downstream aquatic habitats.
Potential Impact:	Direct, negative, medium, long term, medium probability impact.
Mitigation Measures:	Design mitigation includes: • Stilling ponds, emplaced as pairs in series, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses. Stilling ponds will be designed to retain the volume associated with a 1 in 100 year 24 hour return period rainfall event for 6 hours; • Stilling ponds are designed to reduce the flow velocity of discharge water. Inspection and maintenance of these drainage controls during operational phase is critical to their functioning to stated purpose; • Check dams along the drainage route will reduce the velocity of flow thereby preventing channel erosion; • Vegetation filters, that is areas of existing vegetation, accepting drainage water issuing from level spreaders as overland flow, will remove any suspended sediment from water channelled via interceptor drains or any remaining sediment in waters channelled via swales and stilling ponds; • Discharge from level spreaders will be positioned outside of surface water buffer zones; and, • Peat/subsoil repository areas will quickly be re-vegetated and the potential for sediment laden runoff will be negligible.
Residual Impact:	Neutral, imperceptible, long term, low probability impact.

8.5 Conclusion

The site is situated in two surface water catchments. The majority of the site drains into the Annagh River (57%) which flows in a south-westerly direction to the north of the site.

The closest turbine to the Annagh River will be located at a distance of approximately 320m.

The southern section of the site (43%) and most of the proposed development area drains into a small unnamed first order stream (S1) which flows in a westerly direction along the southern boundary of the site. The closest turbine to S1 is approximately 20m.

Mitigation measures will ensure that surface runoff from the developed areas of the site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the site.

Due to the distance of the Annagh River to the proposed development areas, negligible to no impact is anticipated for this water course after mitigation measures are put in place.

Direct, negative, slight to imperceptible, short term, low probability impacts on Stream S1 are anticipated during the construction phase. This relates primarily to tree felling and excavation work.

Neutral, imperceptible, long term, low probability impacts on stream S1 are anticipated during the operational phase.

The aquifer at the site is classified as Locally Important Aquifer, having bedrock which is generally unproductive except for local zones (LI).

Direct, negative, imperceptible, short term, low probability impacts on groundwater quality are anticipated during the construction phase. No impacts on groundwater quality are anticipated during the operational phase.

Any proposed excavations at the site (*i.e.* borrow pits) do not intersect any flow paths which are contributing groundwater to local water supply wells (*i.e.* there are no wells down-gradient of the development areas). Borrow pits and other excavations cannot therefore impact on yields from any local water supply wells.

The generally low permeability of the aquifer means that any impacts on groundwater levels will remain in very close proximity to the borrow pits and excavations.

Site Figures are provided in Appendix 8, EIS Volume III: Appendices.

Related figures, tables and geotechnical investigation (Trial pits, peat stability etc) information is provided in Chapter 7 Soils and Geology and in Appendix 6 and 7 of the EIS Volume III Appendices.

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Wind Farm Development Guidelines for Planning Authorities (September, 1996).

9 AIRBOURNE NOISE

This chapter addresses the impact of noise emissions from the proposed development. This chapter is based on monitoring and modelling carried out by Biospheric Engineering Ltd. This chapter has been prepared by Biospheric Engineering Ltd., with the work undertaken principally by Eugene McKeown, BE, LLB, MSc, C Eng.

All assessment Figures and Tables are presented in Appendix 9 of the EIS Volume III Appendices.

The main purpose of the study was to:

- Establish the existing noise levels in the environs prior to the proposed development;
- Project and assess all of the potential the noise levels which may be generated at different wind speeds by the proposed development;
- Provide a full potential noise impact assessment for all surrounding sensitive receptors such as private dwellings;
- Advise on appropriate mitigation measures.

9.1 Noise

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment and is normally localised.

Environmental noise is normally assessed in terms of A-weighted decibels, dB(A), when the 'A weighted' filter in the measuring device elicits a response which provides a good correlation with the human ear. The criteria for environmental noise control are of annoyance or nuisance rather than damage. Noise emissions from wind farms are regulated under planning law and specific planning guidelines for the development of wind farms have been published by the Department of Environment, Heritage and Local Government.

Construction and industrial noise sources are normally assessed and expressed using equivalent continuous levels, L_{Aeq}. Another parameter of major importance is the L_{90}, which is regarded as the "background" noise level.

Noise emitted by wind turbines can be associated with two types of noise source. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources which are associated with components of the power train within the turbine, such as the gearbox and generator and control equipment for yaw, blade pitch, etc. These sources normally have different characteristics and can be considered separately. It should be noted that the gear box is generally the most significant from of noise from wind farm developments, however the chosen turbine for the Coor project is the Enercon E82, One of Enercon's key innovations is the gearless (direct drive) wind turbine in combination with an annular generator.

9.1.1 Mechanical Noise

Mechanical noise is normally perceived within the emitted noise from wind turbines as an audible tone or tones which is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are normally associated with: the gearbox and the tooth mesh frequencies of the step-up stages in older turbines; generator noise caused by coil flexure of the generator windings which is associated with power regulation and control; generator noise caused by cooling fans and control equipment noise caused by pitch regulation and yaw control.

Turbine manufacturers now ensure that sufficient forethought is given to the design of quieter gearboxes and generators. Design improvements now mean that modern turbines do not emit any clearly distinguishable tones. As previously mentioned the Enercon E-82 turbine proposed for this development has no gearbox in the nacelle.

9.1.2 Aerodynamic Noise

Aerodynamic noise produced by the passage of the rotor blades through the air. The main noise source emissions from modern turbines are those associated with aerodynamic noise, however with continuing improvements in design, lower rotational speeds produce higher rated outputs. Aerodynamic noise is broad band in nature and therefore closely simulates noise generated from the interaction of wind on trees/vegetation. It is accepted internationally that there are no audible tonal or impulsive emissions from turbines.

9.2 Noise Assessment Methodology

As recommended in the Wind Farm Planning Guidelines published by the Department of Environment, Heritage and Local Government (2008), noise impact has been assessed with reference to the nature and character of the noise sensitive locations in the vicinity of the site.

The methodology comprised of the following steps:

- Measurement of existing background noise levels;
- Prediction modelling of turbine noise;
- Recommendation of mitigation measures where required.

9.2.1 Noise Guidelines

The Wind Farm Planning Guidelines published by the Department of Environment, Heritage and Local Government state:

In general, a lower fixed limit of 45 dB(A)10 or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy

developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).

Separate noise limits should apply for day-time and for night time. During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night.

As can be seen below the background noise level can drop below 30 dBA during the day in light winds. A daytime LA90, 10 min of 37.5 dBA has therefore been adopted as an appropriate limit. Based on the Wind Farm Planning Guidelines, the appropriate night time limit is 43 dBA. As the turbines operate on a round the clock basis the critical value is therefore the day time limit of 37 dBA (rounded down).

9.2.2 Noise Sensitive Locations

A number of properties, 27 in total were identified in the vicinity of the proposed wind farm. The location of these is set out in Figure 9.1 Noise Sensitive Locations (see Appendix 9, EIS Volume III).

While 27 locations were identified the following belong to project developers and are not considered as noise sensitive as with the non-project related noise sensitive locations.

- Residence 16 (formerly M. Crowley)
- Residence 17 (J. McMahon)
- Residence 24 (M. Glynn)

As these locations are related to an interest in the proposed development they can be discounted from further consideration in this chapter.

9.3 Background Noise Levels

Background noise levels were measured on the site on the 17th and 18th of December 2010. Measurement locations are set out in Figure 9.2 Noise Measurement Locations (see Appendix 9, EIS Volume III).

Measurements were taken using a Bruel & Kjaer model 2260 type 1 sound level meters with modular real-time analysis using BZ7210 noise analysis module and BZ 7208 FFT module. The instruments were calibrated using a Bruel & Kjaer model 4231 sound level calibrator. The system was calibrated by Bruel and Kjaer 10th August 2010. No drift in calibration was evident during the monitoring period. Post Measurement analysis was carried out using Bruel & Kjaer Noise Explorer software. During measurement the height of the microphone was 1.3 metres above ground at the sampling location.

The noise measurements on site were carried out using a weatherproof enclosure with the microphone mounted on a stainless steel pole. The microphone was enclosed in a Bruel & Kjaer UA 1404 Outdoor Microphone Kit. This microphone kit is capable of operating at windspeeds in excess of 30 metres per second. B.S. 4142 *Rating of Industrial Noise affecting mixed residential and industrial areas* indicates that windshields are effective in wind speeds up to 5 m/s. The performance of the UA 1404 is vastly superior to that of a windshield and would appear to have no impact on measurements in windspeeds of up to 10m/s.

Noise measurements were taken in accordance with International Standards Organisation ISO 1996 – Acoustics – Description and Measurement of environmental noise.

A long term noise measurement was carried out at location 'Meas 1' to correlate wind speed with background noise level (see Figure 9.2, Appendix 9, EIS Volume III).

9.3.1 Background Noise vr's wind speed

In order to determine how the background noise level varies with wind speed, a series of measurements were carried out at the base of the wind mast on site and the resulting plot of Wind Speed vr's Background Noise (LA90) is plotted in Figure 9.3 Coor Wind Farm ETSU Curve – No Mitigation (see Appendix 9, EIS Volume III).

As can be seen from this curve, which included overnight measurements, the background noise level can drop down to 20 dBA in still conditions. Above 8 m/s the noise level increases significantly.

Based on the Department of Environment, Heritage and Local Government wind farm planning guidelines (2008), the area can be considered a 'low noise' area therefore the daytime noise limit has been set at 37 dBA at windspeeds below 7 m/s and background plus 5 dBA for wind speeds above this threshold.

9.3.2 Wider Area Background Noise Levels

The background noise levels in the area are typical of a rural area. Daytime activity (farming & local traffic) that can reach levels around 50 dBA, with occasional peaks in excess of that. We are particularly interested in LA90 levels and specifically what are the lowest levels recorded. It can be seen that levels in the region of 25 to 30 dBA occur, in particular during calm weather.

It must be stressed that these noise levels are outdoor noise levels. Noise levels are reduced by 15 dBA from outdoor to indoor, allowing for a window being left ajar (partly open). The noise level in a typical living room with the television on is 65 to 70 dBA and in a quiet bedroom 35 dBA. The noise level limit for night time is set at 45 dBA to ensure bedroom levels remain around 30 dBA.

It is at low noise levels the question of audibility arises, while the noise level is below acceptable noise level limits, it may be possible under certain meteorological conditions to hear the noise if you are outdoors.

The noise levels recorded in the wider area of the proposed wind farm are as follows:

Table 9.1 Background Noise Level Measurements 17 Dec 2010.

Location	**Time**	**LAeq**	**L90**
Near Residence 6	12:28	50	31
Near Residence 7	12:51	34	27
Crossroads at Residences 11 to 15	13:23	38	30
Near residences 16 and 17	14:15	44	32
Near residences 21 to 24	14:47	42	32
Near Residences 23 to 27	15:13	49	35
Near Residences 1 to 4	15:40	38	33

9.4 Potential Impacts

The potential impacts of the development can be broken down in two phases; noise impacts during construction and noise impacts during operation.

9.4.1 Potential Impacts during Construction

The main activity associated with construction will involve road construction and the placing of turbines in-situ. Construction noise levels tend to be loud for short periods coinciding with peak construction activity. As most of the noise sensitive locations are located several hundred meters from a turbine, the impact on any individual location is likely to be minimal.

Construction activity will comprise standard construction techniques using standard equipment. L_{eq} measurements taken of construction noise sources at other sites at 20m from the geometric centre of activity when equipment was in continuous operating mode are given in Table No. 9.2.

Table 9.2 Construction Noise Sources.

Noise Source	dB (A)
Readymix truck	70 dB(A)
Large Excavator	73 dB(A)
Volvo dump truck	71 dB(A)
JCB wheeled excavator	68 dB(A)

All construction will be carried out in accordance with BS 5228: Part 1: 1997 (Noise Control on Construction and Open Sites - Part 1. *Code of Practice for Basic Information and Procedures for Noise Control*). Accordingly all construction traffic to be used on site should have effective well-maintained silencers. Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery. Where possible the contractor will be instructed to use the least noisy equipment. With efficient use of well-maintained mobile equipment considerably lower noise levels (3-6 dBA) than those usually associated with construction projects can be attained. The Project Engineer will closely supervise all construction activity. Construction activity due to its nature is a temporary activity and thus any impacts will be short term. All construction works will be carried out during the day-time period.

Material deliveries and work force movements will be via the local road network. The increase in traffic flow along the local road network will be insignificant. There is a logarithmic relationship between noise levels and traffic volume. Typically, doubling the traffic flow produces a 3 dB(A) change in noise level. The increase in noise levels resulting from construction road traffic will be no more than marginal and there will be no night time traffic noise associated with the proposed development.

9.4.2 Potential Operational Phase Impacts

The turbine sound power in 9 octave bands at varying (hub) windspeeds is indicated below This data is based on manufacturers data for the Enercon E-82 turbine (Table No. 9.3). This data was then used to prepare a noise prediction model for the proposed development comprising six turbine sources.

The noise prediction model chosen was constructed using Bruel & Kjaer "Predictor" Package. The Predictor software package is a comprehensive acoustic modelling system. The program calculates the received noise level from specified sources, propagated via intermediate obstacles and media, based on national and international standards. Consequences of noise reduction measures can be rapidly assessed and it is possible to compare calculated, measured and permitted values.

Model data is held in a database under the complete control of Predictor. The types of item in a model include sound sources, objects and sound receivers. Each item has positional information, which relates it to the base area in 3-D terms. The base area is usually superimposed upon a 2-D topographical map, the background, which is used to align each item in the model relative to an actual survey of the area under study.

The models in the variants can be calculated to predict the sound pressure levels at the receiver points. The calculation for each model is done with a specific calculation method ISO 9613.1/2.

The model based on the sources outlined above is a comprehensive model containing sound power data. A three dimensional receptor grid for the area contains receptor points which enables noise contour levels to be plotted for the area surrounding the proposed development.

Table 9.3 Turbine Sound Power Levels.

Wind speed m/s	L_{WA} dB	Octave bands (Hz) Sound Power Levels dB (unweighted) per band								
		31.5	63	125	250	500	1k	2k	4k	8k
5	95.7	81.4	81.4	87.4	87.9	90.1	89.9	83.6	71.2	70.5
6	100.2	84.4	84.4	91.1	91.5	95.2	95.4	88.5	75.3	74.9
7	102.3	85.2	85.2	92.5	93.9	97.3	97.4	91.1	78.2	74.1
8	104.1	85.5	85.5	93.1	94.5	98.1	98.4	92.1	79.3	73.3
9	103.5	86.7	86.7	94.7	94.4	97.4	98.8	93.9	81.6	73.5

Data based on Enercon E82 E2 2.3MW Turbine, Test Report 209244-04.01 IEC.

Sound Pressure Levels are normally stated to the nearest dB due to measurement uncertainty. The desired result at 6m/s and 7m/s windspeeds is therefore a sound pressure level of 37 dBA at noise sensitive locations. At higher windspeeds it is desirable to remain below the background noise level.

The following standards are used in the ISO industry calculation method:

ISO 9613-1 Acoustics – Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere;

ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation;

VDI 2571 Schallabstrahlung von industriebauten.

9.4.3 Prediction Results

Seven separate models were prepared as follows (all windspeeds at 10 metres above ground level). All Figures 9.5 to 9.11 supplied in Appendix 9, EIS Volume III (Appendices) as follows:

Figure 9.5 The noise level at 5 m/s.
Figure 9.6 The noise level at 6 m/s.
Figure 9.7 The noise level at 7 m/s.
Figure 9.8 The noise level at 8 m/s.
Figure 9.9 The noise level at 9 m/s, above which wind noise increases at a greater rate than turbine noise.
Figure 9.10 The noise level at 6 m/s with mitigation measures in place.
Figure 9.11 The noise level at 7 m/s with mitigation measures in place.

The results of the model calculations are illustrated in the attached Noise Models.

The predicted noise levels under the various scenarios are outlined below in Table No. 9.4.:

While the noise levels in the turbine area are elevated the levels reduce rapidly with distance. In addition the geographical layout of the wind farm, the natural attenuation due to the ground contours also assist in mitigating the noise levels. Significant effort has been carried out to provide a very detailed topographical survey of the site; the final resolution is notably accurate. This topographical data has been input to the noise models. The models indicate that the proposed wind farm Guideline Noise Limits will be exceeded at noise sensitive properties at wind speeds of 6m/s and 7m/s. The predicted noise levels are as follows:

Table 9.4 Noise Prediction Results.

Wind Speed m/s	Noise Limit dBA	Impacted Properties	Mitigation	Residual Impact
5	37	16	None	16
6	37	16, 24 4, 7, 8, 20, 23	None	
6	37		T4 & T6	16,24
7	39	16,24 4, 7, 8, 20, 23	None	
7	39		T3, T4, T5 & T6	16,24
8	44	16	None	16
9	50	16	None	16

The noise levels are easily mitigated by de-rating the turbines indicated. De-rating is the process where individual turbines which may have the potential to cause a noise impact at a noise sensitive location are programmed to cut out i.e. reduce output or stop operating at certain wind speeds. Turbines are generally de-rated or programmed to stop working at low or intermediate wind speeds which have associated low background noise levels. This has an impact on Wind Farm output at

intermediate wind speeds. The only locations with residual impacts are in the ownership of the Wind Farm developers.
While these levels are within the acceptable limits this does not mean that the noise from the wind farm will be inaudible at all times. Certain adverse wind conditions could lead to some persons (when outdoors) being able to hear a noise from the turbines. This will not generally be the case however, as in most conditions the wind farm will be inaudible at all noise sensitive locations in the locality.

The wind farm therefore complies with the DoEH&LG guidelines (2008), complies with good practice and does not generate noise levels that are likely to cause a nuisance.

9.5 Mitigation Measures

Mitigation measures are required to ensure the wind farm is constructed and operated in compliance with the Department of Environment, Heritage and Local Government Guidelines (2008) during the construction and operational phases.

9.5.1 Mitigation During Construction

The site activity associated with the construction of the wind farm (placement of turbines) will result in maximum hourly L_{eq} values in the region of 65 dB (A) at the nearest residence during normal working hours, while for most of the construction period the Leq values will be considerably less than 55 dB (A).

9.5.2 Mitigation during Operational Phase

All pertinent points relating to mitigation are outlined below:

- Noise levels do not exceed the guideline figure of 37 dB at wind speeds below 7m/s and background plus 5dBA at wind speeds of 7m/s and above;

- In event of any malfunction of the turbines, which may cause a tonal, or impulsive noise emission, immediate action will be taken to correct same. These action (if necessary) will form part of the contractural maintenance works associated with the running and operation of the turbines;
- All proposed turbines are located at appropriate distances from all residences as part of the final site layout;
- Operational control measures (pre-programmed de-rating) on individual turbines will be implemented as required to mitigate noise levels at higher wind speeds. These are required on turbines numbered T3, T4, T5 and T6;
- Following installation a long term noise monitoring programme will be agreed with the County Council to ensure compliance with the noise limits.

9.6 Conclusions

The noise emission from wind farms tends to be steady broadband noise with significant energy in the inaudible low frequency spectrum. Noise emissions close to wind farms tend to equate to natural (non-man made) sounds and is normally characterised as wind generated noise, noise emanating from the wind effects on trees, shrubs etc. The noise characteristic will closely simulate noise emission from wind effects on trees / vegetation. When wind is away from residences, the noise emission should be indiscernible. In most rural areas the ambient noise environment is controlled in the main by the wind speed influences / interaction on wind on foliage / vegetation – the higher the wind speed the higher the noise levels generated. Level for level, wind turbine generated noise is less objectionable than industrial or road traffic noise. In elevated wind speeds, above 8m/s, the noise emissions from the wind farm will be masked either partially or totally. In periods of low wind speed the

turbines will not operate, as the cut-in speed will be fixed. There will be no tonal or impulsive sounds contained in the wind farm noise emissions.

In summary the noise from the wind farm will not exceed the Wind Farm Planning Guidelines (2008) at any noise sensitive location for wind speeds below 6 m/s. At 6m/s and 7m/s mitigation measures comprising a de-rating of a limited number of turbines can easily control noise levels to within the guidelines.

The noise levels from the wind farm (37 dBA) and are 8 dB below the permitted level of a fossil fuelled equivalent electrical generator.

References

1. County Clare Wind Energy Strategy, Clare County Council, 14th Dec. 2009.
2. Planning Guidelines for Wind Energy Developments, Department of Environment, Heritage and Local Government.
3. Best Practice Guidelines for the Irish Wind Energy Industry, Irish Wind Energy Association, 2008
4. Dept of Trade & Industry UK (ETSU), The Assessment and Rating of Noise from Wind Farms Energy Technology Support Unit, 1996.
5. ISO 1996-1 Acoustics – Description and measurement of environmental noise – Part 1: Basic quantities and procedures
6. ISO 1996-2 Acoustics – Description and measurement of environmental noise – Part 2: Acquisition of data pertinent to land use
7. ISO 1996-3 Acoustics – Description and measurement of environmental noise – Part 3: Application to noise limits
8. ISO 9613-1 Acoustics – Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere;
9. ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation;
10. BS 5228-1 Noise & Vibration control on construction and open sites Part 1- Code of practice for basic information and procedures for noise and vibration control

10 AIR QUALITY AND CLIMACTIC FACTORS

This Chapter provides an assessment of baseline air quality at the proposed development locality and assesses air quality in terms of short term potential impacts and long term potential residual impacts. In addition the climatic environment for the locality is presented and applied for the assessment of air quality and local climactic factors.

10.1 Introduction

Despite the continued reliance on fossil fuel generated energy, Ireland as a whole is relatively free of air pollution, when compared with other more industrialised countries. The biggest threat facing air quality in Ireland is emissions from road traffic and the burning of fossil fuels. The combustion of fossil fuels for energy remains the principal source of air pollutants such as particulate matter, surphur dioxide (SO_2), nitrogen oxides (NOx) and carbon monoxide (CO). Until the phasing out of lead it was also the main source of lead in the air.

Scientific evidence is uncompromising in attributing the increase in levels of greenhouse gases in the atmosphere to the progression of climate change (IPCC 2007). Human-induced climate change is a global issue and is the primary environmental challenge of this century. The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) (1998), adopted in 1997, imposes legally binding emissions targets to be achieved in the period 2008 – 2012. These changes include;

- 5% overall reduction in the emission of greenhouse gases in developed countries
- 8% reduction below 1990 levels within the EU
- Ireland's contribution is a limit of 13 % above 1990 levels

- countries not fulfilling their obligations will be forced to purchase carbon credits on an open market from compliant countries

Ireland's target is to limit the growth of emissions to 13% above 1990 levels. In 2007 Ireland's emissions were 24.6% above the level for 1990, the base year for Kyoto targets (Ireland's National Greenhouse Gas Emissions Inventory 2007). The EPA has produced provisional estimates of greenhouse gas emissions for 2009. In 2009, the total national greenhouse gas emissions were estimated to be 62.32 million tonnes carbon dioxide equivalent (Mt CO_2eq), which is significantly lower (7.9% lower) than emissions in 2008. While this closes the gap to our Kyoto Protocol limit, it still results in an overall exceedance of the limit by 6.21 Mt CO_2eq (Ireland's National Greenhouse Gas Emissions Inventory 2009).

The main contributors to Ireland greenhouse gas emissions in 2009 include:

- agriculture – 29.1%
- transport and energy 21.1% (energy down 10.7% compared with 2008)
- industry and commercial – 14.8% (down 20% compared with 2008)
- residential – 12%
- waste 1.9%

The lower emissions primarily reflect the downturn in economic activity during 2009. A reduced demand for electricity from end-users in Ireland, coupled with a rise in the share of renewables to 14.1%, reflected an overall decrease (10.7%) in emissions from energy in 2009 (Ireland's National Greenhouse Gas Emissions Inventory 2009).

Penalties will be imposed on countries not meeting their Kyoto targets. These countries will be forced to buy 'carbon-credits' from over-compliant countries with carbon emissions lower than the allowable limit. If Ireland does not meet the emissions reduction goals set by the Kyoto Protocol and upheld by the EU, significant fines could be levied on the Irish Government.

The Kyoto Protocol is, however, only a first step in addressing the serious global threat of climate change. The ultimate goal of the UNFCCC is to stabilise atmospheric concentrations of greenhouse gases at a level that prevents human interference with the climate system. Thus, in January 2008, the EU Commission put forward a package of proposals to deliver a 20% reduction in total EU greenhouse gas emissions by 2020 (relative to 1990 levels) and at the same time to increase to 20% the share of renewable energies in energy consumption. The emissions reduction will be increased to 30% by 2020 when a new global climate change agreement is reached (Ireland's National Greenhouse Gas Emissions Projections to 2020, 2008).

10.2 Relevant Legislation

The European Air Quality Framework Directive (96/62/EC) set out the principles of ambient air quality monitoring, assessment and management and was followed by four daughter directives;

- Air quality 1st Daughter Directive (99/30/EC) deals with sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead.
- Air quality 2nd Daughter Directive (2000/69/EC) deals with carbon monoxide and benzene.
- Air quality 3rd Daughter Directive (2002/3/EC) deals with monitoring of ozone levels.

- Air quality 4th Daughter Directive (2004/107/EC) covers polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air.

Air quality monitoring, assessment and management in Ireland is now carried out in accordance with the Clean Air For Europe (CAFÉ) Directive of 2008 (2008/50/EC). These Regulations transpose the European Air Quality Framework Directive (96/62/EC) and the above daughter Directives into Irish Law, and establishes new air quality standards, reference methodology and dates by which the limit values for each pollutant must be achieved.

Table 8.1 shows the limit or target values specified by the five published Directives that set down limits for specific air pollutants. The four Directives cover;

- sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead;
- carbon monoxide and benzene;
- ozone;
- polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air.

Table 10.1 Limit values specified by Directive 2008/50/EC for specific air pollutants.

Pollutant	Averaging Period	Limit Value ug/m^3	Basis of Application of the Limit Value	Limit Value Attainment Date
SO_2	1 hour	350	Not to be exceeded more than 24 times in a calendar year	1 Jan 2005
SO_2	24 hours	125	Not to be exceeded more than 3 times in a calendar year	1 Jan 2005
NO_2	1 hour	200	Not to be exceeded more than 18 times in a calendar year	1 Jan 2010

Pollutant	Averaging Period	Limit Value ug/m^3	Basis of Application of the Limit Value	Limit Value Attainment Date
NO_2	calendar year	40	Annual mean	1 Jan 2010
$NO + NO_2$	calendar year	30	Annual mean	19 July 2001
PM_{10}	24 hours	50	Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM_{10}	calendar year	40	Annual mean	1 Jan 2005
$PM_{2.5}$ – Stage 1	calendar year	25	Annual mean	1 Jan 2015
$PM_{2.5}$ – Stage 2	calendar year	20	Annual mean	1 Jan 2020
Lead	calendar year	0.5	Annual mean	1 Jan 2005

(Source http://www.epa.ie)

10.2.1 Specific Air Pollutants

10.2.1.1 Sulphur Dioxide

SO_2 is a major precursor to acid rain, which is associated with the acidification of soils, lakes and streams, and accelerated corrosion of buildings and monuments. It is an irritant gas which attacks the throat and lungs. Prolonged exposure can lead to increases in respiratory illnesses like chronic bronchitis. The main source of SO_2 in Ireland is burning of coal and oil to heat homes and industries and to produce electricity. In general SO_2 is not a pollutant of concern in Ireland. Low levels of SO_2 have been achieved by substantial fuel switching from high sulphur fuels such as coal and oil to natural gas, decreases in the sulphur content of oil and integrated pollution control licensing. To date there is no difficulty in complying with the health related limits for SO_2.

10.2.1.2 Nitrogen Oxides

Nitrogen oxides (NO_x, being nitric oxide (NO) and nitrogen dioxide (NO_2)) are harmful to the respiratory system, contribute to the formation of acid rain and are also involved in the formation of ground level ozone. Primary health effects are emphysema and cellular damage.

Emissions from traffic are the main source of nitrogen oxides in Ireland along with electricity generating stations and industry. The levels of NO and NO_2 in urban areas are largely determined by traffic volumes and they vary considerably in space and time. Levels in Ireland are moderate but increasing due to growth in traffic numbers. NO_2 concentrations in major urban areas, particularly Dublin, indicate that NO_2 levels are close to the 2010 air quality standards. For this reason, nitrogen oxides are one of the highest priority pollutants for monitoring and control.

10.2.1.3 Ozone

Ozone is a natural component of the atmosphere. Most ozone is found high up in the stratosphere, the layer of the atmosphere between 12 km and 50 km above sea level. Stratospheric ozone is essential to life on earth as it protects us from harmful rays of the sun.

Ozone is also found in the troposphere, the layer of the atmosphere next to the earth. Ozone is a secondary pollutant formed by the interaction of nitrous oxides, carbon monoxides and various volatile organic compounds in the presence of sunlight. High concentrations of ground level ozone can effect the functioning of the respiratory system and damage crops and other vegetation. Exposure to high concentrations of troposphere ozone causes chest pains, nausea and coughing in humans. Tropospheric ozone contributes to the greenhouse effect and subsequent global climate change. Ozone levels recorded in Ireland are generally low and as such ozone is not an environmental problem here.

10.2.1.4 Particulate Matter

Particulate matter (dust) can be formed from reactions between different pollutant gases. In recent years the assessment of particulate matter has focussed on the smaller particles of less than 10 and less than 2.5 microns. The coarse fraction, PM_{10} consists of particles with an aerodynamic diameter smaller than 10 µm. Particles of this size can reach the upper part of the airways and lung. The fine fraction, $PM_{2.5}$, consists of particles with an aerodynamic diameter smaller than 2.5 µm.

These may be considered as more dangerous because they penetrate more deeply into the lung and can reach the alveolar region. There are many sources of particulate matter including vehicle exhaust emissions, soil and road surfaces, construction works, industrial emissions, quarrying, and combustion of fuels in power plants. There are high levels of PM_{10} in many cities and towns.

10.3 Air Quality in the Existing Environment

Air quality in Ireland is regarded as good, particularly in rural areas such as west Clare where prevailing south westerly winds carry clean, unpolluted air from the Atlantic Ocean onto the Irish mainland.

The CAFÉ Directive deals with each EU Member State in terms of 'Zones' and 'Agglomerations'. For Ireland, four zones are defined in the Air Quality Regulations (2002). The site of the proposed Coor Shanavogh Wind Farm in Co. Clare lies within Zone D. Zone D represents rural areas located away from large population centres.

The air quality index is calculated based on the latest available measurements of ozone, nitrogen dioxide, PM_{10} and sulphur dioxide within each Zone. Zone D, within which the proposed development lies, has a current air quality index of 'Good'. Table 8.2 outlines the Air Quality Index values.

Table 10.2 Air Quality Index Values.

Index	SO_2 (1 hr avg, µg/m^3)	No_2 (1 hr avg, µg/m^3)	O_3 (1 hr avg, µg/m^3)	PM_{10} (24 hr avg, µg/m^3)
Very Good	0 – 49	0 – 36	0 – 39	1 – 19
Good	50 – 129	37 – 94	40 – 119	20 – 49
Fair	130 – 209	95 – 139	120 – 179	50 – 74
Poor	210 – 349	140 – 199	108 – 239	75 – 99
Very Poor	≥ 350	≥ 200	≥ 204	≥ 100

(Source: www.epa.ie**)**

Both the EPA and the UK Environment Agency undertake continuous ambient air monitoring at various sites in Ireland and Northern Ireland. There are 53 air quality monitoring stations nationwide, the closest of which to the proposed Coor Shanavogh Wind Farm is located in Ennis town. Ennis is an urban area with a population greater than 15,000 and therefore lies within Air Quality Zone C. Zone C also has a current air quality index of 'Good'.

An air quality assessment for all required parameters was carried out at Ennis in 2006/ 2007. The site was located in the Ennis Town Council yard and assessment monitoring was done using a mobile unit containing continuous monitors for sulphur dioxide, nitrogen oxides, carbon monoxides and benzene. Continuous samples were also taken for PM_{10} and lead. Results were collected from January 25th 2006 to April 18th 2007.

Hourly averages are produced for the gases while the particulate and lead samples are taken away for laboratory analysis every three weeks. Results are compared with the assessment thresholds in the Air Quality Regulations (2002) to determine the type of monitoring required long term.

No limit values have been exceeded at Ennis during the ambient air modelling programme which commenced on January 25th 2006, with the exception of PM_{10} which is above the upper assessment threshold. Concentrations of carbon monoxide, sulphur dioxide, nitrogen dioxide, benzene and lead are currently below their respective lower assessment thresholds. The implications of this assessment are that levels of PM_{10} must be monitored continuously.

Continuous monitoring of PM_{10} and $PM_{2.5}$ began in March 2009. A sulphur dioxide analyser was also installed in January 2010 at Ennis. Figure 8.1

shows the results for PM_{10} and $PM_{2.5}$ monitoring for the month of December 2010. Sharp changes in levels are often due to maintenance visits. There have been 13 PM_{10} exceedences in 2010. PM_{10} limits are deemed breached if more than 35 exceedances have occurred. Figure 8.2 shows the results for SO_2 monitoring for the period 3rd to 10th January 2011.

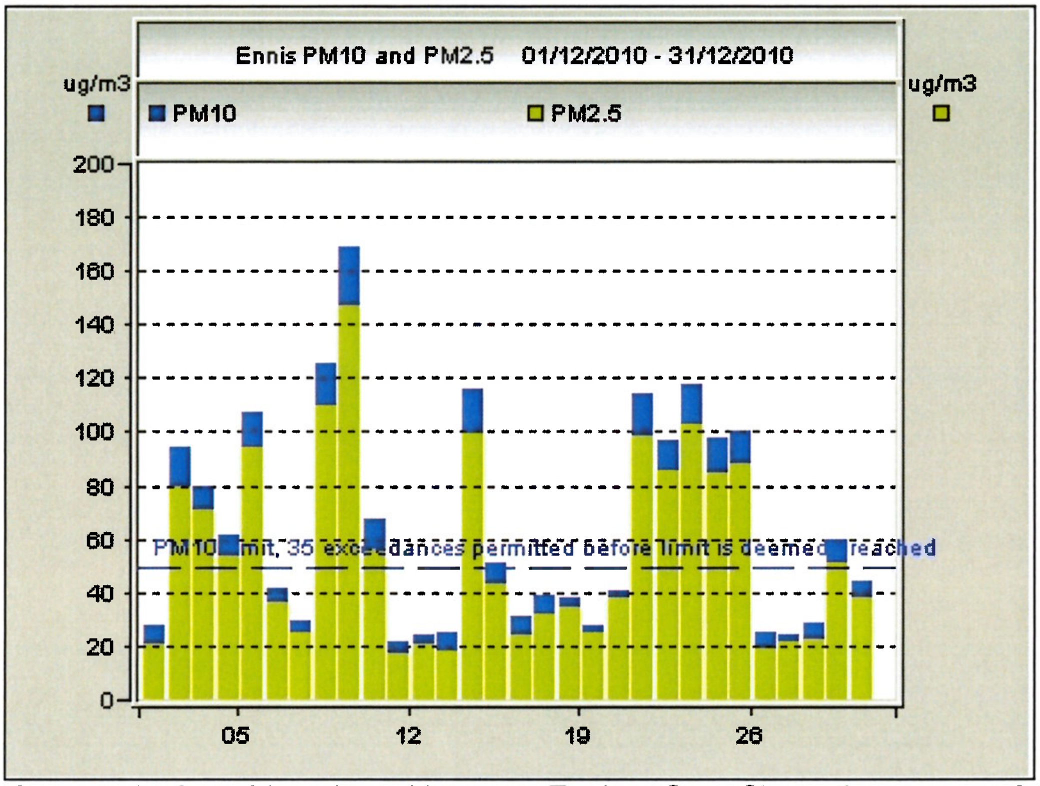

Figure 10.1: PM_{10} deposition at Ennis, Co. Clare (courtesy of www.epa.ie).

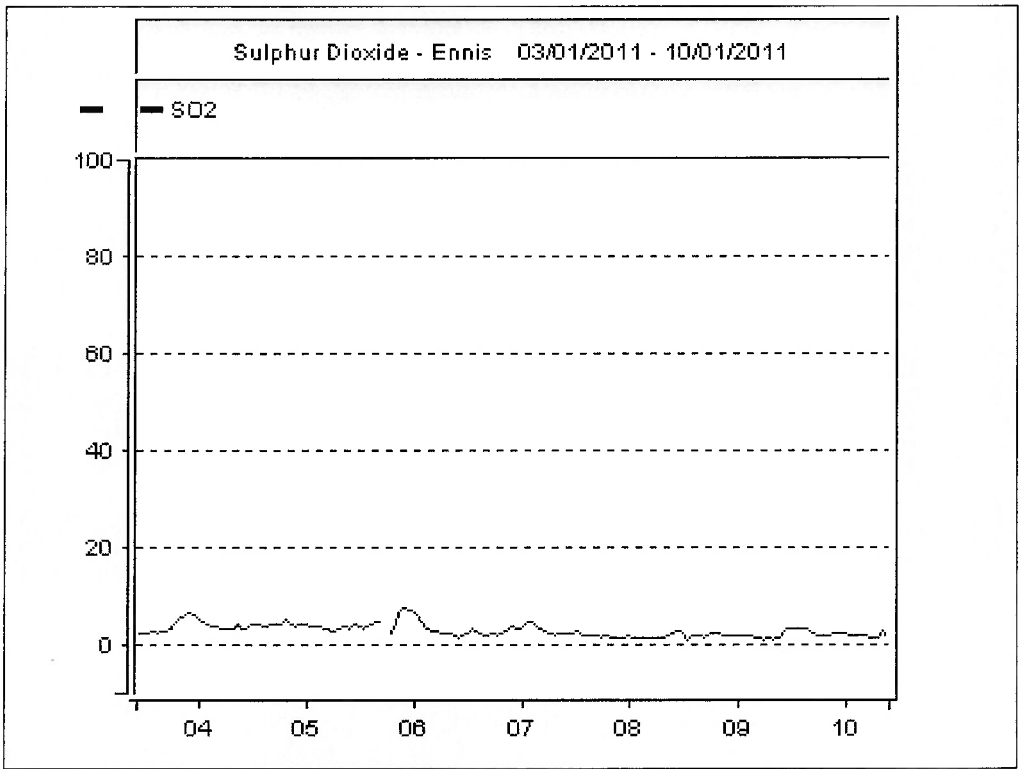

Figure 10.2: SO_2 deposition at Ennis, Co. Clare (courtesy of www.epa.ie).

The Ennis air monitoring site was last visited on the 6th January 2011, at which time there was an instrument problem with the particulate monitor.

The primary sources of air pollution in the vicinity of the proposed development at Coor Shanavogh are considered minimal but include;

- exhaust emissions from machinery associated with the forestry industry
- agricultural activities such as spreading of fertilizer, and to a less extent insecticides

10.3.1 Climate in the Existing Environment

The dominant influence on Ireland's climate is the Gulf Stream. Consequently Ireland does not suffer from the extremes of temperature experienced by many other countries at similar latitude. Average annual temperature is about 9°C. The nearest synoptic station is located at

Shannon Airport, approximately 25 km east of the site. The nearest climatilogical station is in Kilmaley, Co Clare 15 km to the east of the site.

Rainfall

Rainfall in the west generally averages between 1000 and 1400 mm. In many mountainous districts rainfall exceeds 2000mm per year. The wettest months, are December and January. April is the driest month generally across the country. Hail and snow contribute relatively little to the precipitation measured.

The met Eireann statistics indicate that the Coor wind farm is within and area where rainfall is 1200 to 1600 mm per year for the locality

Hourly totals exceeding 25mm are rare in this country and when they do occur they are usually associated with heavy thunderstorms.

Wind speeds

Wind is the movement of air caused by pressure differences at the earth's surface, which in turn are caused by the differential heating of the earth's surface by the sun. Winds play a key role in the global transport of heat and energy. The wind regime at the surface is influenced by local topography. Wind measuring sites need to be open, level and free from obstructions due to buildings and trees etc., for this reason wind speed and direction are measured generally at 10m above ground level. Wind blows most frequently from the south and west for open sites while winds from the northeast or north occur least often. In January the southerly and south-easterly winds are more prominent than in July, which has a high frequency of westerly winds. Easterly winds occur most often between February and May and are commonly accompanied by dry weather. Wind speeds recorded from the site meteorological mast indicate that the site has favourable wind speeds for a wind farm.

Sunshine duration

In Ireland the sunniest months are typically May and June. During these months, sunshine duration averages between 5 and 6.5 hours per day over most of the country. December is the dullest month with an average

daily sunshine level ranging from about 1 hour in the north to almost 2 hours in the south east. Over the year as a whole, most areas get an average of between 3.25 and 3.75 hours of sunshine each day
Mean sunshine duration at Shannon airport is approximately 3.5 hours per day; while the greatest daily duration was 16 hours between 1979 and 1988. The mean number of days without sun was 62.

10.3.2 Potential impacts of the development on Climate

The change in Irelands climate has been identified as one of the most serious environmental problems that Ireland faces at present. The EP| has stated that Ireland must quickly develop a greener economy involving energy efficiency and alternative energy sources. The release of greenhouse Gases is known to be a major contributor to global warming.

10.3.3 Potential interaction of local Climactic environment and proposed development

The proposed wind farm will have no notable or significant effects on wind directions, wind speeds, sunshine and/ or precipitation.

10.4 Potential Impacts 0n Air Quality

10.4.1 Construction Phase

The internal combustion engines used in the construction industry produce gaseous emissions including carbon dioxide (CO_2), carbon monoxide (CO), nitrous oxides (NOx), unburnt hydrocarbons and particulates. However, the primary issue with respect to construction and air pollutants is not related to exhaust emissions but to the potential generation of dust from the preparation of material for and laying of access tracks. The amount of dust created is a function of the terrain and weather conditions (dry conditions in high winds create the greatest amount of dust).

Dust not a likely significant issue on Irish sites due to the types of soil removed during road construction (more loam than sand), higher rain fall and vegetation cover.

During construction, increased vehicular movement will result in locally increased levels of exhaust emissions and dust. These impacts will be local, of temporary duration and their impacts are not considered significant.

10.4.2 Operational Phase

When in operation the wind farm will have indirect, positive impact on air quality. The proposed development will result in the production of up to 13.8 MW of energy from a renewable source which, once fed into the National Grid, will avoid pollution that would have been caused had the energy been generated by other means, such as the combustion of fossil fuels.

The change in Ireland's climate has been identified as one of the most serious environmental problems that Ireland faces at present (EPA 2000). The release of greenhouse gasses such as CO2 from the burning of fossil fuels is a known contributor to global warming (IPCC 2007). The most important greenhouse gasses are carbon dioxide, methane, nitrous oxide, hydrocarbons, perflurocarbons and sulphur hexafluoride (European Protection Agency http://themes.eea.europa.eu). Wind energy avoids the emissions of nitrogen oxides, sulphur dioxides and especially carbon dioxide, among others.

Every unit (kWh) of electricity produced by the wind displaces a unit of electricity which would otherwise have been produced by a power station burning fossil fuels. This is a generally accepted fact used by many organisations including the British Government in their environmental calculations (www.bwea.com). According to the British Wind Energy

Association (BWEA) emissions reductions can be calculated using the following formulae:

- CO_2 (in tonnes) = (A x 0.3 x 8760 x 430)/1000

  where A = the rated capacity of the wind energy development in MW

  0.3 is a constant, the capacity factor, which takes into account the intermittent nature of the wind, the availability of the wind turbines and array losses

  8760 is the number of hours in a year

A typical turbine being installed onshore in the UK currently has a rated capacity of 2 MW and will therefore contribute emission reductions of 2260 tonnes of CO_2 each year (www.bwea.com).

Thus a wind farm of capacity 13.8 MW, such as Coor Shanavogh, will contribute emission reductions of 36266 tonnes of CO_2 each year.

As outlined in the Introduction to this chapter, Ireland has committed to limiting greenhouse gas emissions to 13% above 1990 levels by 2012. In 2009 the total national greenhouse gas emissions were estimated to be 6.21 million tonnes carbon dioxide equivalent (Mt CO_2eq) above the Kyoto Protocol limit (Ireland's National Greenhouse Gas Emissions Inventory 2009). Furthermore, in January 2008, the EU Commission put forward a package of proposals to deliver a 20% reduction in total EU greenhouse gas emissions by 2020 (relative to 1990 levels).

The development of Coor Shanavogh Wind Farm will contribute to both the reduction in greenhouse gasses and to the EU Commissions' proposal to increase the share of renewable energies to 20% by 2020. Ireland's share of renewables currently stands at approximately 14.1% (Ireland's National Greenhouse Gas Emissions Inventory 2009).

10.4.3 Do Nothing Impact

If the proposed wind farm is not constructed, it is likely that the proposed site would remain as agricultural grassland, and conifer plantation. The

cumulative effect of continued large-scale fossil fuel consumption and limited renewable energy development is likely to have serious consequences for global climatic conditions. If Ireland does not further reduce its emissions to meet the targets set down by the Kyoto Agreement, then the likely financial penalties will be substantial.

10.5 Mitigation Measures for Air Quality

All construction machinery will be maintained in good operational order while on-site, minimising any emissions that are likely to arise.

The majority of the dust emitting activities, which occur with all forms of civil engineering, are easily controllable by best practice measures. Depending on weather conditions at the time of works, best practice measures may include;

- wheel wash facilities and use of a mechanised road sweeper at the public road entrance if mud transfer is identified as an issue;
- dust suppression by water spray on access roads and other areas if dust becomes an issue;
- use of appropriately covered vehicles for transport of potential dust generating material such as sand and cement; and
- control of vehicle speeds on access tracks and other unsurfaced areas.

10.6 Conclusion

The development of the wind farm will itself have a direct, neutral impact on air quality. The generation of electricity from the wind farm will result in an avoidance of greenhouse gas emissions that would otherwise occur from fossil fuel power generating plants. The avoided emissions therefore result in a small indirect, positive impact.

The development of the wind farm will not have any notable or significant impact on local climactic factors of rainfall, sunshine, wind duration, direction or wind speeds.

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11 SHADOW FLICKER & EMI

11.1 Introduction

The shadow flicker report assesses the potential interruption of sunlight, caused by the rotation of the wind turbine rotors, on both residential and other properties. Wind turbines can cast long shadows when the sun is low in the sky. The effect, known as shadow flicker, occurs where the blades of a wind turbine cast a shadow over a window in a nearby house and the rotation of the blades causes the shadow to flick on and off. The effect is rapidly reduced with increased distance. The flicker will only occur under the following circumstances:

- Sunny Conditions;
- The sun is at a low angle;
- Certain positions of the sun;
- When wind direction and window(s) are aligned;
- When the turbine rotor is turning and the sun is in a certain position.

11.1.1 Izzy projects

Izzy Projects is a Dutch company that specialises in delivering development services to the wind energy sector. Izzy Projects is managed by Pim de Ridder who is holding a MSc in Renewable Energy and who is active in developing wind energy projects since 1999. Since Mr. De Ridder joined the wind energy sector he worked on numerous projects in Ireland, The Netherlands, Canada, Norway and Germany all in the development phases of projects.

Over the years Mr. De Ridder has been working in the wind energy sector he developed himself as a specialist in the wind energy project design tool WindPro. Besides gathering experience in various projects Pim underwent formal WindPro training with EMD in Denmark in the following courses:

- WindPro basis (June 2001);
- WindPro Environment including Noise, Shadow and ZVI (June 2001);
- WindPro Energy I (Sept 2002;
- WindPro Energy II (Nov 2003);
- WAsP (Sept 2002).

Izzy Projects has worked on over 30 shadow flicker studies for wind energy projects around the world. A selection of projects includes:

- Moerdijk, 30MW, The Netherlands, 2010;
- Zuid-lob ,100MW, The Netherlands, 2010;
- Peckelsheim, 18MW, Germany, 2009;
- Coega, 24MW, South Africa, 2010;
- Port Hardy, 10MW, Canada, 2009;
- Kilbraney, 52,5 MW, Ireland, 2006;
- Curraheen, 32MW, Ireland, 2008;
- Vleemo, 16MW, Belgium, 2009.

In addition to executing studies Mr. De Ridder has acted as expert in several settlements around shadow flicker issues in wind energy projects.

11.2 Assessment criteria

The Wind Energy Development Guidelines include very clear outline regulations for shadow flicker. The guidelines regarding shadow flicker are one of the planning conditions for wind farms in Ireland. The guidelines state that 'careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. However, where shadow flicker could be a problem, developers should provide calculations to quantify the effect and where appropriate take measures to prevent or ameliorate the potential

effect by applying turbine management techniques which include turning off a particular turbine at certain times.'

11.3 Guidance

The guidelines recommend that shadow flicker at neighbouring premises offices, dwellings and other sensitive receptors within 500 meters should not exceed 30 hours per year or 30 minutes per day. Theory on shadow flicker indicates that at distances greater than 10 rotor diameters (820m in this case) from a turbine, the potential for shadow flicker is very low. There are 27 occupied dwellings within 820m of the proposed turbine positions, of which 14 occupied dwellings occur within 500 meters.
Please find below bulleted list of all reviewed and pertinent guidance literature:

- Planning Guidelines, department of Environment, Heritage and local government, Dublin;
- County Clare Wind Energy Strategy 2011;
- WindPro Users guide and instruction manual, EMD, Copenhagen, 2008;
- Climatological data, Met Eirrean, 2011.

11.4 Shadow Flicker Assessment Methodology

In order to calculate the shadow flicker, the angle of the sun, the frequency of sunny conditions, wind speed, wind direction and the location of sensitive receptors have to be taken into account.
WindPRO Version 2.7 software program was used to calculate the shadow flicker within the study area. This is Danish software (see www.emd.dk) and it is one of the current industry standards in wind farm design and planning.
The coordinates and dimensions of the turbines and a representative number of dwellings have been included on a topographic background in

WindPRO. Multiple shadow receptors have been defined for certain dwellings because they may experience shadow flicker from two different wind turbines from different directions.

The result of the calculation consists of a calendar, which specifies shadow nuisance, if any, per day (see Appendix 10, EIS Volume III). It shows the start and end times, the theoretic maximum duration and which turbine caused the shadow nuisance. This is referred to as the worst-case calculation in the program. The worst case is where there is always sunshine, always wind and the wind is always in line with the sun and the receptor. This is also called the Astronomic Maximum. All shadow flicker scenarios have been identified as part of this assessment and they are indicated appropriately.

11.5 Light intensity and angle

There is a large difference in light intensity between shadow at a short distance and shadow a long distance from a wind turbine. The level is greatest at a short distance as the rotor blade screens all the sun. Shadows at a greater distance have a low intensity as the blades do not cover the sun completely. If an observer experiences shadow when the sun is at a lower angle than 3°, the distance to the wind turbine will be so great that it is likely that the shadow is hardly perceivable. Also, where the sun is lower than 3°, the sunlight is likely to be screened by clouds, hedges, trees and buildings. In the calculation, it is assumed that shadow flicker will only occur when the angle of sun is greater than 3°.

11.6 Passing frequency

The passing frequency is the rate at which rotor blades cut the line of sight between an observer and the sun. The passing frequency is determined by the speed of the rotor and the number of rotor blades. The proposed turbines have a speed of no more than 20.5 revolutions per minute and three rotor blades. The maximum passing frequency from the turbines is therefore 61.5 times per minute, or a frequancy of 1.025 Hz.

Flicker from turbines that interrupt or reflect sunlight at frequencies greater than 3 Hz poses a potential risk of inducing photosensitive seizures. At 3 Hz and below the cumulative risk of inducing a seizure should be 1.7 per 100,000 of the photosensitive population[2].

Additional research has shown that most people experience the frequencies between 4 and 20 Hz as a nuisance - the highest sensitivity being between 8 and 10 Hz[3]. Below 2.5 and above 20 Hz virtually no nuisance is experienced. The proposed frequency from the wind turbines is well below the nuisance standard. The effects of passing frequencies are not considered an issue and therefore have not been considered further in this report.

11.7 Shadow flicker parameters

The potential impact of shadow flicker is reduced with increased distance from a turbine. However, as the distance from the wind turbines increases, the shadow flicker effect diminishes as the low-angle light bends around objects and becomes diffuse.[4] In the calculations, the shadow flicker is calculated up to a distance of 10 times the rotor diameter from each turbine, as this distance is indicated in chapter 5.12 of the Irish planning guidelines. The area of inspection is presented in Figure 12.1 and bordered by the orange line.

The orange contour line, see Figure 12.1 below represents a distance of 820m (ten times rotor diameter), within which six shadow receptors have been positioned. These six receptors have been positioned so that the most sensitive points are represented and at which the 30 hours per annum threshold might be exceed. These are the ones closest to the turbines and it is assumed that there will be a direct line of sight between the turbines and the windows of the buildings.

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[2] http://www.magasbakony.hu/szeleromu/Harding_et_al_Wind_turbines_flicker_epilepsy.pdf
[3] http://www.epilepsy.org.uk/campaigns/survey/windturbines and
[4] http://nepa.energy.gov/documents/EA-1737F_AppendixD-1_ShadowFlickerAnalysis.pdf

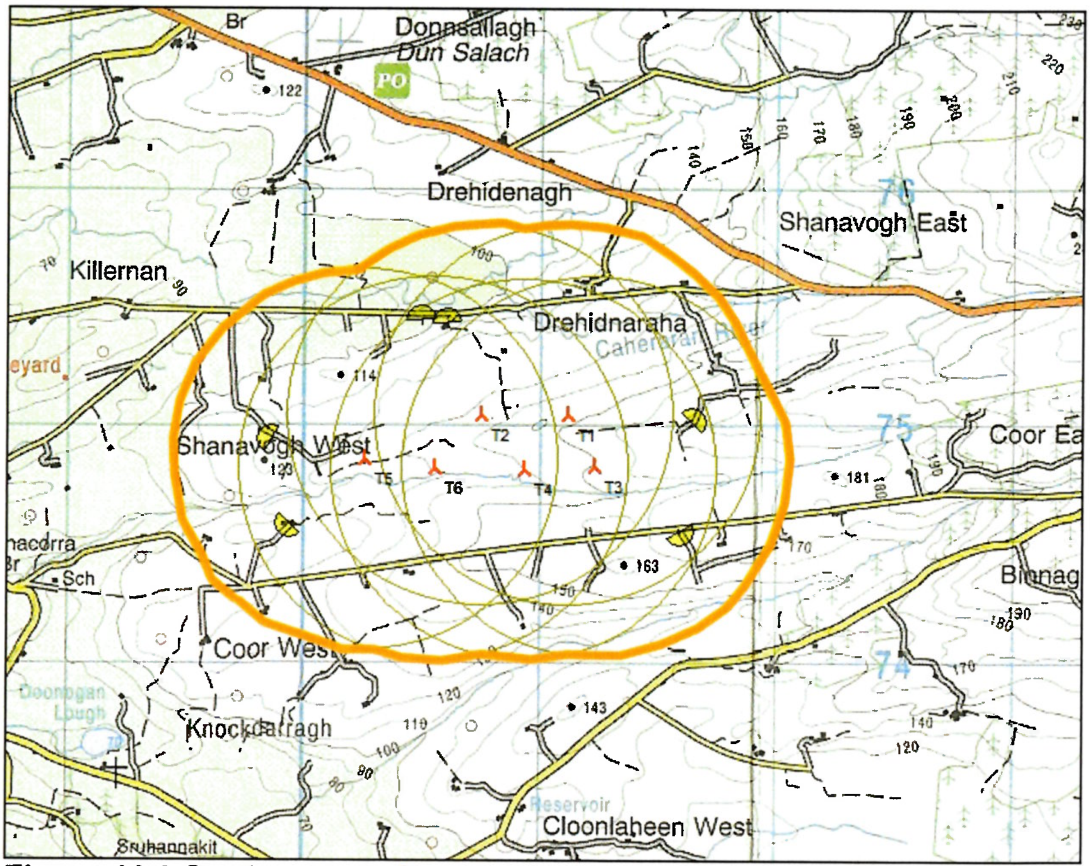

Figure 11.1 Starting points for the calculations. The red crosses specify the locations of the wind turbines. The orange contour line shows the 820m radius from a turbine (10 times rotor diameter).

11.8 Probability that there is sunshine

There will be no rotor shadow if the sun is not shining. This is the reason why the probability of the sun shining is taken into consideration. The values used in this study are average statistical probabilities deducted from long term measurement series that there is sunshine, as determined by the meteorological station at Birr. While Shannon met station is closer than Birr, Birr is selected because of the quality of the available time series is significant higher and recommended by EMD to use for shadow flicker calculations. These are shown in the Table 11.1 below.

Table 11.1 Probability of sunshine, average daily sunshine hours.

Month	Average hours of sunshine per month
January	49
February	58
March	85
April	131
May	161
June	131
July	129
August	121
September	106
October	83
November	58
December	38

11.9 Probability that there will be wind and wind direction

The rotor of the wind turbines will start at a wind speed of 3 m/s (known as the cut-in wind speed). If the rotor is not moving, there will be no pulsating light level, and therefore no shadow flicker. A wind turbine directs the rotor at right angles to the wind - the rotors turn to face the wind - when there is sufficient wind. The wind direction is, therefore, the determining factor for the position of the rotor and also for the position of the rotor in relation to the sun. Wind direction and position of the sun do not usually lie on the same line. The surface affected by shadow is, therefore, not usually the maximum surface. This is corrected by introducing the frequency of the wind direction, in order to determine how often the straight line between sun, rotor and shadow receptor will occur.

The wind is not always blowing above the cut-in wind speed. Based on the meteorological data from the on-site measurement mast, the average operational hours will be 8,713 per year. Therefore there is a 99.4%

chance that the turbines are operational (based on the wind resource). The distribution across the different wind directions is given in Table 11.2.

Table 11.2 Frequency distribution of the wind direction and operational hours of the wind turbine at the Coor location.

Direction	Operational hours
N	472
NNE	479
ENE	424
E	509
ESE	987
SSE	794
S	820
SSW	994
WSW	961
W	869
WNW	864
NNW	541

The calculated duration of the shadow flicker is the worst-case scenario. The worst case values have to be corrected to the expected[5] values by applying a series of correction factors, the corrected values give an indication as the likely occurrence of the shadow flicker on houses within the zone of potential shadow flicker, denoted by the orange contour line in figure 11.1 above.. No allowance is made in the expected shadow flicker values for further reductions due to the presence of screening caused by houses, hedges, trees, tree-lines, areas of forestry, agricultural buildings, fences etc. Normally this screening does apply and therefore shadow flicker on houses is in most cases less than the estimated

[5] Expected based on the metrological facts that the sun is not always shining (covered by clouds), turbines not always rotating and the impact of the wind direction.

duration. Field studies of the study area have revealed that there are many tree-lines, agricultural buildings, outhouses, fences and areas of forestry in the area and these will reduce the expected level of shadow flicker further. In Appendix 10 EIS Volume III the shadow calendars present the expected values. They show the time, duration and the probability of shadow flicker at each receptor/ private dwelling. As stated above no adjustments have been made for any natural screening which currently exists. To calculate the expected real duration of shadow flicker, based on probability of sunshine, wind direction, turbines in operation, the shadow calendar is used. The expected real duration of shadow flicker is only calculated for the 30 hours a year criterion. For the 30 minutes a day criterion the worst-case situation is used, as on a short time period of one day, the meteorological statistics cannot be applied - it is unlikely that statistics would remain valid for the period of one day.

11.10 Shadow flicker calculations

11.10.1 Do nothing impact

If a wind farm is not constructed on this site there will be no shadow flicker.

11.10.1.1 Construction phase

No shadow flicker will occur during the construction phase.

11.10.1.2 Operational impact

The area enclosed within the red contour line in Figure 11.2 below shows the 30 hours per annum shadow flicker duration isoline (contour line) of shadow flicker in a raster format (hours per year) based on the assumptions as described above. As is shown by the shadow contours, no shadow sensitive receptors (e.g. occupied houses) will experience 30 hours per annum, in accordance with the DEHLG guidelines.

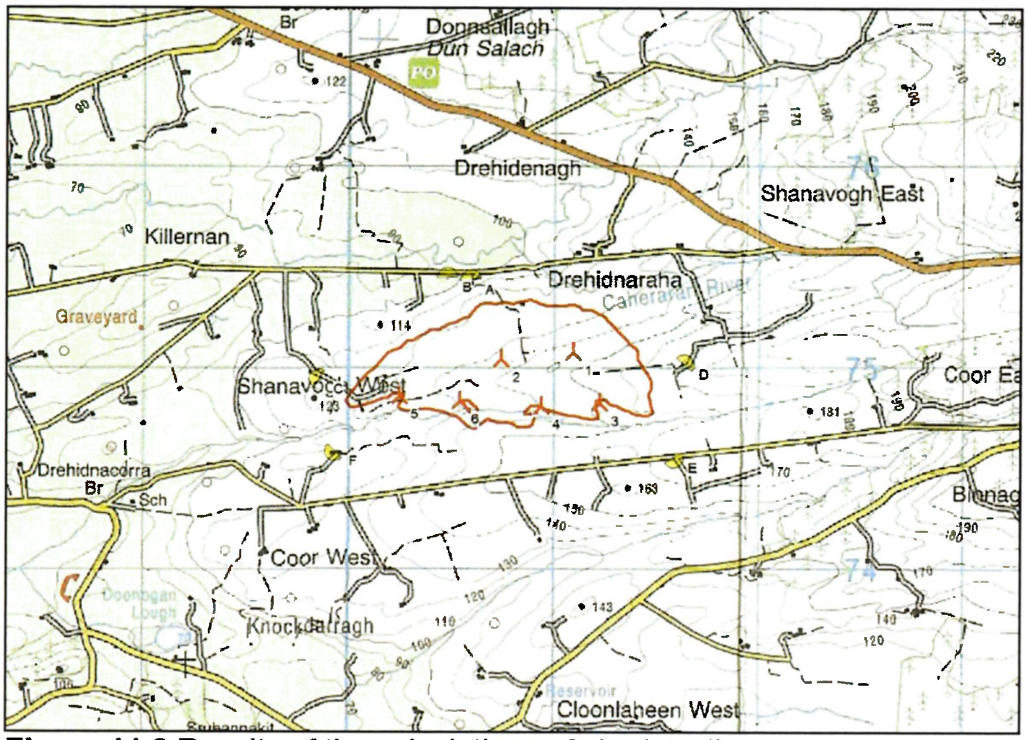

Figure 11.2 Results of the calculations of shadow flicker contours in hours per year.

Table 11.3 below identifies six shadow receptors within 820m the 10 rotor diameter distance from the turbines that might be critical in experiencing more than 30 hours of shadow flicker per year. The results are the maximum duration of the shadow flicker that might be experienced on the shadow receptors i.e. occupied dwellings. As the weather cannot be predicted, it was decided to present the worst case scenario where there is always sun, always wind, turbines and observer are in line and possible screening by vegetation or buildings is excluded from the calculation. The calculated results of the duration of shadow flicker on the shadow receptors are given in Appendix 10, EIS Volume III)

Table 11.3 Shadow receptors that might exceed the 30 hours per year (see Figure 11.2).

Shadow receptor	Hours per year
A	18:17
B	13:13
C	9:50
D	10:13
E	5:50
F	12:10

The shadow calendars in Appendix 10, EIS Volume III, indicate the shadow flicker on the six receptors for each day of the year. The figure in the middle column shows the minutes of shadow in the worst-case scenario (the sun is always assumed to shine and the turbine is always rotating). Reductions to transfer the worst-case scenario into real expected values are done on the basis of the correction factors at the bottom of each column.

Receptor A on Jan 8 is most heavily exposed to shadow flicker. On that day Receptor A will receive 100 minutes of shadow flicker in the worst-case scenario. By applying the following correction factors (sun shine (0.19), operational time (0.99) and wind direction (0.63)); the expected shadow flicker is estimated to be of 12 minutes duration in the real-case scenario. The correction factors are the input factors (metrological, wind etc). These values are calculated by WindPro on the basis of wind direction and sun shine inputs.

On all other days the shadow impact is less and none of the other receptors will get more than the estimated 12 minutes duration in a real-case scenario as identified for Receptor A on Jan 8. This 12 minutes is well below the threshold and is given without the inclusion of potential screening provided by vegetation, fencing etc.

11.11 Potential mitigation measures

As none of the receptors exceeds the threshold of 30 hours per annum set out in the Irish planning guidance directions, no mitigation is required. Mitigation is only recommended, in cases where the 30 hours per annum or the 30 minutes per day criterion is reached. The duration of shadow flicker was assessed using worst-case scenarios for the selected turbine and a long term meteorological characteristics. However, on a short time scales e.g. a period of one day, the meteorological statistics cannot be applied. Consequently, it is likely that all receptors would experience less shadow flicker impact than modelled. It is further likely that marginally affected receptors may not experience shadow flicker at all. Furthermore, at times when shadow-flicker does occur, the intensity is likely to be very low given the time of day at which it is likely to occur (early morning or late evening).

There are no shadow-sensitive receptors within the locality of the proposed Coor Shanavogh wind farm that exceed 30 hours per year. The maximum shadow minutes per day is 12 minutes at receptor A and is caused by turbines number 4 and 5. Shadow flicker will only occur at this receptor in the months of January and February and October to December. However the guidance threshold will not be exceeded and the effect will most probably not even reach 12 minutes. Appendix 10, EIS Volume III, includes the shadow calendar for the neighbouring premises.

11.11.1 Mitigation measures

Mitigation measures can take the form of:

Screening – It may be possible to avoid shadow flicker through evergreen planting and screening. Care would need to be taken to ensure that flicker effects were not felt during the time it takes for the vegetation to mature and that the vegetation itself does not create significant

overshadowing, however it should be noted that this mitigation is not needed and not recommended.

Operation Management – The shadow path of a turbine is a finite measure which can be modelled over time. The stand-still principle can be applied when the weather conditions (wind, wind direction) and the necessary alignment of the turbine rotor and receptor occur. In such circumstances the turbines can be programme to automatically switch off i.e. stop rotating for the period of time in which shadow flicker is likely to occur. Once the period of time in which the shadow flicker is likely to have occurred or the weather conditions change e.g. a change in wind direction, the turbine will automatically switch on again. This form of mitigation is not needed at the Coor Shanavogh proposed wind farm site.

11.12 Electromagnetic Interference

This chapter covers the potential adverse impact of wind turbines on various types of electromagnetic communication such as phone TV and/ or navigational equipment and their related signals.

11.12.1 General Comments on Effects

Wind farms, or individual wind turbines, like all large structures have the potential to interfere with television or radio signals. The towers are large steel obstacles and can provide a physical blockage to microwave links, and the alternating current electrical generating and transformer equipment, like all electrical equipment, generates its own electromagnetic fields. However, the most significant effect, at a domestic level, is straightforward involving a possible flicker effect caused by the moving rotor, particularly on television signals.

The wind turbines to be used in the proposed development, like all electrical equipment would require assurances that they meet the required European Standard with regard to the level of emissions (EN

55011) and immunity to interference (EN 61000). Therefore, EMI from these turbines would not pose a problem.

Information from the National Transcommunication Link (NTL) in the UK suggests that in locations where there is potential for interference it is limited to between 5 and 10km behind a wind farm or within 500m elsewhere (depending on wind farm size).

Obstruction or reflection of radio waves by a wind turbine can degrade the performance of fixed radio links due to the effect of the rotating blades. The three principal mechanisms for introducing electromagnetic interference are near field effects, diffraction and reflection /scattering. The level of interference caused by a wind turbine depends on:

- The location of the wind turbine relative to the transmitter and receiver,
- Frequency of the radio transmission,
- Characteristics of the wind turbine blades,
- Antenna characteristics, and
- Radio propagation characteristics.

11.12.2 Consultation

The following organisations have been contacted with regard to the potential interference with telecommunication signals:

- RTE,
- Irish Coast Guard,
- Irish Coast Guard Shannon Airport,
- Irish Aviation Authority,
- Garda communications commission,
- ESB telecoms,
- O2,
- Eircom,
- Vodafone
- Meteor,

- UPC Ireland,
- TnaG,
- HSE.

Radio Teilifis Eireann, TV3 and Teilifis na Gaeltachta were all contacted in relation to the proposed wind farm development. RTE stated that they do not have a problem with the proposed development TV3 and Teilifis na Gaeltachta did not make any comment regarding the development, as a result it was taken that they did not have any objections to the proposed development. The proposed wind farm would not interfere with signals from the various TV stations in the vicinity of the proposed development Vodafone, O2 and Meteor were contacted regarding the proposed wind farm development. Vodafone stated that they had no objections to the proposed development. O2 stated that they had no objections to the proposed development. Meteor, stated that they had no objections to the proposed development. Eircom was also contacted in relation to terrestrial based land lines, no response was received. The IAA have no objection to the proposal and they do not expect any impact on there radars for Shannon. Refer to the consultation Table in Chapter 1 for full details.

11.12.3 Principal Transmission Links

The only TV transmission link in and for the locality is Maghera. The nearest television transmitter is located at Maghera, approximately 35 km to the north east of of the proposed site. Maghera is one of the main TV transmitters in Ireland and covers the western regions of both Clare and Galway.

11.12.4 Domestic Receivers

Depending on the topography surrounding a residence, a domestic receiver may receive broadcast signals from more than one location although the strength of those signals will vary with distance from the transmitter. It is normal for the receiver's antenna to be directed towards the most local, and usually strongest, broadcasting station. This is not,

however, always the case particularly if the terrain is such that there is no direct line of sight between the receiver and that transmitter.

There are two potential and different effects depending on the location of the receiver to the wind farm:

Shadowed houses: the majority of the issues are related to receivers 'shadowed' directly behind the wind farm where the main signal passes through the wind farm. In these locations the rotor can create a degree of signal scattering which causes loss of picture detail, loss of colour, and buzz on sound.

Viewers to the side: The effects are likely to be periodic reflections from the blades, giving rise to a delayed image or ghost image on the screen which is liable to flicker as the blades rotate.

The effects in both cases may depend to some degree on the wind direction since the plane of rotation of the rotor will affect both the line of sight blockage to receivers behind the wind farm and the degree of reflection to receivers to the side.

11.12.5 General Radio and Television Signals

Current RTE transmission policy with respect to wind developments is for both parties to enter into a protocol agreement in which (in the event of a problem) an assessment of impact and a methodology of resolution is agreed between both parties. RTENL (RTE Transmission Network Limited) manages this process. RTENL is a wholly owned subsidiary of Raidió Teilifís Éireann which runs Ireland's principal terrestrial television and radio broadcast signal transmission networks. They operate 10 main sites, and over 100 smaller relays and transposers, which carry either television, radio, or both. RTÉ NL distributes and transmits the programme services of RTÉ Radio and Television, TV3, TG4, and Today

FM. They also provide transmission services to a number of local and regional radio broadcasters as well as site services to mobile telephone and broadband operators, private communications companies and the emergency services.

If issues were identified following operation of the proposed wind farm these would be resolved through the procedures agreed within the RTENL protocol agreement. INIS Environmental Consultants Ltd. have already initiated this protocol process with RTENL for the Coor Shanavogh wind farm.

11.12.6 Other Signals

Wind turbines have the potential to affect other signals used for communication and navigational systems. This includes everything from tower to tower microwave communication links to airborne and ground radar systems. The IAA and Shannon airport have already been consulted and no impact to navigational equipment is expected.

Most of these problems if they do arise can be easily dealt with by detail micrositing of the turbines to avoid alignment with signal paths or by use of divertor relay links out of line with the wind farm.

Radar problems on the other hand are somewhat more problematic. The issue here is generally one of false contacts being seen on the radar display and occurs when the wind turbines are close to an airport or directly in line with the instrument landing approach. This a subject of major research exercise in the UK particularly in relation to military aircraft flying at low level when they will appear and disappear on civilian airport radar. This is not a problem here as the proposed site is located outside of Shannon radar.

11.12.7 Private House Radio and telecommuications impacts

Any effects on signals from Maghera are expected to be minimal at worst. If issues with TV and/ or Radio reception were identified following operation of the proposed wind farm these would be resolved easily an inexpensively through the procedures agreed within the RTENL protocol agreement. INIS Environmental Consultants Ltd. have already initiated this protocol process with RTENL for the Coor Shanavogh wind farm.

11.12.8 Proposed Mitigation TV & Radio

The following mitigation measures are proposed in respect of interference to television reception:

- Implementation of the RTENL protocol agreement to be undertaken by the developer in conjunction with RTENL
- Rectification of television reception could initially include modifications to or replacement/ upgrading of antennas being used or replacement with digital television (set top box or new television sets). Experience with existing wind farms demonstrates that significant improvements can be achieved by providing a more directional antenna and/ or converting to digital TV reception (although no terrestrial digital channels are available within the area at this time).
- In the event that replacement of the receiving antenna or conversion to digital TV reception are ineffective, other measures can be implemented to restore reception to a standard no worse than that which existed prior to the development of the wind farm:
- The installation of a TV antenna in an area of good television reception connected to the affected residence via coaxial cable, or the installation and maintenance of a satellite television system.
- Development of local solution using a receiving aerial some distance from dwelling,

- Replacing terrestrial reception equipment with satellite reception equipment

The requirement for implementation of such measures will be addressed individually with RTENL and any other communications providers should the need arise. Currently no service providers have identified any concerns.

The RTENL protocol has already been entered into. This effectively requires the developer to accept responsibility for remedial measures which could be required as a result of potential negative impacts of wind farms on the RTE network.

11.12.9 Mitigation for other EM effects

There are no impacts expected on any other EM signals, no mitigation measures are proposed or required.

11.12.10 Conclusions

Consultation has been carried out with all communication and telecommunication service providers The proposed wind farm at Coor Shanavogh is not expected to significantly affect any communication or telecommunication service providers. Any levels of TV interference can be easily mitigated.

12 TRAFFIC, TRANSPORTATION AND ROUTE DELIVERY SELECTION

The construction of six wind turbines at Coor Shanavogh will require construction vehicles, construction materials, plant and turbine parts to be delivered to the site. This chapter contains a description of the existing transport environment in the vicinity of the proposed Coor Shanavogh Wind Farm, the potential impacts of the proposed development on traffic and transport in the area and mitigation measures relating to roads and transport which will be put in place during the construction and operation of the proposed wind farm.

12.1 The Existing Transport Environment

The proposed wind farm is located in the townlands of Coor, Shanavogh and Killernan, approximately 5.5km from Mullagh, Co. Clare. The elevation of the site ranges from approximately 90 m – 160 m OD (Malin Head), approximately 3km north of Doo Lough. Access to the proposed site is available from the M18 ring road around Ennis to the R474 running west to Coor and Shanavogh West. The site itself may be entered from either the northwest corner at Shanavogh West or the southeast corner at Coor via local roads. There are a number of existing forestry and farming tracks within the site. The proposed new access roads have coincided with these existing tracks as much as possible.

Coor Shanavogh wind farm is located in a remote area. The local roads and regional R474 may be considered relatively light traffic-wise in this area. The N85 and N86 are the main national routes leading from Ennis to West Clare. Thus temporary additional traffic on this route is unlikely to cause significant difficulties. It should be noted that these roads are already regarded as acceptable for removal of forestry during felling operations and consequently heavy vehicle movement would not therefore be an unexpected feature on these local and regional roads.

There is one bridge along the access route to the site, Inch Bridge (Gird Ref 530163, 675426). There is no restriction on this structure in terms of weight limit and it is of sufficient width for passage of up to 32m trailers. A small number of minor improvements have been highlighted along the route following a full route assessment by Exceptional Load Services Ltd (as outlined in Section 12.2.1). This survey assessed two possible routes to the site, the results of which are presented in Appendix 11 of Volume III of this EIS.

12.1.1 Assessment of Potential Routes

The assessment of delivery routes involves assessment for the delivery of turbine and substation equipment which require the use of exceptional load vehicles. For the turbines and substation equipment in principle it involves:

- elimination of non suitable routes;
- elimination of routes which present excessive difficulties;
- assessment of suitable port facilities – principally the availability of off loading equipment and sizeable laydown areas;
- assessment of the delivery route from port to site entrance in relation to road alignment (both vertical and horizontal);
- assessment of the delivery route from port to site entrance in relation to road (and bridge/ culvert) strength and running width.

Exceptional Load Services Ltd., a specialist company which provides route planning for delivery of oversized products such are wind turbine parts, were commissioned to conduct a full delivery route survey and assessment. The results of this survey are presented in Appendix 11 of Volume III of this EIS.

12.2 Potential Impacts on the Transport Environment

12.2.1 Proposed Turbine Delivery Route

It is proposed that all turbine parts will travel from the port at Foynes in Co. Limerick, follow the N69 to the M18 at Ennis and then onto the R474 to local access roads. The proposed turbine delivery route is presented in Appendix 11 of Volume III of this EIS. The completion of the new tunnel under the Shannon provides a convenient detour around Limerick city. The port at Foynes has been used successfully to transport turbine parts in the past, however Ringaskiddy and Dublin Port remain alternative options.

From Hand Cross on the R474 two potential routes were assessed by Exceptional Load Services (see Appendix 11 of EIS Volume III). One involved accessing the site from the local road to the north of the site in Shanavogh West, the other from the south in Coor. The latter route was deemed to be the preferable option as it required minimal land take and modifications apart from road widening in parts.

The following road modifications will be required for turbine delivery:

- Area 1: Inch Bridge – infilling of roadside verge to load bearing and temporary removal of signage to allow for blade overhang.
- Area 2: Left Turn at Hand Cross – removal of approximately 25m^2 of bank and relocation of road signs and ESB pole.
- Area 3: Right Turn onto Site Approach Road – widen road to 4.5m-5m. Current road width averages 2.9m. The rocky terrain on the roadsides will provide for easy widening.
- Area 4: Site Entrance – widen to 4.5m-5m.

No private land take will be required. Only a small area of bank will need to be removed at Hand Cross along with some road widening on the approach road.

12.2.2 Transport of Oversized Loads

The proposed turbines to be installed at Coor Shanavogh wind farm are Enercon E82 2.3MW turbines, of hub height 85m and blade tip height 126m. The turbine specifications are provided in Table 12.1.

Table 12.1 Enercon E82 2.3 MW Turbine Specifications.

Model	**Enercon E82 – 2.3MW**
Rotor Diameter	82m
Hub Height	85m
Height to tip	126m
Rated Power	2,300kw
Sweep Area	5,281m^2
Type	Upwind rotor with active pitch control
No of Blades	3
Direction of Rotation	Clockwise
Rotational Speed	Variable 6 – 18rpm
Pitch Control	Single blade pitch system, one per rotor blade.
Cut out wind speed	28 – 34 m/s
Brake System	3 Independent pitch controls Rotor Brake Rotor Lock

The turbines will be delivered to site in separate parts. This comprises (for each turbine) five loads of tower sections, one load for the nacelle, three loads for the rotor blades, and half a load each for the rotor hub. The nacelle will be the heaviest single component. The use of trucks

which spread the load over many axles will maintain permissible standard axle loads on the roads. The top section of the turbine (Section 1) will be the longest component at 28.5m.

It is estimated that 57 HGVs will be required to transport the 6 towers, 6 hubs, 18 blades, 6 nacelles and 6 turbine bases to the site, assuming each tower arrives in five sections. This results in a total of 114 HGV movements (in and out) to deliver the required parts for the turbines. While the number of HGVs in itself is not significant, the loads are oversized, and will require co-ordination with Clare County Council and the Gardaí. To minimise disruption, these materials and parts will be delivered in a convoy of two to four vehicles. Longer convoys of more than four vehicles will not take place at any one time.

Two cranes will be required to transfer equipment on and off vehicles. The main erection crane will have around 650 tonnes lifting capacity, the second crane approximately 100 tonnes. While travelling to the site on public roads, the crane will be de-rigged and its axle weights will be at permissible levels. The axle width of the crane will be approximately 3m wide and its components when de-rigged will be transported on conventional haulage vehicles approximately 18m long.

12.2.3 Other Construction Traffic

It is proposed that general construction traffic, such as personnel and material deliveries, will use the same access route as that for oversized loads, where appropriate. However, some vehicles and plant may come from different directions, depending on source locations.

There will be an increase in local traffic during the construction phase of the project. Construction personnel including plant operators, electricians, engineers and trades-people will be commuting to and from the site. Intermittent deliveries of building material will also take place. Concrete, will be sourced locally where possible. It is expected that the suppliers will

also use the same regional and country roads to access the site. HGV movements on public roads have been minimised by the proposed use of rock fill from a borrow pit within the site.

Vehicles requiring access to the site during the construction phase are outlined below. All access will be via the proposed entrance at the south eastern end of the site. Visibility splays and design details for this entrance are presented and outlined in the scaled application drawings Volume V of this EIS application.

12.2.3.1 Civil Works

- Prior to construction commencing, a small number of low loaders will access the site, transporting construction equipment and site office accommodation. It is estimated that this traffic would consist of approximately 15 deliveries including 5 excavators, 6 dumpers, 1 compactor and 3 site offices/ equipment. These deliveries would be over a one week period.
- During the 4 month construction period, the number of construction personnel on site at any one time is unlikely to exceed 30. Personnel will be transported to and from site by private vehicles or minibuses. This will total up to 10 vehicles per day. Small increases in private car/ van movements at the beginning and end of each day are expected.
- For construction of the site access road stone will be sourced from the proposed borrow pits on site. Equipment such as dump truck, excavator and stone crusher will be required. It is estimated that this would require approximately 10 deliveries.
- For the construction of the substation and control building approximately 8 lorry deliveries will be required.
- Not more than 3 cable drums will be required to deliver the underground cabling which interconnects the individual turbines to the substation. Ten drums can be accommodated on each trailer requiring one delivery to site.

- The substation requires approximately 191 m^3 of concrete.
- Approximately 5 vehicles will be required to deliver construction fuel.

12.2.3.2 Wind Turbine Erection

- A typical turbine base consists of approximately 345 m^3 of concrete and will require ~40 deliveries of an 8-9 m^3 concrete truck. The reinforcing steel for each base will require 1-2 truckloads. This gives a total of approximately 42 deliveries per turbine and therefore a site total of 252 construction deliveries for the turbine bases.
- Each turbine tower will be delivered to site in five sections and assembled at the turbine positions. Ten deliveries per turbine will be required (including towers, nacelle, blades and hub), totalling 57 deliveries for the site. (The nacelles will be delivered with the hub separate: 6 deliveries will be required for the nacelles, and 3 for the hubs. The blades will be delivered individually giving a total for the site of 18.) One delivery of cables, switchgear, transformers, spare materials and nacelle cabinets will be required giving a site total of 6 vehicles. Base rings/ anchor bolts used to anchor the towers to the foundations will be delivered in groups of two per vehicle, giving a total of 3 deliveries for the site.
- Cranes - Two mobile cranes will be required of approximately around 650 tonnes lifting capacity, the second crane approximately 100 tonnes to carry out erection of the turbines.

Table 12.2 summarises the predicted total traffic movement during the 4-month construction period assuming a five day week with public holidays (73 days). The predicted traffic levels are commensurate with other developments of this level of investment. Normal practice is for construction work to be conducted over 5.5 to 6 days per week and this will reduce intensity of traffic and potentially shorten the overall period of disruption.

The following is, however, based on 5 days per working week and includes both delivery to site and return journeys (two way).

Table 12.2 Summary of Vehicle Movements during Construction.

Item Transported	Type of Vehicle	Vehicle Movements To and From
Construction		
Construction personnel	Light Vehicles (5 cars at twice/day)	~730
Site accommodation and construction equipment	Low loader	~40
Equipment for sourcing stone	Low loader	~40
Concrete (6 turbine foundations and substation)	Concrete lorries, 8-9m^3 trucks	~251
Steel reinforcement	Flat bed	~12
Turbine towers	Semi-low extendable trailer	60
Base rings	Semi-low extendable trailer	6
Nacelle units	Semi-low extendable trailer	12
Blades	Semi-low extendable trailer	36
Turbine equipment	Flatbed	~16
Cranes	Lowloader	4
Cables	Flat bed	2
Substation & Control Building	Flat bed/lowloader	~160
Other items		
Construction Plant fuel	Fuel tankers	~10

HCV traffic to and from the site will increase during the construction phase of the development, which is expected to last for about 4 months.

Any impact on roads will be local, on weak sections of the pavement, and these should only require a local repair to the approval of Clare County Council; these works will be carried out as soon as is feasible by a road repair contractor appointed by the developer.

Movement of HGCV traffic will be managed to minimise congestion. Further, advance warning will be given to the local residents and other regular users of the expected delivery times for HCV traffic and in particular large loads etc.

There is a possibility that mud or dust could be transferred from the site during construction. This will be effectively mitigated by good construction practices including the use of a wheel wash inside the site entrance, and water spraying to suppress dust where needed. Mitigation measures are detailed further in Section 12.3.

12.2.4 Operational Traffic

During the operation phase there will be one worker / caretaker attending site on a regular basis in a van or 4x4 vehicle, and the occasional visit from maintenance personnel by van. There will therefore be negligible impact during the operational phase of the proposed wind farm.

A summary of traffic movements for the operation and decommissioning phases of the project is shown in Table 12.3.

Table 12.3 Summary of Vehicle Movements during Operation and Decommissioning.

Item Transported	Type of Vehicle	Vehicle Movements To and From
Operation		
Regular Inspections	4 x 4 or Van	1 per day
Emergency Repairs	Crane (100-600t)	As required
Decommissioning		
Removal of rotor assemblies	650 tonne crane	2
Cranes	650 tonne crane 100 tonne crane	4
Dismantling turbines	650 tonne crane 100 tonne crane	4
Removal of turbines	Lowloaders	130
Removal of substation	20 tonne lorry	30

12.2.5 Driver Distraction

There is no evidence from any existing wind farms in either Ireland or the UK that turbines provide any significant issue with respect to driver distraction. The R586 tourist route Bandon to Bantry passes close to the foot of Millane Hill and no increase in road traffic incidents have been recorded as a result of that wind farm. Similarly on the A68 a major traffic route just south Edinburgh in the Scottish Borders which passes through the middle of the Dun Law wind farm no increased evidence of traffic incidents have been noted by the local police force.

No effects of driver distraction are expected.

12.3 Mitigation Measures for Traffic and Transport

To mitigate against the impacts of traffic associated with the project, the following mitigation measures will be implemented:

- The timing of turbine delivery along the N69 and R474 routes will be agreed with Limerick and Clare County Council's and the Gardaí to ensure that the affect on the public and emergency services is minimised.
- Parking facilities will be provided on site for construction traffic.
- A transport co-ordinator will be appointed to regulate all HGV movements to ensure easy access and egress to the site, as well as minimising the impact on local users.
- An experienced road repairs contractor will be appointed to carry out any necessary repairs to country roads upon completion of construction works, or earlier if deemed necessary by Clare County Council Roads Engineer; this is to ensure that access to the site is deemed passable at all times to minimise impact on local community.
- A condition survey of country roads will undertake pre-construction and the condition of the road agreed with the local Roads Engineer to provide a benchmark against which the condition of the road can be reviewed.
- A wheel wash, located inside the entrance to the proposed site, will mitigate the effects of mud or dust on the local road network.
- Water spraying will be used for dust suppression as required.
- A road sweeping vehicle will be provided as required to remove any mud that accumulates over time on the pubic road.
- Any road works will be carried out in accordance with the relevant environmental legislation.

- The application for on-site borrow pits significantly reduces the traffic impacts associated with the construction of the wind farm site, all rock aggregates will be sourced onsite.

12.4 Conclusions

Access to the site has been deemed by Exceptional Load Services as straightforward with minimal land take and modifications required. Although HGV/ HCV movements to and from the site will increase during the construction phase of the development, this will be temporary. On a long term basis, once the site is in operation, it is anticipated that the development will not generate any adverse impacts on traffic in the vicinity of the site.

13 CULTURAL HERITAGE & ARCHAEOLOGY

13.1 Background

As part of the initial planning works for the Coor Shanavogh wind farm project TVAS Archaeological Services were commissioned during May 2010 by Vaughan & Associates Consulting Engineers, to assess the cultural heritage and archaeological impact of a proposed wind farm at Coor Shanavogh, Co. Clare. The initial scope of this work was for an area much larger than that outlined as part of the landholding and site layout proposed as part of the final application scope. Nevertheless the original TVAS archaeological and cultural heritage assessment covers the entire landholding application area and site project planning area of this application. The original report is included in Appendix 12, EIS Volume III. As the site layout was revised, TVAS were contacted by INIS to re-establish the assessment process. Upon finalisation of the site project layout the final project layout was superimposed on a geo-referenced map produced by TVAS Archaeological Services. This map detailed the areas of archaeological interest, the layering of the TVAS archaeological map and the final project site layout map allowed the assessment of the final layout in relation to archaeological features, this final overlaid map with site layout plans and archaeological details was resubmitted to TVAS for their comments. TVAS reassessed the new finalised site layout and provided their reassessment in a report letter, provided in Appendix 12, EIS Volume III. The revised TVAS comments and recommendations are included below in sub section 13.4.2.

13.2 Relevant Legislation

The management and protection of cultural heritage in Ireland is achieved through a framework of international conventions and national laws and policies (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the European

Convention on the Protection of the Archaeological Heritage (Valletta Convention) and European Convention on the Protection of Architectural Heritage (Grenada Convention). Cultural heritage can be divided loosely into the archaeological resource, including sites and monuments from the prehistoric period (7000BC) until the Past-medieval period (1600AD); and the built heritage resource, encompassing standing structures and sites of cultural importance dating from the post-medieval and modem period.

The National Monuments Acts 1930 to 2004, the Heritage Act 1995 and relevant provisions of the National Cultural Institutions Act 1997 are the primary means of ensuring the satisfactory protection of archaeological remains, which are deemed to include all man-made structures, of whatever form or date, except buildings habitually used for ecclesiastical purposes. A national monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (Section 2, National Monument Act, 1930).

There are a number of mechanisms under the National Monuments Act that are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places (formerly the
Sites and Monuments Record) (RMP), and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Since 2002, the administration of national policy in relation to archaeological heritage management has been undertaken by the Department of Environment, Heritage and Local Government.

The State may acquire or assume guardianship of national monuments by agreement with site owners or under compulsory order. Once the site is in ownership or guardianship of the State it may not be interfered with

without the written consent of the Minister. There are no national monuments located within a 1km radius of the proposed wind farm site.

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference to the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation surrounding the site must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders by the written consent, and at the discretion, of the 1V1inister. There are no sites subject to preservation orders located within a 1km radius of the proposed wind farm site.

Section 12 (1) of the National Monuments (Amendment) Act, 1994 made provision for the establishment and maintenance of a Record of Monuments and Places (RMP) deemed to have cultural heritage potential. Superseding the Register of Historic Monuments, which was established under the 1987 Amendment to the Act, the RMP comprises of a list and maps of monuments and relevant places in respect of each county in the State. All sites recorded on the RMP receive statutory protection under the National Monuments Act 1994 and any work undertaken at these sites must be done so under licence (Section 12 (3)). There are three sites of archaeological significance recorded within a 1km radius of the proposed wind farm site boundary.
Protection of architectural or built heritage is provided through a range of legal instruments including:

Protection of architectural or built heritage is provided through a range of legal instruments including:

The Heritage Act, 1995 This Act protects all heritage buildings owned by a local authority from damage and destruction. Section 2.1 describes architectural heritage as 'all structures, buildings., traditional and

designed, and groups of buildings including streetscapes and urban vistas, which are of historical, archaeological, artistic, engineering, scientific, social or technical interest, together with their setting, attendant grounds, fixtures, fittings and contents, and without prejudice to the generality of the foregoing, includes railways and related buildings and structures and any place comprising the remains or traces of any such railway, building or structure'. The Heritage Council was also established under the Heritage Act. The Council seeks to promote the interest in, knowledge and protection of Irish heritage, including the architectural resource.

The Architectural Heritage Act 1999 (National Inventory) requires the Minister to establish a survey to identify record and evaluate the architectural heritage of the country. The function of the National Inventory of Architectural Heritage (NIAH) is to record all built heritage structures within the Republic of Ireland. Inclusion in an NIAH inventory does not provide statutory protection; the document is used to advise local authorities on compilation of a Record of Protected Structures (RPS) as required by the Local Government (Planning and Development) Act, 2000. No structures have been recorded by the NIAH within a 1km radius of the proposed wind farm site boundary.

The Local Government (Planning and Development) Act 2000. Under this Act, all Planning Authorities are obliged to keep a 'Record of Protected Structures' of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. As of the 1st January 2000, all structures listed for protection in current Development Plans, have become 'protected structures'. Since the introduction of this legislation, planning permission is required for any works to a protected structure that would affect its character. If a protected structure is endangered, planning authorities may issue a notice to the owner or occupier requiring works to be carried out. The Act contains comprehensive powers for local authorities to require the owners and occupiers to do works on a protected structure if it is endangered, or a protected structure or a

townscape of special character that ought to be restored. There are no protected structures within a 1km radius of the proposed wind farm site as per the Clare County Development Plan 2005-2011.

13.3 Assessment Works

13.3.1 Desk Study

A desktop survey of cultural heritage sites within the study area was carried out in order to assess cultural heritage constraints. The Record of Monuments and Places (RMP) of Co. Clare, as published by the Archaeological Survey of Ireland, was the principal source for identifying archaeological constraints. Additional information was gained from the Sites and Monuments Record (SMR) for the county and a review of local journals and publications. In addition the following sources were consulted:

- National Inventory of Architectural Heritage (NIAH) Survey Report for Co. Clare (2009);
- All available Ordnance Survey maps for the area;
- Clare County Development Plan 2005-2011;
- Archive material on Clare County Library website http://www.elarelibraryle;
- Excavations database (1970-2004) & Excavation Bulletins 2001, 2002, & 2003;
- Archaeological Impact Assessment of a proposed wind farm development at Coor Shanavogh. Unpublished report prepared by R. Crumlish in 2002! & submitted to Clare County Council.

13.3.2 Recorded Archaeological Monuments and Places

The Record of Monuments and Places (RMP) is compiled by the Archaeological Survey of Ireland (ASI) and comprises lists and maps of monuments known to the National Monuments Service. Monuments

recorded in the Record of Monuments and Places are protected under the National Monuments Acts 1930 to 2004. The information contained within the RMP is derived from the earlier non-statutory Sites and Monuments Record (SMR); some entries, however, were not transferred to the statutory record, as they do not fall within the strict criteria for inclusion within the RMP; some, for instance, could not be located with sufficient accuracy. Such sites however remain part of the SMR. The record is a dynamic one and is updated so as to take account of on-going research.

There are fifteen recorded monuments and sites within the study area, defined by a *500m buffer (see Appendix 1, TVAS Report). Of these fifteen features, three are located in the northern extent of the proposed development; one is situated in the southern section while the remaining eleven recorded monuments and sites are found within the buffer zone.

*Please note that the new site landholding covers a much smaller area and excludes the southern landholding shown in Appendix 1 of the TVAS report given in the EIS Volume III Appendices.

13.3.3 List of Monuments in State Ownership or Guardianship

National monuments may be acquired by the Minister whether by agreement or by compulsory order. The State or Local Authority may assume guardianship of any national monument (other than dwellings.). The owners of national monuments (other than dwellings) may also appoint the Minister of the Local Authority as guardian of that monument if the State or Local authority agrees. Once the site is in the ownership or guardianship of the State it may not be interfered with without the written consent of the Minister.

There are no National Monuments located within the study area.

13.3.4 List of Preservation Orders

Sites deemed to be in danger of damage or destruction can be allocated Preservation Orders under the 1930 National Monuments Act. Preservation Orders make any interference to the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation surrounding the site must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders by the written consent, and at the discretion of, the Minister.

There are no monuments with Preservation Orders located within the study area.

13.3.5 Recorded Archaeological Finds

The National Museum of Ireland's topographical files are a national archive of all known archaeological finds from Ireland. They relate primarily to artefacts but also include references to monuments and contain a unique archive of records of previous excavations. The topographical files were consulted to determine if any archaeological artefacts had been recorded from the area. No recorded finds were noted within the study area from a search of the published catalogues (Rattigan 2005).

13.3.6 Cartographic Sources

Reference to cartographic sources is important in tracing land use development within the area as well as providing important topographical information on sites and areas of archaeological potential. Primary cartographic sources consulted consisted of the Ordnance Survey 6" maps, first and later editions (Clare County Library Local Studies Centre: Clare, Sheets 31 and 39).

13.3.7 Previous Excavations

The excavation bulletin website (www.excavations.ie) was consulted to identify previous excavations that may have been carried out within the study area. This database contains summary accounts of excavations carried out in Ireland from 1970 to 2004. The available Excavations publications were also consulted. One published excavation has been undertaken in the area (see Appendix 2).

13.3.8 Historical research

Historical research began with a search of the British and Irish Archaeological Bibliography (www.biab.ac.uk) and the Royal Historical Society Bibliography (www.rhs.ac.uk/bibl/bibwel.asp). A number of local historical publications were consulted in addition to Lewis's *A Topographical Dictionary of Ireland* (1837). Other sources consulted include the Irish Tourist Association survey of the parish (ITA 1942-3), Joyce's study of place names (1995), The *Parliamentary Gazetteer of Ireland* (1845) and Westropp's study of antiquities in the area (1904-5).

13.3.9 Site Investigation

In addition to the desk-top research undertaken, and leading on from the results of that research, a field survey of the area of the proposed development was undertaken by two suitably qualified archaeologists/ built heritage specialists (TVAS Archaeological Services). The field survey was undertaken on Tuesday, 18th May 2010 under adverse weather conditions. The field inspection relates to the physical environment, the cultural landscape and the archaeological potential of the area of the proposed development. The primary purpose of the field assessment is the identification of potential low-visibility or previously unrecorded archaeological and/or historical features and areas of archaeological potential that may be impacted upon during development. Field inspection also aims to confirm the extent and location of recorded

monuments, structures and features and considers the possible impacts of the proposed development on such. The field survey assesses the present topography and land-use and addresses the landscape potential of the area by examining the recorded human activity in the past in relation to a particular landscape and considering the possible interactions between existing monuments or sites.

13.3.10 Final Site Layout- TVAS Comments

All areas were accessible and the site was assessed in terms of landscape, land use, vegetation cover, presence or lack of archaeological sites and potential for undetected archaeological sites/features. Upon finalisation of the site project layout the final project layout was superimposed on a geo-referenced map produced by TVAS Archaeological Services. This map detailed the areas of archaeological interest, the layering of the TVAS archaeological map and the final project site layout map allowed the assessment of the final layout in relation to archaeological features, this final overlaid map with site layout plans and archaeological details was resubmitted to TVAS for their comments.
A photographic record was also taken and is presented in the full TVAS report, Appendix 12, EIS Volume III.

13.3.11 Limitations of the Study

As noted above, this assessment included a comprehensive paper survey or archaeological, historical and cartographic sources available for the study area. Furthermore, as detailed designs are not currently available, it was not possible to fully assess the possible extent of any potential impacts.

13.3.12 Impact Assessment Methodology and Results

Development impacts have been assessed as per EPA, 2003 Advice Notes on Current Practice (in the preparation of Environmental Impact

Statements) on Cultural Heritage, including folklore/ tradition, architecture/ settlements and monuments/ features, following a baseline study of the existing cultural heritage features in the area of the proposed development, as well as per the Institute of Archaeologists (IA1) Good Practice Guidelines.

Assessment and classification of impacts have been identified in terms of:

- Direct or indirect effect,
- Primary or secondary effect,
- Cumulative properties of impact,
- Length of term of effect (short, medium or long term),
- Permanence of effect,
- Positive or negative effect.

13.3.13 Characteristics of the Development

The scope of the initial wind farm project which TVAS assessed in December 2009 comprised of fifteen wind turbines, a total of 3.9km of new 4m wide access roads and a sub-station/ electrical compound measuring 50m by 30m. The turbine bases each measured 12m by 12m and there will be hard standing areas adjacent to each turbine (35m by 18m + 5m by 12m).

The scope of the finalised 2011 Coor Shanavogh wind farm project (as assessed with this EIS) will comprise 6 wind turbines. The new site road and turbine layout was forwarded to TVAS for reassessment, their comments are outlined below.

13.3.14 Archaeological and Historical Background

There is no available written evidence of the prehistoric activity within the study area. Although, the Recorded Monuments and Sites define one of the relevant sites as a hut site (CL031-030---), "a structure usually discernible as a low, stone foundation or earthen bank enclosing a circular, oval or sub-rectangular area, generally less then 5m in maximum dimension. The remains are generally too insubstantial to classify as a house but the majority probably functioned as dwellings". These sites may date to any period from prehistory (c. 4000 BC – AD 400) to the medieval period (AD 400 – 1500). As can the ringforts – raths examined within the study area of the proposed development.

The barony of Ibrickan was in the pre Anglo-Norman period, in all probability, a separate Triocha Cet. A "Triocha Cet (triuca ceud) was originally the area from which 30 hundred fighting men might be drawn". By the 7th or 8th century the military significance of the Triuca Ceud changed to political or social one, i.e. it became more of a unit of topography in the modern sense. When the Normans came to Ireland in the later 12th century and royal grants for Irish land were made they based on the existing Triuca Ceud to a large extent (Ryan 1969, 3).
Ibrickan or Ui Bracain formed a part of the country of the Corca Baiscin until the end of the 12th century, when the Leinster family of MacGorman settled in it under the auspices of O'Brien. The MacGormans held the land in Carlow, under the tribe name of Ui Bairrché, being descendants of Daire Barrach, son of Cathaoir More, monarch of Ireland in the 2nd century. They were driven out by Walter de Riddlesford, who became the lord of Carlow around that time. The first of the family to come to Co. Clare was Murtagh, the son of Donogh MacGorman. A poem by Maoelin Oge MacBrody recounts how after the MacGormans had been banished from their original possessions, they came to the country of the O'Brien's and settled in the district of Ibrickan. MacBrody goes on to say that the MacGormans had been in Ibrickan for four hundred years, nourishing poets and feeding the poor. It appears that they were what in Irish legal

phrase was called *Brugh Fir*, i.e. men who were obliged by their tenure to keep open houses of general hospitality for wayfarers:

"Under the distinguished race of fair O'Briens. This tribe of ever living fame have been during a period of four hundred years. Supporting poets, and feeding the poor. Over this fair-glebed plain of cooling breezes" (O'Donovan & Curry 1997, 279).

James Frost in his *History and Topography of the County of Clare* (1893) lists the references to the members of the family in the annals and records of the country:
"In 1413, Cu-abha MacGorman died. In 1484, died Donald MacGorman of Ibrickan, one of O'Brien's servants of trust, who kept a house of general hospitality, and was the richest man in Ireland in live stock. In 1580, Melaghlin MacGorman died, and his estates of Drumelihy and Cahermurogh (Cahermurphy, parish of Kilmihil) descended to his son and heir Dermot. Mahone MacGorman, son of Dun, was the proprietor of Cahermurogh and other lands adjoining in 1594. [...] In 1641, Daniel and Cahir MacGorman were proprietors of Drumellihy, while Cahermurphy belonged to Daniel MacGorman the elder, Daniel MacGorman the younger, Conor MacGorman, Thomas MacGorman, Teige MacGorman, Manchan MacGorman, and Scanlan MacGorman."

Chevalier O'Gorman was the first of the family to drop the Mac and adopt the O instead. He compiled several works on genealogy and Irish history.

The Kilmurry-Ibrickan parish was one of the territories that were granted to Donough O'Brien, 4th Earl of Thomond in 1585 by Sir John Perrot, as part of the Composition of Connaught scheme. The land was surveyed barony by barony, an agreed annual rent of 10 shillings payable to the crown per quarter of inhabited land was established while the Gaelic land customs and inheritances were abolished (in Lynch & Nugent 2008: 294).

By 1660, Co. Clare had finally accepted the New English administrative system, a process initiated by Henry VIII in 1534 (in Lynch & Nugent 2008, 79). In August 1649, Cromwell arrived in Ireland only to extend his campaign to Co. Clare in 1651. The surviving records of the English army led by Cromwell's deputy Henry Ireton state that almost a third of the county's population perished either by sword, famine or disease from 1650 to 1653 and that only 40 townlands, mostly in the barony of Bunratty, were inhabited (Lynch & Nugent 2008, 80). In 1660, the barony of Ibrickan had 64% of townlands uninhabited.

In the 19th century, the parish of Kilmurry-Ibrickan became part of the landed estate of Colonel George Wyndham, 1st Baron Leconfield (1787 – 1869). The Wyndham estate comprised one twentieth of the entire land area of the county which together with the lands in counties Limerick and Tipperary, Yorkshire, West Sussex and Cumberland made Col. Wyndham one of "great landowners of great Britain and Ireland" (Lynch & Nugent 2008: 291).

The lands of the Clare estate were situated in seven baronies, 33 civil parishes, 108 whole townlands and 19 parts of townlands with the mid-western barony of Ibrickan comprising by far the largest portion of the estate – 28%. The civil parish of Kilmurry-Ibrickan had the largest single portion of the estate, comprising approximately 17% of the estate or 7,696 acres (in Lynch & Nugent 2008, 292).

The barony of Ibrickan also had by far the largest population of the estate, and together with the second most populated barony of Clonderlaw made up half of the total population of the estate. Ibrickan also boasted second highest pre-famine population density of 42 persons per 100 acres (in Lynch & Nugent 2008:293).

In 1838, Col. Wyndham initiated a programme of assisted emigration from his Irish estates. Approximately 1,800 people were removed to Canada and Australia between 1838 and the Great Famine (in Lynch &

Nugent 2008, 303). This scheme sought to relieve poverty associated with the "superabundant population", to increase the productive capacity of the land, and to reduce Col. Wyndham's financial liabilities under the Irish Poor Law (in Lynch & Nugent, 305).

In addition, evictions were regular occurrence on the Wyndham estate. In the period from 1838 to 1852, up to 3,800 people were evicted (in Lynch & Nugent 2008, 329). However, in 1849 the *Illustrated London News* sent a reporter and a sketch artist to Clare to look into the infamous level of evictions and poverty in the Kilrush poor law union. Their account included some of the best known images of the Famine – destitution, hunger, disease, mass evictions and death. However, the reports concerning the lands owned by Col. Wyndham in the parishes of Kilmurry-Ibrickan and Kilfarboy paint a strikingly different picture:

"The face of the country appeared to have changed. It was like passing from the Catholic to the Protestant cantons of Switzerland, or rather like a dream. At once I came on neat white-washed houses and tidy gardens. [...] I had entered the domain of Colonel Windham [sic], who is not tired of his fellow-creatures and does not seek to exterminate them. Not a roofless house did I see here [...] The whole face of the country us altered, and all the people you meet, whether men, women, or children, seem cheerful, as if they had planet of the means of subsistence"(in Lynch & Nugent 2008, 318).

13.4 Results of Field Assessment

The field assessment was undertaken on Tuesday, 18th May 2010 under adverse weather conditions. Out of sixteen recorded monuments and sites located within the study area (see Appendix 1), seven were surveyed: four enclosures/ ringforts, one graveyard and two holy wells (see Plates 1 – 7). The surveying of the remaining nine monuments and sites was not possible due to the lack of access. All recorded sites and monuments lie on low hills, predominantly in field used as pastures.

The field assessment showed that one of the assessed ringforts (SMR, CL039-011---) is situated within 62.5m of the proposed location of wind turbine 9 (T) and that it is possible that ground disturbance associated with the erection of the wind turbine may affect this monument.

The other surveyed and non-surveyed monument and sites will not be impacted by the proposed wind farm. However, there is a possibility that previously unrecorded archaeological material or finds may be encountered during ground disturbance associated with this development.

13.4.1 Archaeological and Architectural Significance of the Site

Due to the relatively high density of the Recorded monuments and Sites within the study area and its vicinity, the site of the proposed development should be recognised as a site of archaeological potential.

13.4.2 Final Site layout and Site Investigation Results

The finalised site layout has been reviewed by TVAS. The complete TVAS review report is supplied in Appendix 12, EIS Volume III Summary of the TVAS comments (in italics) regarding the revised layout are as follows:

- *"The current proposed site layout is smaller than that under consideration in the 2010 assessment report, with the southern and western areas removed. The layout of the turbines and access roads has also been altered, with just six turbines included in the current proposal".*
- *"Just one monument listed on the Record of Monuments and Places (RMP) lies within the current site boundary - CL039-015, a ringfort/rath. According to the submitted plans, although construction activity is proposed for this part of the site, it is over 300m from the ringfort/rath. In addition 'Enclosure (site of)' is marked on the modern Ordnance Survey of Ireland (OSI) 1:5000 digital mapping immediately outside the site*

boundary, north of Turbine T1. This potential monument is not illustrated on any historic maps, nor is there any protected monument in this location on the RMP. It is not clear why the label has been placed on the OSI current map but there is no evidence that there is an archaeological monument here".

- *"It is recommended that all ground works associated with the construction be subject to archaeological monitoring. Particular attention should be paid to the area around Turbine T1 due to the uncertainty surrounding the 'Enclosure (site of)' nearby. Should any construction work take place within 200m of monument RMP CL039-015, the monument should be protected with secure fencing to prevent accidental damage".*

- *"Should any archaeological features or material be uncovered during the course of archaeological monitoring or any phase of the construction works, works will cease immediately, and the National Monuments Section of the Department of Environment, Heritage and Local Government should be informed. Time must be allowed for a suitably qualified archaeologist(s) to inspect and assess any such material. If it is established that archaeologically significant material is present full archaeological investigation and recording will be required. Archaeological excavation is the preservation by record of archaeological remains. Adequate financial and logistical provision should be made for any such archaeological excavation, related post-excavation, testing and/or conservation work and for the publication of the results".*

13.5 Impact Assessment

The pertinent impacts expected are outlined below.

13.5.1 Do Nothing Impact

A 'Do Nothing Scenario' will ensure the continued preservation of hitherto unknown or potential cultural heritage features within the proposed wind farm site.

13.5.2 Potential Impacts Of The Development

The proposed wind farm site has been deemed as a site of archaeological potential based on rigorous desk-based research and field survey. The proposed final layout of the wind farm does not have any

significant immediate impact on local archaeology. TVAS recommendations are outlined above in Sub Section 13.4.2.

Areas of bog, have the potential to seal or contain a wide range of archaeological features and artefacts. Therefore, the potential to reveal sub-surface archaeological remains and/ or stray finds within the proposed development still exists. In this regard, should such sub-surface features or finds exist on-site they will be directly, negatively and permanently affected. It should be noted that there are no predicted impacts on the architectural heritage or local heritage resource.

13.5.1 Construction Phase

The proposed wind farm site will require ground stripping operations and ground excavations. Such construction operations may potentially directly, negatively and permanently affect sub-surface archaeological remains, should any be found to exist on-site.

13.5.2 Operational Phase

Following construction, no direct operational phase impacts are predicted in terms of the cultural heritage resource.

13.6 Recommended Avoidance, Remedial or Reductive Measures

13.6.1 Introduction

In order to mitigate against the potential impact that the proposed development could have on the surviving archaeological, architectural and cultural heritage, the following measures should be considered:

13.6.2 Avoidance

Just one monument listed on the Record of Monuments and Places (RMP) lies within the current site boundary - CL039-015, a ringfort/rath.

According to the submitted plans, although construction activity is proposed for this part of the site, it is over 300m from the ringfort/rath. In addition 'Enclosure (site of)' is marked on the modern Ordnance Survey of Ireland (OSI) 1:5000 digital mapping immediately outside the site boundary, north of Turbine T1. This potential monument is not illustrated on any historic maps, nor is there any protected monument in this location on the RMP. It is not clear why the label has been placed on the OSI current map but there is no evidence that there is an archaeological monument here. (TVAS Revised report 23rd February 2011).

13.6.3 Archaeological monitoring

We recommend that archaeological monitoring of construction works in the proposed development be undertaken.

13.6.4 Archaeological excavation

Should any archaeological features or material be uncovered during the course of archaeological monitoring or any phase of the construction works, works will cease immediately, and the National Monuments Section of the Department of Environment, Heritage and Local Government should be informed. Time must be allowed for a suitably qualified archaeologist(s) to inspect and assess any such material. If it is established that archaeologically significant material is present full archaeological excavation and recording will be required. Archaeological excavation is the preservation by record of archaeological remains. Adequate financial and logistical provision should be made for any such archaeological excavation, related post excavation, testing and/or conservation work and for publication of the results.

Please note that the recommendations given here are subject to the approval of The National Monuments Section of the Department of Environment, Heritage and Local Government.

13.1 Matrix of impacts / mitigation / residual impacts.

Item	Impact	Mitigation	Residual Impact
Construction Phase			
Potential sub-surface archaeology on-site	Direct, negative and permanent	Programme of Archaeological Monitoring of topsoil stripping & excavation works prior to construction followed by licensed archaeological resolution (excavation) if required	N/A
Operational Phase			
N/A	N/A	N/A	N/A

References

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www.buildingsofirelandie
www.excavations.ie
www.archaeology.ie
www.logainm.ie (Placename Database of Ireland)

14 INTERACTIONS OF THE FOREGOING

14.1 Introduction

Chapters 1, 2 introduce and describe crucial aspects and details of the project. These details have been assessed as relevant in the various assessment chapters 3 to 14. Each chapter has dealt with and assessed as appropriate all details of the project and the existing natural environment as per EIA regulations, additional assessment criteria pertinent to the wind farm application (e.g. Avifauna etc) have also been assessed in detail. In addition several aspects of the EIS assessment chapters are interlinked; this is because any impact on one aspect of the environment may also impact on another or several assessments of any of the assessment criteria. When impacts combine the impacts is often termed a cumulative impact, indirect impacts are also possible. A slight cumulative impact on one or more environmental topics may result in a significant impact on another topic. Cumulative impacts have been assessed under several headings already in this EIS, further attention to the interaction of the assessment criteria and cumulative impacts are given here.

Indirect and cumulative impacts were considered during the sitting of turbines to satisfy visual impact, hydrology, shadow flicker and noise generation. Other factors and constraints such as the habitat at each location, proximity to archaeological features, geotechnical considerations, and the requirements of Clare County Council County Development Plan were also considered. Because of different environmental constraints there were several revisions of the site layout plan. The site layout plan was finalised following the completion of all assessment work. The remaining interactions after the optimisation of the layout design between the various aspects of the environment are discussed in each chapter assessment section and reproduced here again as necessary in summary.

14.2 Predicted Impact

A matrix of all topics is presented in Table 14.1, which illustrates the overlap or interaction of topics. Please note that identification of interaction between environmental assessment themes/ topic does not necessary imply negative of positive cumulative impacts nor does Interaction in the matrix.

Table 14.1 Interaction matrix.

TOPIC	Human Beings & Material assets	Flora & Fauna	Soils & Geology	Hydrogeology & Water Quality	Air Quality & Climactic	Landscape & Visual	Cultural Heritage	Roads, Transportation and route selection
Human Beings		●	●	●	●		●	●
Flora & Fauna	●		●	●		●		
Soils & Geology	●	●		●		●		●
Water	●	●	●					
Air and Climate	●							
Landscape		●	●					
Cultural Heritage	●							
Material Assets	●		●					

As each diagonal half of the matrix is a mirror image of the other only the vertical side will be described in descending order from the first interaction – Human Beings and Flora and Fauna.

14.2.1 Human Beings

Human beings and:

- Flora and Fauna;
- Soils and Geology;
- Water;
- Air and Climate;
- Cultural Heritage;
- Material Assets;
- Roads, Transportation and Route Selection.

Any negative affect on the environment as a result of this project is produced by Human Beings and, because it is the environment we live in, any negative affect will also affect us as Human Beings. For example, the use of fossil fuels (Material Assets) for electricity generation produces greenhouse gases and fumes (Air and Climate affect) which affects weather patterns and, in turn, agriculture (Human Beings). The partial removal of the reliance on fossil fuels for electricity generation as a result of the project can therefore be seen as having positive overlapping impacts on Material Assets, Air and Climate and Human Beings. Because no negative affect has been predicted for Human Beings there are no negative interactions with the other overlapping topics. No mitigation measures are proposed as part of this interaction outline.

14.2.2 Flora and Fauna

Flora and Fauna and;

- Human Beings;
- Soils and Geology;
- Water;
- Landscape.

There is a close interrelationship of Flora and Fauna with the topics Soils and Geology and Water. A negative affect on one of these topics has the potential to affect the other three. For example vegetation removal decreases soil stability, which can result in surface water runoff with high suspended solids content. Conversely, reduced water quality or the

removal of large areas of soil would result in negative effects on flora and faunal species.

These types of impacts will be dealt with by reducing the vegetated area (project final footprint and project construction phase footprint) which is to be affected by the project. The construction phase method statements will carefully control the movement of vehicles during construction, will prevent excess land take and will manage construction phase drainage. Any surface water runoff, which originates at, or passes over exposed soil or peat, particularly at road construction, will be drained into specially designed settling ponds to allow the suspended solids to be removed before joining natural watercourses. In additional any excavated soils or peaty soils or peats will be managed accordingly by placement in specially designed storage areas which will provide drainage management. The drainage management of stored excavated soils may also incorporate the use of temporary silt traps and run off control and treatment mechanisms. These mitigation measures are outlined in the relative section and design details are given in attached drawings; further detailed design and layout plans will be given as part of construction management and construction phase method statements. The potentially negative affects associated with the aforementioned points are only expected to occur at construction stage and are considered to be adequately mitigated by the measures outlined. There will be no residual impact.

Affects on Flora and Fauna can also affect landscape in terms of vegetation. In the case of this site there are no trees to be removed, the project plan layout out indicates that no major areas of mature vegetation will be removed. Any impact on this habitat will be short term, no significant negative effect can be predicted and no mitigation measures are proposed.

14.2.3 Soils and Geology

Soils and Geology and:

- Human Beings;
- Flora and Fauna;
- Water;
- Landscape;
- Material Assets.

Several of these interactions described above are also relevant here. However water quality with respect to human use is an additional potential impact. However as mentioned above mitigation measures to protect water resources for flora and fauna indicate protection of water resources for human use.
The interaction between Soils and Geology and Landscape is concerned with the changes the landscape undergoes as a result of changes in the soil coverage or geological makeup. Landscape is usually viewed at a distance and the removal of small quantities of soil and rock should not be visible from even nearby viewpoints. No material assets of significant will be impacted due to interactions. The material impact of Landscape character is assessed appropriately in the Landscape Impact Assessment Chapter.

No significant negative effects are predicted, mitigation measures (in terms of site layout site foot print site turbine design) are proposed in the relative assessment chapters and no additional mitigation measures are proposed here.

14.2.4 Hydrology, Water Quality and Hydrogelogy

Water and:

- Human Beings;
- Flora and Fauna;
- Soils and Geology.

These three interactions have been discussed above and assessed in detail throughout the relative chapters. No negative effects are predicted and no additional mitigation measures are proposed. No significant water resource is needed as part of the project. No significant impact on water quality is expected from either the construction phase or the operational phase.

14.2.5 Air Quality and Climactic Factors

Air and Climate and:

- Human Beings.

These three interactions have been discussed above and assessed in detail throughout the relative chapters. No negative effects are predicted and no additional mitigation measures are proposed.

14.2.6 Landscape Character

Landscape and:

- Flora and Fauna;
- Soils and Geology.

These three interactions have been discussed above and assessed in detail throughout the relative chapters. No negative effects are predicted and no additional mitigation measures are proposed.

14.2.7 Material Assets

Material Assets and:

- Human Beings;
- Soils and Geology.

These three interactions have been discussed above and assessed in detail throughout the relative chapters. No negative effects are predicted and no additional mitigation measures are proposed.

14.3 Mitigation Measures

Mitigation measures have been outlined specifically for each environmental assessment criterion. No additional mitigation measures are required to be outlined here.

14.4 Conclusion

Following the assessment of the interactions of the foregoing topics it can be concluded that no significant negative effects from the proposed Coor Shanavogh Wind Farm are expected. Evaluations of the potential impacts for each environmental topic are given in the relative assessment chapters. Evaluations are given in some instances both before and after application of mitigation measures. Evaluation of impact is also given where necessary as an in-combination or cumulative impact. In short the necessary mitigation measures have been outlined for implementation in the relevant assessment topic chapters. Mitigation measures will also be applied as part of management protocols during the start up of the construction phase. Specific mitigation measures will be applied to the construction phase via construction management method statements.

Based on positive energy and climate impacts of the proposed development and the modest visual, peat, ecology and noise impacts, it is considered that Coor Shanavogh is a suitable site for the development of a six turbine wind farm.