INTERNATIONAL

Oweninny Wind Farm Development

Oweninny Power Limited (OPL)
Response to An Bord Pleanála
Further Information Request
Assessment of Alternative Option
Phase 1 and Phase 2 only

Document No.: QS-000169-02-R460-003

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Change History of Report

Date	New Revision	Author	Summary of Change
09/10/2015	001	PL	Legal Comments on Introduction incorporated
			Review and update of Cumulative Impacts in each Section

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1 INTRODUCTION

Bord na Móna and ESB, through their wholly owned joint venture company Oweninny Power Ltd., lodged an application for a wind farm development on the Oweninny site to An Bord Pleanála in July 2013 (Ref 16.PA.0029). The proposed development comprised a wind farm of 112 wind turbines with ancillary infrastructure comprising 4 electrical substations, an Operation and Maintenance Building, 8 anemometer masts, 78 kilometres of access track, a visitor centre, temporary batching plant, borrow pit, peat repository area and contractors lay down areas. The Oweninny site comprises some 50km^2 being mainly a former industrial peat harvesting site providing peat to the now decommissioned Bellacorick Power Station.

The country's first commercial wind farm was established at the site at Bellacorick in Co. Mayo in 1992 and in 2003 planning permission was granted for 180 wind turbines on the site (Planning Reference 01/2542, ABP reference PL.16.131260). However, the construction of this 180 turbine wind farm was evidently not progressed due primarily to grid connection issues. A 5 year extension of the planning permission for this original wind farm was sought from Mayo County Council and the request was granted by the Planning Authority in 2014,

The proposed development at Oweninny in 2013, comprising 112 wind turbines with a rated output of 372MW, was equivalent to the development granted permission by An Bord Pleanála in 2003 and differs primarily only in terms of the number of turbines (decreased from 180 to 112) from the original planning approved wind farm.

The project has received Grid Connection Offers from EirGrid for 371.9 MW. Of this, 172 MW of the project has been assigned connection capacity on the existing 110 kV grid at Bellacorick substation with the remaining capacity scheduled to be available – only after EirGrid carries out further works to provide network capacity in the area under the Grid West project. In addition the new proposal is to be developed in 3 Phases, with Phases 1 and 2, with a rated export of 172 MW being connected to the existing ESB 110kV substation at Bellacorick.

EirGrid has published details of underground and overhead options for the Grid West project, as outlined in its report to the Government-appointed Independent Expert Panel (http://www.eirgridprojects.com/projects/gridwest/iep/). The Grid West report sets out, in detail, the technical, environmental and cost aspects of three technology options:

- a fully underground direct current cable;
- a 400kV overhead line and;
- a 220kV overhead line with partial use of underground cable

The Independent Expert Panel Report identifies two potential locations for the Grid West Substation or DC to AC Converter Station (which would be required if a High Voltage Direct Current (HVDC) cable option was selected). EirGrid plan to consult on the options in late 2015 with a view to seeking planning permission in 2016.

The final location of the Grid West substation site has not yet been identified by EirGrid and no planning application for it has been made. For this reason planning permission for Phase 3 of the development is no longer being sought. Instead permission is being sought for part of the development contained in the planning application i..e. the development of Phases 1 and 2 excluding Phase 3. These phases already have a grid connection point at the existing Bellacorick Substation location. The Oweninny planning application provided details and assessment of grid connections for Phases 1 and 2 to this substation. Renewable wind energy from the Oweninny Wind farm will therefore be exported to the grid via the existing Bellacorick Substation

The option exists to proceed with the planning approved 180 turbine wind farm

If the development of Phase 1 and Phase 2 is granted planning permission then the new design will replace the existing planning approved design resulting in a reduced number of larger more efficient turbines on the site.

1.1 SCOPE

This Phase 1 and Phase 2 development assessment has been prepared to accompany the revised EIS application by Oweninny Power Limited as requested by An Bord Pleanála in their Request for Further Information. It follows the format of the original EIS submitted but with reference to Phase 3 in terms of description and impacts being removed and focussing on updating information where relevant.

It should be noted that the red line boundary of the Oweninny wind farm site remains unchanged from the original application and hence the baseline information remains the same with minor updates.

The proposed wind farm site is located in North Mayo, west of Crossmolina and east of Bangor Erris, just north of the N59 road - see Figure 1-1. The site still comprises some 50 km^2 and the Phase 1 and Phase 2 development would comprise a footprint of some 1.16 km^2 of this.

The site lands are owned by Bord na Móna and comprise cutover and cutaway bog land, (see Table 1.1).

The total installed capacity of Phase 1 and Phase 2 is expected to be approximately 172 MW. The site is situated in the townlands indicated in Table 1.1. The Phase 1 and Phase 2 wind farm development will comprise 61 wind turbines, which will be used to harness the natural energy of the wind to generate electricity.

Table 1.1: Oweninny wind farm Phase 1 and Phase 2 project townlands

Townland Name	Proposed turbine numbers	Other structures
Bellacorick	No turbine[L2]	N/A
Corvoderry		Access Tracks, Peat disposal area (reduced in size)
Croaghaun West	56, , 67, 68, 69,	Access Tracks, Met Mast x1, Batching Plant, O&M Building, Sub-station x1, Sub-station (part), Contractors Compound x1, Overhead Line, U/G Cable
Doobehy	No turbine[L3]	N/A
Dooleeg More	No turbine[L4]	Board Gais Pipeline Existing
Formoyle	No turbine[L5]	N/A
Kilsallagh	88, 89, 90	Access Tracks, Contractors Compound (1), Site entrance no 2, Board Gais Pipeline Existing
Knockmoyle	1, 2, 3, 4, 5, 6, 7, 12	Access Tracks, Met Mast x1,
Laghtanvack	8, 9, 10, 13, 14, 15, 23, 24, 25, 29, 30, 37, 41, 42, 43, 45, 46	Access Tracks, Met Mast x2, Borrow Pit, Gravel Storage Area (part)
Moneynierin		Access Tracks, Board Gais Pipeline Existing, Site entrance no 1 & 3, Gravel storage area x1, Visitor Centre & parking (part)
Shanvodinnaun	31, 44,	Access Tracks, Contractors compounds x1, Gravel storage area (part)
Shanvolahan		Access tracks
Sheskin	19	Access Tracks, Board Gais Pipeline Existing
Srahnakilly	11, 18, 20, 21, 22, 28, 36, 40, 54, 55, 65, 66, 80, 82, 91	Access Tracks, Met Mast x1, Sub-Station x1, Contractor Area x1, Overhead Line, U/G Cable
Tawnaghmore	27, 33, 34, 35, 39, 51, 52, 53, 64, 79, 87	Access Tracks, Met mast (1), Board Gais Pipeline Existing

N/A = No structure

1.2 General Overview Phase 1 and Phase 2 Development

Bord na Móna has been involved in peat production operations at the site since the 1950s. Milled peat production ceased on the site in September 2003 and peat deliveries to the ESB power station at Bellacorick ceased in 2005. As part of the conditions of the Integrated Pollution Prevention and Control (IPPC) operational licence for the site, a bog rehabilitation programme was developed to enhance post-peat-harvesting recovery of parts of the site and ensure minimum residual impact on the environment. The bog remnant and bog rehabilitation areas will not be significantly affected by the proposed wind farm development of Phases 1 and 2 and the overall site development will be carried out in a manner that integrates with the bog rehabilitation programme.

The country's first commercial wind farm was established at the site at Bellacorick in Co. Mayo in 1992. It comprises 21 wind turbines with a total installed capacity of 6.45 MW, and produces enough electricity to supply approximately 3,500 households. This existing wind farm, if still in operation, will be replaced during the final phase of the proposed new development at Oweninny.

In 2003 planning permission was granted by An Bord Pleanála for 180 wind turbines on the site (An Bord Pleanála Reference PL 16.131260 – Mayo County Council Register Reference Number 01/2542). Subsequent to this Mayo County Council granted a 5 year extension of the planning permission duration. The original permission will now expire in 2018.

The Phase 1 and Phase 2 development is essentially lower in terms of installed capacity to the development granted permission by An Bord Pleanála in 2003 and differs from the development permitted primarily in terms of the number of turbines (decreased from 180 to 61) and turbine size (overall dimension from foundation level to blade tip increased from 100 metres (m) to a maximum of 176 m). These changes are to accommodate what are now essentially industry standard turbine models and reflect the technological advances that continue to occur in wind turbine design.

1.2.1 Proposed Phase 1 and Phase 2 development

The Phase 1 and Phase 2 development will comprise 61 wind turbines. The location and layout of these is exactly the same as that provided in the Oweninny Wind Farm Planning application. No change in the position or dimensions of the infrastructure described originally will occur.

The exclusion of the Phase 3 part of the proposed development will of course result in a reduction in the length of access track, number of turbines (from 112 to 61), number of substations (only substation 1 and substation 2 are required) and meteorological masts (a reduction from 8 to 6).

Phase 1 and Phase 2 will include 61 wind turbines and crane hardstands at each turbine, construction of 49 kilometres of new access tracks, two electrical substations containing control buildings and substation, underground electrical cables linking the turbines with the control buildings, underground communication cables, six permanent meteorological masts, two 110 kV overhead lines linking the substations to the existing transformer station at Bellacorick, an Operation and Maintenance facility and all related site works and ancillary development including batching plant and borrow pits. The gravel storage area associated with the borrow pit will be retained as part of the Phase 1 and Phase 2 development as will part of the proposed peat repository area. The latter will be accessed via the access track leading via the original trackways to T83 and T70 which formed part of the Phase 3 development.

In addition the purpose built Visitor Interpretative Centre will be developed providing insight to the history of power generation, peat production, wind energy development, the bog rehabilitation programme, ecological interests and the social history of the area. In terms of other temporary works Phase 1 and Phase 2 will require 4 contractor's lay down areas.

The rated electrical output of the Phase 1 and Phase 2 development will be approximately 172 MW. The exact output cannot be specified at this stage. In accordance with procurement regulations that apply to the joint venture development company a competitive procurement process will be undertaken to select turbines for the project. Outputs of wind turbines are particular to the design of individual manufacturers and it is thus not possible in an open international competition to specify the exact output without prejudice or favour to one manufacturer. The overall rating may thus ultimately be marginally more or less than cited. However, throughout the EIA process, consideration of significant environmental impacts of the proposed development is based on the largest size of development foreseen. The choice of turbine model will not affect the assessment of impacts outlined herein.

1.2.2 Changes to Cumulative Impact Projects

A number of projects with potential for cumulative impact were assessed as part of the Oweninny wind farm application. Since the application was made and following on from the oral hearing some changes have occurred with respect to existing projects and some additional projects have entered the planning process. These are outlined as follows:

- The Coillte Cluddaun Wind Farm Development has been refused planning permission (ABP Planning Reference 16.PA0031).
- EirGrid proposed modification of existing Bellacorick Substation comprising construction of an extension (approx. 60sqm and 3.2m high) to the south western elevation of the existing 110kv control room. installation of 1 no. new 110kv cable bay with equipment and apparatus comprising busbar disconnect, circuit breaker, combined current/voltage transformer, line/earth disconnect, surge arrestor and cable sealing end and all associated site development works, (see Mayo Planning Reference 15456)
- EirGrid proposed upgrade of the Bellacorick to Castlebar 110kV OHL (that is the Bellacorick substation to Castlebar substation) (Planning

Reference P14/410). Planning permission has been granted on appeal by An Bord Pleanála (Reference: PL 16. 244534).

- EirGrid lodged a planning application for the Bellacorick to Moy 110 kV OHL deep works (Mayo Planning Reference 1545). Notification of permission was issued on 04/08/2015.
- ESB Networks planning application for the Bellacorick to Bangor Erris 38kV overhead line refurbishment/uprate project was lodged with Mayo County Council in September (Reference P15/611)
- Proposed Windfarm development at Tawnanasool (Planning Reference P14/666). Notification of refusal was issued by Mayo County Council on the 14th August 2015. The applicant appealed the decision to An Bord Pleanála on the 20/08/2015 with case listed to be decided by the 23/12/2015.
- Planning permission has been granted for a temporary three year meteorological mast development in the townland of Sheskin by ABO Wind Ireland Ltd (Planning Reference P15/460)
- Grid West Project
  - Undergrounding of Grid West option. The Government-appointed Independent Expert Panel confirmed that EirGrid has completed the report for the Grid West project in line with its (the Panel's) Terms of Reference. This includes a comprehensive analysis of underground and overhead options for the project, including assessment of potential environmental impacts, technical efficacy and cost factors.
  - EirGrid has published the full report and accompanying appendices (July 2015). The Grid West options assessed in the report include the following;
    - 400kV Overhead line with 400kV substations
    - 220kV overhead line with 220kV substations
    - HVDC underground cable with Inverter Stations

A cumulative impact assessment of each of these projects is included for the Phase 1 and Phase 2 development under each heading as appropriate.

1.3 METHODOLOGY

For the description, impact assessment and mitigation of the Phase 1 and Phase 2 development the assessment follows the EIA principles and format adhered to for the Oweninny wind farm application and takes all elements into account including the construction, operation and decommissioning of the wind farm.

The assessment of the Phase 1 and Phase 2 development is presented in the grouped-format structure of the original EIS with each category (Human Beings, Noise, etc.) being considered under the separate headings: Description of Existing Environment; Impact of the Development; Mitigation (where appropriate); Cumulative Impact and Conclusions (where appropriate).

Where appropriate, the assessment utilises readily available updated baseline information and also includes clarifications provided at the Oweninny Wind farm Oral Hearing, held in April 2014.

As the Bellacorick Iron Flush Special Area of Conservation (cSAC) is within the Phase 1 and Phase 2 proposed development area and as there are other designated areas hydraulically connected to or within 15km to the site, a separate appropriate assessment under Article 6.3 of the Habitats Directive has been made and is provided separately to this report.

Every effort has been made in the preparation of the document to keep it as concise as possible while also ensuring that relevant material is adequately covered.

In an effort to minimise repetition and to keep the document as concise as possible, mitigation measures that are applicable to a number of topics may or may not be repeated in the document. In general, only mitigation that is associated with the primary impacts is described.

While every effort is made to present together all details relating to individual topics, these should not be considered in isolation of others and without reference to context.

1.4 ORAL HEARING INFORMATION

As previously stated clarifications on issues raised by third parties were provided at the Oweninny Wind Farm oral hearing, which took place in Ballina in April 2014. The assessment of the Phase 1 and Phase 2 development includes clarification information provided at the oral hearing.

1.5 CONTRIBUTORS

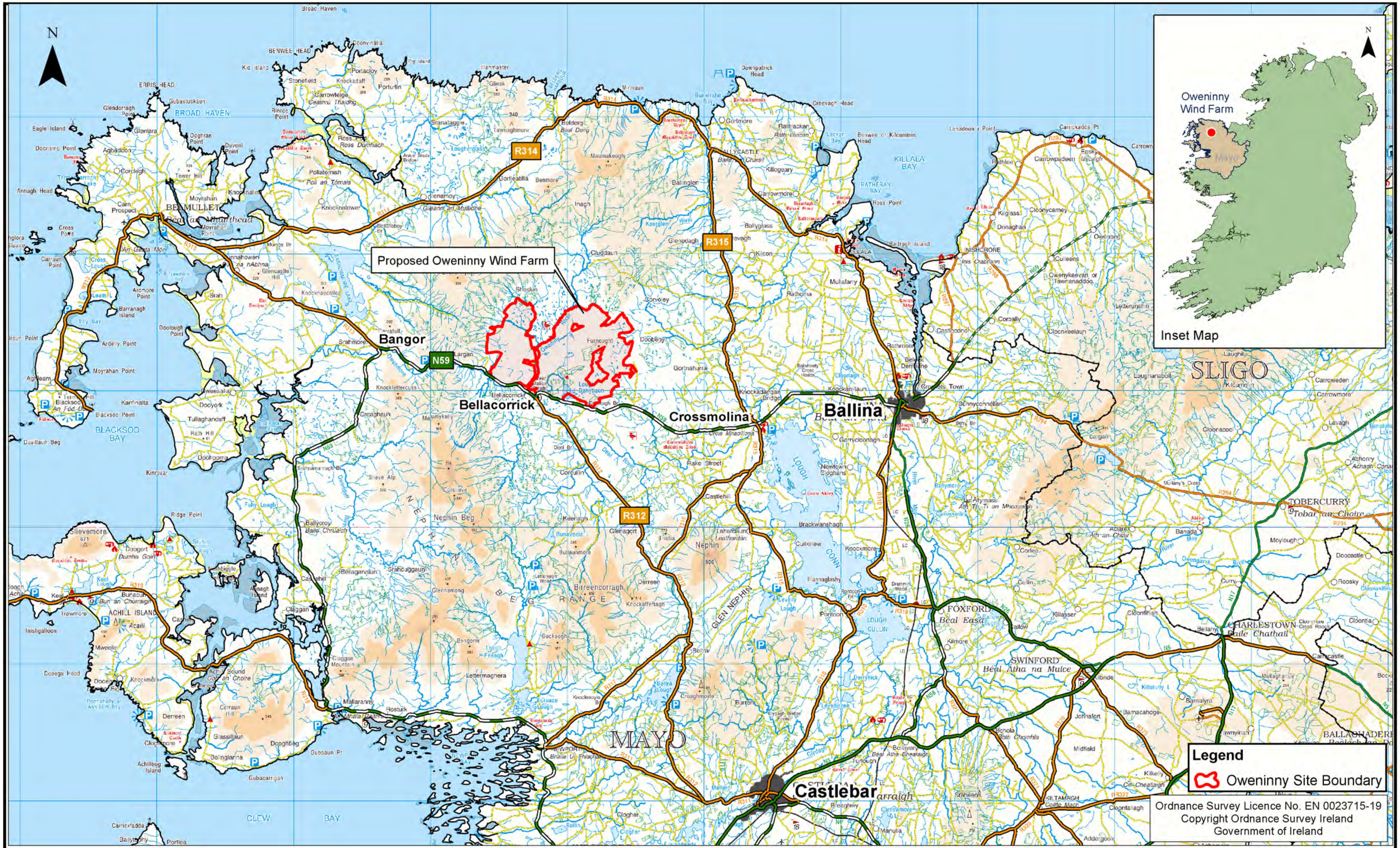
The Phase 1 and Phase 2 assessment was prepared by ESBI Civil and Environmental - Pre Development Group, Stephen Court, 18-21 St. Stephen's Green, Dublin 2, Ireland. The consultants and organisations who prepared the specialist reports for the original Oweninny wind farm EIS also contributed to the preparation. These are listed as follows:

- Bord na Móna
- ESB Wind Development
- RPS (the consultant in Biospheric Engineering Limited who prepared the noise assessment is now employed by RPS (Noise))
- Hayes McKenzie Partners Ltd (Noise)
- Biosphere Environmental Services (Terrestrial Ecology)
- Aquafact International Ltd. (Aquatic Ecology)
- Byrne Mullins & Associates (Cultural Heritage)
- AECOM (URS Ireland who prepared the original Landscape Assessment are now part of AECOM (Landscape))
- Hydro-environmental Services Limited (Bellacorick Iron Flush study)

No significant difficulties arising from lack of information were encountered in the development assessment process.

1.6 CONSULTATION

The issues identified through Stakeholder and public consultation and addressed in the Oweninny Wind Farm EIS remain current and no additional consultation was undertaken with respect to the assessment of Phase 1 and Phase 2 only.



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Site Location Map
Project	Wind Farm Project at Oweninny, Bellacorick, Co. Mayo
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
EO'S	C.F	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:250,000

MAP REFERENCE

FIGURE 1.1

2 DESCRIPTION

2.1 BACKGROUND

The Phase 1 and Phase 2development of Oweninny Wind Farm will be developed by Oweninny Power Ltd, a joint venture between ESB Wind Development Limited and Bord na Móna Energy Limited.

The wind farm will comprise 61wind turbine generators, each of approximately 2,500 -3,500 kilowatt (kW) capacity. The rated electrical output of the wind farm will be approximately 172Mega Watts (MW) and the electricity generated will be supplied into the deregulated electricity market on the national electricity network.

The development will also include:

- Two electrical substations,
- Underground cables from the wind turbines to the substations,
- 49 kilometres of access tracks (these will be largely new with c.6km of existing access tracks being upgraded),
- One operation and maintenance building,
- Two 110 kV overhead lines, (circa 1.7 km from Electrical Substation 1 and 2.5 km from Electrical Substation 2) comprising angle masts and twin wooden pole sets connected to the existing Bellacorick substation by two underground electricity cables.
- A visitors centre,
- Six permanent meteorological masts
- Temporary works will include
- A borrow pit to provide material for access track construction
- Concrete batching plant with associated materials storage
- Contractor(s) construction lay down area and materials storage area.
- Peat repository area

2.2 THE DEVELOPERS

The joint developers of Oweninny Wind Energy Project Phase 1 and Phase 2 are Bord na Móna Energy Limited and ESB Wind Development Limited. A joint venture company, Oweninny Power Limited has been established for this purpose with registered offices at ESB International, Stephen's Court, 18 – 21 St. Stephens Green, Dublin 2.

2.3 THE SITE

No change in the site boundary submitted as part of the Oweninny Wind Farm application has occurred.

The site is located in North Mayo, approximately 8.9 km west of Crossmolina and 7.3 km east of Bangor Erris (see Figure 2.1). It is located just north of the N59 road and comprises some 50 km2. The L52925 local road runs through the centre of the site, the L52926 is located to the west of the site and the L5292 is located to the east of the site. The site is irregular in outline and extends in an east west direction for some 11km and in a north south direction some 7.4km. It comprises two distinct areas divided almost entirely by a narrow strip of private land holdings but is linked by an internal bridge, within the ownership of Bord na Móna, over the Oweninny River. Bord na Móna was involved in industrial scale peat production operations at the site for half a century to supply the ESB Bellacorick peat burning power station. Peat production commenced in the 1950s and peat operations ceased in 2005 following the closure and the power station which was subsequently decommissioning.

The site lands are owned by Bord na Móna and comprise cutover and cutaway bog land. Peat harvesting operated under an Integrated Pollution Prevention and Control License (IPPC License Number 505) issued by the Environmental Protection Agency (EPA). In accordance with the licence for the site a bog rehabilitation programme has been developed and implemented to enhance rehabilitation of parts of the site. Those parts of the bog that were not harvested by Bord na Móna, known as bog remnants, and bog rehabilitation areas will not be significantly affected by the proposed wind farm development and the wind farm will be integrated into the bog rehabilitation already underway.

The site encompasses Lough Dahybaun, a Special Area of Conservation (SAC) protected under the EU Habitats Directive. The Bellacorick Iron Flush SAC is also located within the site boundary. This flush area is owned by An Taisce and by the National Parks and Wildlife Service of the Department of the Arts, Heritage and the Gaeltacht. A large area, approximately 3.6 km2, known as O'Boyles Bog is located within the north-western portion of the site and although within Bord na Móna ownership no development will take place there. The Sheskin stream forms its southern boundary.

The Oweninny River drains the central part of the site. The Oweninny river is fed by the Srahmeen river and Knockmoyle Stream from the west and by numerous small tributary streams from the east (Fiddaungal, Fiddaunnaglogh, Fiddaunnameenabane, Fiddauncam and the Fiddaunnamuinggeery) before entering the Oweninny wind farm site. The Oweninny is joined by the Sheskin Steam which drains the forested south-eastern slopes of Slieve Fyagh and also forms the site's internal boundary with the O'Boyles Bog area. The Oweninny and the Fiddaunnamuingeery form part of the site boundary. The Sruffaunnamuingabatia, which drains the Bellacorick Iron Flush SAC area within the site, flows westwards and joins the Oweninny river. The Oweninny is also joined by the Muing River which drains Lough Dahybaun within the site. The Owenmore drains a catchment of approximately 332 km2 before entering the sea at Tullaghan Bay. The Oweninny flows southwards, externally to the site and effectively dividing the site in two before joining the Owenmore turning westwards after Bellacorick Bridge and paralleling the N59. The Owenmore is joined at this location by the Altanabrocky river flowing northwards from the Nephin Mountains.

The north-eastern part of the site is drained by small tributaries (Fiddaunfura) which rise in Shanvodinnaun and flow eastwards to the main easterly flowing river, also named the Owenmore. This river rises in the townlands of Cluddaun and Shanetra to the north of the site before flowing eastwards becoming the Cloonaghmore River before entering the sea at Rathfran Bay which is within Killala Bay. It is also referred to as the Palmerstown River. The Cloonaghmore River drains a catchment of approximately 132 km2 before entering the sea at Rathfran Bay.

The south-eastern part of the site drains to tributaries of the Shanvolahan River (Fiddaunagosty, Shanvolahan and Fiddauntooghaun) before entering the Deel River which drains to Lough Conn and eventually joins the River Moy at Ballina before entering the sea at Killala Bay. The River Moy drains a catchment of approximately 1,966 km2 before entering the sea at Killala Bay. The area of the Shavolahan catchment before it enters the Deel River is approximately 23.7 km2.

The site encompasses some 352 hectares of Coillte forest plantation, on Bord na Móna owned lands, comprising mainly Sitka Spruce and Lodgepole pine. This is located mainly around and to the northwest of Lough Dahybaun. The site also encompasses 192 hectares of private forest plantation land at Corvoderry. This area has received planning permission for a wind farm development in 2012 (Planning File Reference 11838) and has a right of way through the Bord na Móna lands.

The N59 (Ballina to Belmullet) National Primary Road runs immediately adjacent to the southern site boundary. Bellacorick village is located on the N59 towards the south centre of the site with a local road (L52925 or Srahnakilla road) running north through the site in parallel to the Oweninny River. To the west a local road (L52926) runs north off the N59 near Ballymonnelly Bridge for a short distance to Tawnaghmore townland becoming the Western Way, passing Sheskin Lodge and veering north by northeast. To the east a local road (L5292) runs northwards from the N59 to the townlands of Shanvolahan and Formolye.

The site is bounded to the north by the Knockmoyle Nature Reserve, part of the Bellacorick Bog Complex cSAC and by Coillte forest plantation land to the north-east and north-west.

Access to the Oweninny site will occur at two existing site access locations off the N59, the existing Bellacorick Wind Farm access and an existing access to the Bord na Móna lands at the western part of the site.

The altitude of the site is approximately 100m above sea level.

All turbines will be located within the site on areas of worked peatlands.

Map on which the site appears is Ordnance Survey (OS) Discovery Series (1:50,000) Sheet No 23.

2.3.1 Changes to general description compared to original application

The Phase 1 and Phase 2 only alternative is situated in the northern, middle and western part of the Oweninny site

There will be no structures located within the Oweninny site boundary which are hydraulically connected to the river systems in the north-eastern part of the site or south eastern part of the site, that is no drainage from any structure leading to the Cloonaghmore Catchment (the easterly flowing Owenmore River) or the Moy system which includes the Deel river and its important Freshwater Pearl Mussel (*Margaritifera margaritifera*) population.

There are no structures proposed within the catchment area of Lough Dahybaun, the designated cSAC lake within the Oweninny boundary.

Of the 352 hectares of Coillte forest plantation on Bord na Móna owned lands only approximately 1.05 ha will be impacted by the proposed development of Phase 1 and Phase 2.

The overall area of the subject site is approximately 5,090 hectares (ha) excluding the Bellacorick Iron Flush and Corvoderry wind farm site located within the site boundary with the Phase 1 and Phase 2 development occupying approximately 116 ha of this. This is equivalent to 2.3 % of the overall lands, including borrow pit, gravel storage areas and peat repository. Excluding these elements the development (buildings, turbines, hardstands and access tracks) comprises 1.2% of the site.

2.4 PLANNING HISTORY

The only change in the planning history of the site is the grant of extension to the 2003 Planning Permission for 180 wind turbines by Mayo County Council in 2014.

2.5 DESCRIPTION OF PHASE 1 AND PHASE 2 SCHEME

2.5.1 Scheme Components

The Phase 1 and Phase 2 development will generate electricity by harnessing the wind and will supply the power to the National Grid. The development will consist of a maximum of 61 wind turbines, each of approximately 2,500 – 3,500 kW rated capacity. It is anticipated that the project will generate between 270 – 303 Gigawatt hours (GWh units) of electricity per annum.

The capital costs of the proposed development are projected to be in the order of up to €326M.

The main components of the scheme are wind turbines, access tracks, two Electrical substations containing electrical control buildings and substation, an operation and maintenance building, a visitors centre, two 110 kV overhead lines with pole sets and angle masts, underground cables and six permanent meteorological masts. The layout of the site with Phase 1 and Phase 2 can be seen in Figure 2.1.

The wind farm components will occupy a very small part of the Bord na Móna lands at Oweninny (118 hectares or 2.3%, including borrow pit, gravel storage areas and peat repository. Excluding these elements the development comprises 1.2% of the site). The remainder will be available for existing or other uses.

The currently approved development comprises 180 wind turbines arranged in a fixed linear pattern. The geographic spread of the Phase 1 and Phase 2 development adopts a nonlinear pattern to maximise energy yield from the site. The rehabilitation process on the site has resulted in ground cover that largely screens any view of the former peat harvesting operations drainage network within the site. Therefore the previous rationale for the layout to reflect the regularity of the drainage network no longer exists on the site.

2.5.2 Wind Turbines

There is no change in the overall dimensions of the wind turbines proposed in Phase 1 and Phase 2 only.

The turbines will have a maximum base to blade tip dimension of 176 m.

This will likely comprise a tower height in the range 100 - 120 m and three blades, each with a blade rotor diameter in the range of between 90 - 120 m, i.e. turbines may be configured as comprising a tower/blade configuration within these ranges, with a maximum tip height of 176m.

The increased dimensions allows for greater flexibility in choice of turbines by the inclusion of a significantly larger number of candidate turbine models. It also facilitates greater sustainable capture and deployment of Ireland’s prime renewable energy source.

The wind turbines, a typical view of which is shown in Figure 2.2, will be selected from a range of models that have been demonstrated successfully throughout Europe and certified to the highest international standard. The contract to supply and construct the wind farm will be open to international competition under international procurement rules to which both ESB and Bord na Móna are subject. For this reason it is not possible to specify the exact turbine which will be deployed at Oweninny but it will be within the range indicated.

While the choice of make and model has not yet been finalised, the wind turbines under consideration for installation are three bladed, horizontal axis machines. There are a number of candidate machines, with those indicated in Table 2.1 being typical. However, turbines of larger rating will also be considered for the site within the overall height envelope of 176m.

The turbine towers will be either of tubular steel design or hybrid concrete/steel tapering from about 4.5 m diameter at the base to about 3.2 m diameter at the top where the nacelle will be mounted. A three blade rotor will be attached to the nacelle. The blades will be made of fibreglass-reinforced epoxy material with each blade typically consisting of two blade shells, bonded to a supporting beam.

The nacelle will contain the generator and control unit, which will be designed for computer controlled monitoring of all major functions of the turbine. It will have effective sound insulation and smooth performance of moving parts will ensure minimal noise. The components of a typical nacelle are shown in Figure 2.3.

Table 2.1: Candidate Wind Turbines*

Model	Rating (MW)	Hub Height (m)	Rotor Diameter (m)	Overall Dimension (m)
Alstom	3.0	100	110	155
Enercon E101	3.0	108	82	149
GE 2.5xl	2.5	100	100	150
Nordex N100	2.5	100	100	150
Nordex N100/3300	3.3	100	117	158.5
Siemens 101	3.0	120	101	170.5
Vestas V90	3.0	120	90	165
Vestas V112	3.0	120	112	176

**Note this is not an exhaustive list of turbines*

The steel tube towers with high specification, factory applied, paint finish will be fixed to concrete bases, the exact depth and structural design of which will depend on site conditions and may vary slightly from one turbine to another. An alternative tower type which is becoming available consists of concrete/steel construction. These can offer advantages where transportation constraints are identified as concrete towers could be delivered in small precast concrete sections which could be assembled on site.

Two types of wind turbine foundation are envisaged as follows:

- For turbines located on good ground bearing stratum the turbine foundation will be either circular or hexagonal shape with square dimension of approximately 22m. For the purpose of planning foundation with hexagonal design have been shown.
- For turbines on difficult ground or within proximity of sensitive areas with high dependence on ground water, turbine foundations will be piled. Piles will be reinforced concrete of approximately 900mm diameter and with an average length of 17m.

Detailed geotechnical investigations will be undertaken at the site prior to commencement of construction to enable detailed structural design of foundations.

Access to the turbine is via a staircase located outside on the hardstand and a secure hinged door into the tower. Personnel access in the turbine towers and nacelles will meet all safety regulations. The equipment will be protected from lightning strike by deep earthing and from corrosion by multiple coatings.

All wind turbines are located at minimum distance of 1000m from the nearest dwelling, are at least 100m from the site boundary, 200m from designated areas and 100m from major rivers and their primary tributaries.

2.5.2.1 Method of Operation

The basis of wind turbine operation is as follows:

- A yaw mechanism turns the turbines so that they face the wind.

- The wind forces the blades of the turbine to rotate.
- The rotation of the blades rotates a generator within a nacelle (housing) located at the turbine hub to produce the electrical power output.
- The electricity generated in the nacelle is fed via cables in the tower and subsequently underground to electrical transformers where it is transformed to a higher voltage for supply to the National Grid.

Sensors will be used to monitor wind direction and the nacelle will yaw to keep the blades facing into the wind.

The turbine blades will rotate at about one revolution every 3 – 5 seconds, depending on wind speed. The turbines will have active pitch regulation whereby the angle of the rotor blades can be adjusted by the machine control system. This system has built-in braking, as the blades become stationary when they are fully 'feathered'. The turbines will commence operation at a wind speed of about 4 m/s, will attain maximum output at about 15 m/s and will shut down when the wind speed reaches a 10-minute average of 25 m/s. Power will be controlled automatically as wind speed varies.

2.5.2.2 Locations

The wind turbines in Phase 1 and Phase 2 will be located at elevations in the approximate range 83 – 112 m OD. Details with coordinates in ITM are as shown in Table 2.2. Note the number sequencing of turbines is not continuous as it follows the turbine position numbering of the original EIS with all three phases. This allows for direct comparison with the original EIS layout.

An initial layout of 124 wind turbines was considered for the site and this was subsequently reduced to 117 turbines, based on the constraints identified arising from the planning conditions set out by An Bord Pleanála (Ref. PL 16.131260). The layout showing 117 wind turbines formed the basis for consultation purposes with key stakeholders (Scoping exercise).

The layout of the 61 turbines in Phase 1 and Phase 2 is a subset of the final proposed layout of 112 turbines submitted for planning to An Bord Pleanála, which was arrived at on the basis of consultation undertaken and on the basis of hydrogeological, geotechnical, ecological and cultural heritage investigations on site. Further detailed investigation at the time of construction may lead to minor repositioning of a small number of individual turbines, as described in the DoEHLG Windfarm Planning Guidelines (Section 5.3).

“Provision must be made for carrying out site-specific geo-technical investigations in order to identify the optimum location for each turbine. These investigations may suggest minor adjustments to turbine location. In order to accommodate this practice there should be a degree of flexibility built into the planning permission and EIS. The extent of flexibility will be site specific but should not generally extend beyond 20 metres,”

The stochastic layout lends itself to micrositing of turbines if this is required. Avoidance of deep peat, bog remnants and maintaining the setback distances proposed for the development overall will be the key objective of any turbine micrositing. In the event that a requirement for minor changes arises, the final layout will be agreed with the Planning Authority before commencement of construction. Any suggested micrositing will be subject to the constraints that it does not lead to greater visual prominence of overall development and that a minimum separation of 1000 m from the nearest occupied residence is maintained.

Table 2.2: Locations of Turbines

No.	Easting(ITM)	Northing (ITM)	No.	Easting (ITM)	Northing (ITM)	No.	Easting (ITM)	Northing (ITM)
T1	500679	825900	T23	499479	824493	T51	494705	823015
T2	501885	826011	T24	500039	824570	T52	495156	823287
T3	500201	825741	T25	501682	824600	T53	495392	822935
T4	501097	825748	T27	494793	824169	T54	496176	823310
T5	502287	825640	T28	495923	824181	T55	496111	822744
T6	501500	825507	T29	499767	824160	T56	498926	822711
T7	499736	825368	T30	500712	824225	T64	495246	822497
T8	500696	825374	T31	502311	824317	T65	495630	822204
T9	501882	825225	T33	494342	823881	T66	496627	822512
T10	502707	825322	T34	494695	823724	T67	498288	822487
T11	495474	824971	T35	495248	823885	T68	498678	822140
T12	499611	824951	T36	496429	823868	T69	499365	822186
T13	500264	825007	T37	501394	824010	T79	495028	822060
T14	501005	824996	T39	494314	823446	T80	496141	822085
T15	502312	824929	T40	495619	823550	T81	495443	821807
T18	495876	824813	T41	498975	823591	T82	496582	821837
T19	495051	824580	T42	500061	823736	T87	494965	821622
T20	496248	824591	T44	502016	823723	T88	495432	821388

No.	Easting(ITM)	Northing (ITM)	No.	Easting (ITM)	Northing (ITM)	No.	Easting (ITM)	Northing (ITM)
T21	495495	824385	T45	498521	823145	T89	495886	821677
T22	496761	824355	T46	499305	823276	T90	495971	821255
						T91	496454	821284

Note: Coordinates in ITM.

2.5.3 Transformers

A separate transformer will be associated with each wind turbine to step up the generation voltage of the turbines from 380 – 1000 V to a higher voltage for connection to the electrical substation via underground cables.

In modern wind turbines in the range of sizes under consideration, the transformer is most commonly located within the nacelle or turbine tower. However, depending on the turbine manufacturer, for safety reasons, it may be located outside of the tower close to the base. Where not accommodated within the wind turbine, it is not feasible or good practice from a safety perspective to locate the transformer underground. Rather, it will reside within a compact glass-reinforced plastic or steel enclosure measuring approximately 2.5 m x 2.5 m in plan and approximately 2.2 m high. The enclosure will also contain a ring main unit (RMU) switchgear complete with feeder circuit-breaker and close over-current / earth-fault protection.

The hermetically sealed wind turbine transformers, likely contained within the wind turbine tower or otherwise located close by, can be considered as leak free and maintenance free. They are dispatched from the factory leak free and can only be damaged during transport or installation. Once in service, they remain closed for their lifetime.

2.5.4 Site entrance

Access to the site will be off the N59 Ballina to Belmullet road. There will be two site entrances as follows:

- Entrance 1: Existing Bellacorick wind farm entrance
- Entrance 2: Existing access to the western part of the site

The locations of the proposed access points to the site are shown on Figure 2-4.

An existing entrance, off the N59, to the Bord na Móna workshops will not be utilised for the Phase 1 and Phase 2 wind farm construction, operation and maintenance.

2.5.5 Access Tracks

Access is required to facilitate construction of the turbine bases and erection of the turbines. Access tracks, which will be un-surfaced, will be constructed directly on the underlying firm material.

There is an extensive network of existing tracks within the site comprising an existing access track to the existing Bellacorick wind farm, access track to former farm buildings within the site and access track ways formerly used as railway beds in the peat operations which took place on site. All railway tracks were removed from the railway beds as part of the rehabilitation process. Where possible the existing access tracks have been incorporated into the development to the extent possible. Peat probing along the proposed access routes to turbine locations was undertaken to identify the optimum route along corridors of minimal peat depth and also avoiding very wet areas of the site. The tracks provide access to points relatively close to all turbine locations, each of which can be accessed without major constraints of poor ground, steep inclines or significant watercourses. The existing tracks, of which use will be made, will be strengthened and widened and new sections will also be constructed.

Approximately 49km of access tracks will be required in total for Phase 1 and Phase 2 only. Tracks will be approximately 5.5m wide with passing bays provided at appropriate locations and horizontal bend radii designed and constructed to accommodate the Contractor's transport equipment. Access track depth will vary depending on the depth of peat to bearing stratum and bearing capacity of the underlying soils. Peat depths along proposed access track routes were probed to identify optimum routes across shallow peat depth areas. Resulting from this approximately 45km of access track will be constructed on shallow peat areas with a dimension 5.5m x 0.8m built on the bearing stratum. Excavated peat material will be side cast adjacent to the access tracks and dressed to blend in with surrounding landscaping and partially obscure sight of the road where feasible. The remaining 4km of road will be constructed over deeper areas of peat. These will be constructed either as floating access tracks or by excavating and backfilling. Construction of the access tracks in these areas will require excavation to an average depth to bearing stratum of 2.0m. Excavated peat will either be sidecast where feasible or removed and deposited in the peat repository area located in the centre of the site.

The access tracks will require a cambered top surface to assist the drainage of rainwater to either side of it. A site drainage plan has been developed to manage surface run off from the access tracks and cranepads, turbine locations and other structures associated with the development.

- Existing access tracks to be incorporated: 6 km
- Additional access tracks to be provided: 38.5 km

The layout of the additional access tracks has been developed to follow the natural contours of the site, to avoid areas of deep peat and very wet areas and to minimise their overall length and achieve acceptable gradients. The latter are expected to be a maximum of 8 ° (14%) longitudinally and 2 ° (3%) laterally.

All power and control cabling within the site will be either direct buried or contained in PVC ducts and will be laid underground. Cable trenches, which will typically be 0.5 – 1.0 m wide and 0.75 – 1.00 m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks.

2.5.6 Crane stands

A triangular shaped cranepad comprising a hardstanding area will be provided adjacent to each wind turbine to facilitate construction. They will be retained for the lifetime of the wind farm to facilitate any large scale maintenance involving the use of a large crane that could arise during the operational phase of the wind farm. The dimensions of the cranepad will be approximately 96 m x 76 m x 130m. The crane stand will be constructed adjacent to the access trackway beside each turbine and will comprise an area of approximately 3,600m^2. It will accommodate the main crane (1,200 ton capacity) and the assist crane which will be used to erect and dismantle the main lifting crane. It will also accommodate the tower and nacelle components prior to construction. Adjacent to the crane pad an area of 16m x 33m will be provided on either bogmats or hardstanding to support fames in the blade laydown area. The main crane will lift turbine blades from this area to the turbine nacelle.

The various turbine suppliers have differing requirements as to the arrangement and orientation of the cranepad relative to the position of the turbine.

The likely arrangement is shown on the submitted project drawings, (see Planning Drawing QR320201-P-000-042) but the actual orientation will be a matter to be agreed with the selected turbine supplier.

2.5.7 Electrical Substation

Two 110 kV Electrical Substations at the site will occupy an L shaped hard-standing area of approximately 8853m^2 and will consist of a compound containing outdoor switchgear comprising a 110 kV busbar, one 110 kV line bay, two 110/33kV transformers and associated bays, house transformer and 2 Control Buildings. The substation footprint will be such as to allow for the inclusion of two additional transformer bays. These additional areas are required by EirGrid, the National Transmission Operator, to future-proof the requirements of Grid 25. The layouts of the Electrical substations are shown in the planning drawings (see Planning Drawings QR320101-P-000-043 to QR320201-P-000-050). Substation locations are provided in Table 2.3.

Table 2.3: Electrical Substation Locations (Centre point)

Sub Stations	Easting_ITM	Northing_ITM
Sub Station 1	499043	822521
Sub Station 2	496158	823089

Equipment within each control building will include a Supervisory Control and Data Acquisition (SCADA) system, which will allow for off-site monitoring via a telephone or fibre optic connection.

Each control building will be designed to the standard required for the accommodation of sub-station equipment. Each will comprise a control room, relay room, switchgear rooms, battery rooms and store room. It will be single storey, approximately 25 m x 9 m in plan. The control buildings will have rough-cast walls and a pitched roof with tiles or slates. Each control building's appearance will be in keeping with its location.

The control buildings will be unmanned, but will include sanitary facilities comprising a single toilet and wash hand basin.

Surface water arising from roof drainage will be allowed to percolate naturally within each Electrical substation compound.

Each substation within the electrical substation will further step-up the voltage for transmission to the national electricity network. Electrical equipment will consist of a transformer, circuit breaker, over-current and other protection devices, metering equipment and other small items of switchgear.

Each Grid Transformer will be located within an impermeable bund capable of oil retention in the event of a total leakage from the transformer. The bund will have a capacity of at least 110% of the volume of oil to preclude any release of contaminants to the environment. Drainage arising from the transformer bund will be discharged following passage through an appropriate oil interceptor.

Permanent 2.6 m high palisade fencing, the colour of which will be agreed with the planning authority prior to construction, will be provided around each electrical substation for public safety purposes. This need arises from the presence within each compound of high-voltage electrical equipment to which public access must be prevented. Access to the site and to the turbines within it is safe for people and animals under normal conditions.

2.5.8 Meteorological masts

Meteorological masts with a height corresponding to that of the turbine hubs are normally included in wind farm developments in order to monitor wind speeds and validate operation of the wind turbines.

Permission was granted to Bord na Móna Energy Ltd. for the erection of 3 no. 50 metre high wind measuring masts at Corvoderry, Laghtanvack, Srahnakilly, Bellacorick, Co. Mayo (Planning Authority Ref. P12/554). These were used to capture the initial data required for wind analysis purposes. An application to retain these structures, and an 80m high mast installed in 2011, was made in October 2012 to continue data capture. Permission for retention was granted in February 2013.

These meteorological masts will be replaced by six permanent meteorological masts on the site. The locations of these are shown in Table 2.4. Note that the numbering follows that of the original proposal, which had eight meteorological masts, and is therefore not sequential.

Table 2.4: Meteorological Mast

Mast	Townland	ITM	
		Easting	Northing
Location 1	Tawnaghmore	494456	823188
Location 2	Srahnakilly	496034	822999
Location 3	Croaghaun West	498664	822405
Location 5	Laghtanvack	499676	824409
Location 6	Knockmoyle	500037	825658
Location 7	Laghtanvack	501485	823574

The overall separation between the outermost turbines at Oweninny is such that variation in wind speeds across the site would be expected. Thus, given the scale of the site eight meteorological masts are proposed with each comprising a lattice steel tower with anemometers and wind vanes attached. The overall height will approximately correspond with the tower height of the turbines, i.e. a maximum of 120m. Occasionally other equipment such as noise monitoring equipment may be located near to ground level on the meteorological masts.

Further to the above, power curve testing will be carried out at a number of turbine locations within the site. Power curve testing comprises site calibration and reference, and entails temporary installation of anemometer masts for selected turbine sites at two locations, a calibration mast corresponding to the location of a turbine and the reference mast elsewhere within the site. The data generated is used subsequently to validate the contracted performance of the wind turbines.

Evidently, the masts at the location of the selected turbines will be removed to allow construction of that turbine in the wind farm development and the other mast will also be removed prior to completion of the development.

2.5.9 Overhead Transmission Lines and Underground Cables

Phase 1 and Phase 2 of the project will connect to the existing 110 kV Bellacorick substation and will export power via the existing Bellacorick to Castlebar 110 kV overhead line infrastructure, which will be strengthened by EirGrid.

Within the wind farm, clusters of wind turbines will be connected via underground cables to the two 110 kV substations.

To minimise the potential visual and landscape impact the overhead line from substation locations 1 and 2 will be undergrounded as it approaches the Bellacorick substation site for a distance of up to 2km. A cable interface tower will be utilised as a transition structure to accommodate the transition from overhead line to underground cable. A cable interface tower has the same dimensions as the normal angle tower though additional hardware is added to accommodate the cable / line transition. The overhead lines and underground cable routes are shown on Figure 2-1.

Cables routes from the Phase 2 part of the site will be ducted across the Bord na Móna internal bridge across the Oweninny river which will be fitted with a new deck, see the originally submitted Planning Drawing Number QR320201-P-000-065.

This approach is consistent with the Department of Environment Wind Energy Development Guidelines 2006 which states the following in Section 6.11.3:

“Power line connections between turbines and from turbines to the control building should be underground.

Power lines should be interred alongside turbine access roads in order to minimise spatial extent of soil/hydrological and vegetation damage/ disturbance.

The cost of underground connection from the compound to the national grid is generally prohibitive. This connection can thus be above ground in all but the most sensitive landscapes.

In certain landscapes, such as highly sensitive Mountain Moorland, consideration should be given to burying the cables until such a distance as the poles and cables would be visually acceptable, for example, where other power lines exist.

In order to reduce visual impact, connections should preferably be carried on wooden poles rather than lattice towers, except where necessary for changes in direction and within the compound.

Power line connections to the grid should, where possible, avoid running perpendicular to contours, especially on Mountain Moorland slopes. Where practicable, it should not cross the horizon at ridge level unless a line already exists. Where passing through a forest, power line connections should follow existing firebreaks or roads. In landscape types where human presence and rectilinear landscape patterns are typical, power line layout can be more flexible."

Each 110 kV overhead line will consist of three overhead conductors carried on double wood pole portal structures, whose poles are 5m apart (centre to centre) and average height of 18 metres. The pole structures will have a maximum height of up to 22 m. The average distance between structures will be approximately 180m. An earthwire, consisting of two continuous wires, will be clamped to each set of wood poles and steel lattice towers. Where the line changes direction, a steel lattice angle tower up to 24.5 m in height and an average base area of 5m x 5m will be utilised. Typical overhead line structures are shown in Figure 2-5 and on the originally submitted Planning Drawings QR320201-P-000-079 to QR320201-P-000-082.

2.5.10 Visitor Centre

The proposed development offers an ideal opportunity to relate the socio-economic and ecological history of the site and general area thorough a purpose built visitor centre. Both Bord na Móna and ESB have had long association with the area dating from the 1950's. Bord na Móna has been involved in peat production operations at Oweninny to fuel the ESB peat burning station at Bellacorick (see Plate 2-1). This provided not only electricity but much needed employment in a traditionally economically deprived area.

Plate 2-1: Bellacorick power station

With the closure of the power station in 2005 peat operations also ceased. Emerging wind energy technology was seen as a logical natural replacement for peat based energy production which could continue to give gainful employment in the area.

The site itself plays an historical role in Ireland's drive towards sustainable renewable energy with the country's first commercial wind farm established at the site in 1992. It comprises 21 wind turbines with a total installed capacity of 6.45 MW (Mega Watts), and produces enough electricity to supply approximately 3,000 households. This wind farm, if still operational, will be replaced in the final stages of the planned development.

The site also relates an interesting ecological story. In accordance with its Integrated Pollution Prevention Control licence for the site Bord na Móna has developed a bog rehabilitation programme to enhance recovery of parts of the site. The harvesting operations and rehabilitation programme have created a mosaic of differing habitats and species. The ecological history and current status of the bog can therefore be depicted through the bog remnants, bog rehabilitation areas and protected areas and the variety of habitats and species that they support.

The visitor centre will offer the unique history of the bog throughout its development showing the transition from peat harvesting to wind energy development. In parallel, the story of the changing ecology of the bog, the ongoing bog rehabilitation programme and the diversity of species and habitats that has resulted will be told. It will provide a place not only to learn about renewable energy but to observe it first-hand whilst also providing an opportunity to observe the ecology of the area.

The Visitor Centre location is shown on Figure 2-1. Plan and elevation drawings are shown in Figure 2-7 and Figure 2-8.

2.5.11 Temporary Site Compound

Temporary site compounds will be established throughout the site for the duration of the construction phases. These will comprise temporary construction buildings, materials and equipment storage. The site compound will be segregated into four separate sub compounds to facilitate the likely different contractors expected on site. A typical layout of a proposed site compound is provided in Figure 2-9.

In addition, an area adjacent to substation 2, an area at the western entrance (Site Entrance 2) and an area behind the existing Bord na Móna workshops have been identified as potentially suitable site compounds. However, It will be a decision of the construction contractor as to where the temporary site compounds will finally be located.

2.5.12 Batching Plant

A temporary batching plant for concrete production will be established adjacent to Electrical substation 2 (Figure 2.1). This will comprise the following components:

- 4 x Aggregate stockpile areas each of approximately 5,000 tons capacity
- 4 x Aggregate bays
- 1 x Ramp and feed hopper
- 2 x Cement Silos
- 1 x Mixer House
- 1 x Bunded Additives Store
- 1 x Control Cabin
- 1 x Three Bay Water Recycler
- Water storage area
- Power House & Switch Room
- Mobile Plant Refuelling Area
- Bunded and covered Gas Oil Tank
- Site office
- Laboratory
- Canteen
- Welfare facilities
- Parking

The batching plant compound will be fenced with chain-link fence.

A typical batching plant layout is shown in Figure 2-10. Drainage control including sediment control and settlement and pH neutralization will be provided at this location. The batching plant will incorporate a three bay water recycling system to minimise water usage and loss of suspended solids. The three bay water recycler will be cleaned regularly and any build-up of settled solids will be removed to a hard standing area which drains to the recycler and the collected solids will be recycled into the concrete batching system. Water for the batching plant operation will be sourced from local ponds or tankered to the location for storage and use as required. The batching plant will be capable of producing 50m^3 of concrete per hour with a requirement of 10 m^3 of water and 20 tons of aggregate and 5 tons of cement.

2.5.13 Wastewater treatment facilities

Sanitary facilities, such as toilets and wash hand basins will be provided at all substation locations and the operation and maintenance building. The visitor centre will have a full café facility, toilets and other sanitary facilities. These facilities will generate foul wastewater which will be treated before discharge to groundwater. To determine the appropriate level of treatment of this wastewater discharge site suitability assessments have been carried out by a qualified assessor, BK Engineering Design, at the substation and visitor centre locations. The O&M building will share a common treatment system with substation number 1. The assessments were carried out in accordance with the EPA Wastewater Manual - Treatment systems for Small Communities, Business, Leisure Centres and Hotels" and the EPA "Code of Practice: Wastewater Treatment and Disposal systems". The site assessments indicated that the ground conditions satisfy all requirements specified in the EPA code of Practice and are suitable for discharge following treatment. The site assessor's wastewater treatment system recommended for each location consists of a septic tank followed by a Puraflo system and polishing filter with subsequent discharge to subsoil.

2.5.14 Borrow pit

To reduce the requirement for import of access track construction material to the site use will be made of one borrow pit that has been assessed to contain suitable material. The location of the borrow pit is shown in Figure 2.1. Its footprint is approximately 17 hectares and it will be excavated to a depth of about 2m giving an estimated 340,000m^3 of material for access track construction. The coordinates of the borrow pit are provided in Table 2.5 Excavated material will be stockpiled in an area adjacent to turbine 37, see Figure 2-1.

Peat depths at the borrow pit location are very shallow, being only 100mm in places. This material will be scraped from the surface, stored locally and backfilled into the borrow pit following material extraction

Table 2.5: Borrow Pit Location

Easting (ITM)	Northing (ITM)
501601	824521
501813	824061
501708	823916
501478	824036
501276	824384
501323	824402
501400	824407

Easting (ITM)	Northing (ITM)
501540	824516

The top metre of material will be dry extracted and below this the material from the borrow pit will be wet extracted to prevent a reduction in the water table level. That is, there will be no dewatering of the borrow bit.

2.5.15 Bord Gáis Network

There is a high pressure Gas Transmission Pipeline running along the south side of the site close to the N59 and along the western boundary also. Approximately 2.5km before Bellacorick it enters the wind farm site and continues in the north - west direction. The line route of the gas transmission pipeline is shown in Figure 2.1.

2.5.16 Water supply

Potable water for the site will be provided either through a connection to the water supply scheme operated by Mayo County Council, to which both Bord na Móna and ESB have connections, or alternatively through bored wells with subsequent treatment and storage.

A bored well, if suitably identified, and/or rainwater harvesting will also be used to supplement the water demand at the substations and proposed visitor centre.

2.5.17 Electricity supply

House supply for the visitor centre, substations, batching plant and O&M building will be provided through the existing supply to the Bellacorick wind farm or from power generated on site.

2.5.18 River and stream crossings

The development of the access track network will require the upgrading of existing river crossings and the construction of new crossing locations over streams.

The existing Bord na Móna machine bridge across the Oweninny river will be upgraded to carry electricity cables. There will be no in-river modification works.

The culverts at the site entrance on the Muing river will be removed and replaced by a box culvert or clear span bridge. Further crossings using box culverts will take place upstream on the Muing river and on its tributary the Muingamolt.

A small existing culverted crossing of the Sruffaunnamuingabatia stream will be replaced by a box culvert or clear span bridge.

Stream crossing works will be discussed with Inland Fisheries Ireland and will be carried out in accordance with the "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites" [1] or any updates as appropriate.

2.6 MATERIAL QUANTITIES

Estimates of the material quantities for stone fill, concrete and rebar for phase 1 and phase 2 of the project are provided in Table 2.6.

Table 2.6: Estimates of material quantities

Project Phase	Material	Quantity
Phase 1	Fill (m3)	196,153
	Concrete (m3)	33,222
	Rebar (t)	3,013
Phase 2	Fill (m3)	206,175
	Concrete (m3)	30,180
	Rebar(t)	2,695

2.7 PEAT STABILITY RISK ASSESSMENT

A Peat Stability Risk Assessment (PSRA) has been prepared for the site. See Appendix 4 of the main EIS submitted in 2014. The assessment is based on the Natural Scotland Scottish Executive "Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments" (2006) supplemented by the experiences of ESBI on previously developed sites. Peat stability risk is categorised as insignificant, significant, substantial or serious.

[1] Eastern Regional Fisheries Board, Fisheries Protection Guidelines, Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites, http://www.fisheriesireland.ie/Research/recent-publications.html

Construction can take place in areas where risk categories range from insignificant to substantial with varying mitigation requirements. The insignificant and significant categories represent areas where the risk of peat instabilities are either considered negligible in a standard construction environment or considered manageable by the adoption of specific additional mitigation measures respectively. In the context of this development, the substantial risk category represents areas where more rigorous site investigation is required prior to construction at detailed design stage, more onerous mitigation measures are actioned and a higher level of site supervision is locally imposed in order to reduce the risk to lower levels.

Approximately 90% of the construction area is classified as having insignificant or significant risk. The risk at these areas will be mitigated with good design and construction practices and part geotechnical supervision. The remaining 10% of the construction area is categorised as having substantial risk of peat instability, however, in these cases the level of risk is on the lower end of the substantial (i.e. close to the significant risk category) and is suitable for construction with suitable site investigation, good design and construction practices and geotechnical supervision during works in critical areas. No areas are categorised as serious.

Further clarification of the Peat Stability Risk Assessment was provided at the Oweninny wind farm oral hearing (by Dr. Paul Jennings). This indicated the following:

- The main contributory factors in peat instability are peat thickness, slope and peat strength. Peat instability here refers to a peat slide. For instability to occur an adverse combination of these factors is required, a single factor alone is not sufficient to cause instability. A review of these factors at the site shows the following:
  - Most of the peat has been removed as part of commercial peat harvesting. The peat thickness in extensive parts of the site is less than 0.5m. The reduced peat thickness at the site would greatly reduce the risk of peat failure.
  - The site is relatively flat with the ground slope at the proposed wind farm infrastructure locations predominantly less than 3° and in many cases less than 2°. For peat instability the lower threshold for slope instability is in the range typically of 4 to 8°.
  - The EIS notes that the range of undrained peat strength recorded from site investigation ranges from 6 to 30kPa. This would be considered a relatively high strength for peat and reflects the harvesting activity, particularly the drainage of the peatland. Based on a review of peat slides the in situ peat undrained strength is low, and has been measured at about 2.5kPa.
- Based on the above, the site as a whole has none of the characteristics that would contribute to peat instability.

The Peat Stability Risk Assessment (PSRA) methodology used in the EIS was developed by ESBI over a number of years based on their experience of working in peat. The methodology is by nature [very] conservative and a cautious approach to identifying areas of potential elevated peat instability. The peat stability assessment allows the site to be broken into different risk zones and for each risk zone a set of mitigation measures are applied.

The purpose of the cautious peat stability assessment used in the EIS is to discriminate between zones of varying risk to allow more stringent mitigation measures to be focused in areas indicated as having potentially elevated peat instability. The results of the peat stability assessment in the EIS cannot be interpreted, per se, as a measure of the actual peat stability at the site, having regard to the very conservative nature of the approach taken. The actual peat stability at the site in terms of Factor of Safety calculations show that overall the site has a notably high Factor of Safety against peat sliding, and notably greater than the acceptable minimum requirements for civil engineering works.

2.8 INDICATIVE PROJECT PHASING

2.8.1 Phasing

The project will be developed in 2 phases which are determined construction scheduling. The following indicative phase developments will take place, (see Figure 2-11).

Phase 1 will comprise the construction of 70 - 90 MW of wind energy comprising construction of wind turbines in the central section of the site, associated access tracks, one Electrical substation, substation, overhead lines and cables. The Visitor Centre and Operation and Maintenance Building will also be constructed during this phase. This phase will connect to the existing 110 kV substation at Bellacorick and the construction is expected to commence in 2016 with completion of Phase 1 by 2018.

Phase 2 will comprise the construction of 70 - 90 MW of wind energy comprising construction of wind turbines in the western part of the site, associated access tracks Electrical substations, substation, overhead lines and cables. This phase will also connect to the existing 110 kV substation at Bellacorick and the construction is expected to commence in 2017 with completion of Phase 2 by 2020.

The indicative project phasing is shown in Table 2.7.

Table 2.7: Indicative Project Phasing

Phase	Rated Output (MW)	Approximate construction period
Phase 1	70 – 90	2016 - 2018
Phase 2	70 - 90	2017 - 2020

Actual project phasing will be determined by the nature of any permission granted for the site, the output size of the turbine selected following a full procurement process and the availability of grid capacity.

2.9 OPERATION, MAINTENANCE AND DECOMMISSIONING

2.9.1 Operation and Maintenance

2.9.1.1 Project Lifetime

It is envisaged that the project will remain in operation for about 30 years following its commissioning, although depending on circumstances it may be viable to continue the project for further periods thereafter. The Bellacorick wind farm is in operation at the site for 21 years now and continues to perform well with high availability and turbines maintained in good condition. It is expected to have a useful operating life in excess of 25 years in the same environmental conditions and wind regime as those that can be expected for the Oweninny wind farm.

Condition No. 3 in the current planning permission (PL16.131260) for Oweninny Wind Farm limits the life of that development to a period of 20 years from the date of commissioning of the wind farm.

It is believed that an operational life of 20 years for a wind farm is overly restrictive in comparison with recent grants of planning permission by various planning authorities and by An Bord Pleanála, which have specified an operational life of 25 years. A lesser operational life of 20 years as opposed to 30 years for other wind farms imposes a commercial disadvantage on this development in comparison with other similar schemes with which this development may potentially be in competition for supply of renewable electricity.

The DoEHLG Planning Guidelines (Section 7.20) have subsequently noted as follows:

"The inclusion of a condition which limits the life span of a wind energy development should be avoided, except in exceptional circumstances."

2.9.2 Wind Farm Operation

It is expected that the wind farm will have an availability of about 98%, i.e. it will be capable of operation for 98% of the time. Actual operation will be determined by the wind conditions experienced. However, on average, turbines turn and therefore produce electricity for about 80 - 85% of the time. The output of the wind turbines will depend upon the wind regime but a capacity factor of around 33 - 35% is expected. This means that over the course of a year each turbine would produce up to 35% of the amount it could theoretically produce if it was working at maximum output at all times throughout the year.

Wind farms are designed to operate largely unattended however given the scale of the development a technical staff of up to 10 people initially will be present for monitoring and routine maintenance operation. This number will increase as subsequent phases of the wind farm are developed. Each turbine will have its own in-built supervision and control system that will be capable of starting the turbine, monitoring its operation and shutting down the turbine in the case of fault conditions.

Supervisory operational and monitoring activities will be carried out remotely using a SCADA system, with the aid of computers connected via a fibre optic or telephone modem link.

Servicing of the wind turbines will be carried out in accordance with the manufacturer's specifications, which would be expected to entail the following:

- Six-month service - three week visit by four technicians
- Annual service - six week visit by four technicians
- Weekly visit by Developer or agents to check over the site, notices etc.

Occasional technical problems may require maintenance visits by the technical staff.

During the six-month and annual service visits, some waste lubricating and cooling oils will arise. These will be recorded, drained into designated storage containers, brought off site and delivered to a suitable independent commercial facility for treatment / re-use / disposal in accordance with applicable legislation.

2.9.3 Decommissioning

2.9.3.1 Options & Removal of Development

The available options at the projected end of the wind farm's operational life are as follows:

- Refit the turbines' key components and continue electricity production.
- Repower with the most up-to-date technology and continue electricity production.
- Decommission the development and reinstate the site.

It is not envisaged at this stage that special environmental considerations will apply during the ultimate decommissioning of the wind farm. The same principles of mitigation works as apply to the construction works will apply to decommissioning.

Decommissioning will comprise the following:

- All turbines will be dismantled by crane, and this will entail removing the turbine blades and the nacelle containing the gearbox and generator, followed by removal of the tower sections.
- Control equipment and switchgear will be removed from the Electrical substation and the Control Building will be demolished.
- The upper sections of the turbine foundations will be removed to below ground level. The remaining lower parts will be covered and the ground will be left to re-vegetate naturally.
- Underground cables will be cut back and left buried in order to avoid disturbance of the already vegetated areas.
- Tracks that are not required on an ongoing basis by the landowners will be covered over and the ground will be left to re-vegetate naturally.
- Foundations will be covered over and marked
- All demolition waste will be removed from the site.
- The Visitor Centre will either be decommissioned or remain in situ. Once the wind farm is decommissioned one of the key elements of the centre

will be lost however, it could continue to provide a focal point for the local community or be redeveloped for an alternate purpose.

2.9.3.2 Costs of Decommissioning

The decommissioned electrical equipment, which will comprise control and switchgear equipment, and turbine transformers and substation transformers, will have a residual value of at least the cost of its removal. This together with the scrap value of wind turbine components, mainly comprising recyclable steel, will provide a fund that will more than meet the financial costs of decommissioning and site reinstatement.

The DoEHLG Wind Farm Planning Guidelines (Section 7.19) recognise that the use of long-term bonds puts an unreasonable burden on developers given the long time span involved in wind energy developments and is difficult to enforce.

It notes as follows:

"The recycling value of the turbine components, particularly copper and steel, should more than adequately cover the financial costs of the decommissioning. Accordingly, the use of a long-term bond is not recommended."

2.10 MITIGATION OF POTENTIAL IMPACTS

The EPA's Advice Notes on Current Practice (in the preparation of EISs) accompanies the Guidelines on the information to be contained in EISs, also published by the EPA.

The Advice Notes are divided into five sections, each providing detailed guidance on specific aspects to be considered in the preparation of an EIS. Section 3 provides guidance on the topics which would usually be addressed when preparing an EIS for a particular class of development, highlighting typical issues which arise. The projects are grouped into 33 generic types, which have similar development or operational characteristics.

Project Type 33 addresses installations for the harnessing of wind power for energy production and the Possible Mitigation Options that are identified are as follows:

- "Site selection to avoid intrinsic sensitivity is the principal mitigation option for this project type.
- Site layout to achieve appropriate orientation and alignment is an appropriate secondary measure.
- Utilisation of non-disruptive construction methods for access roads, buried cables and other site works can significantly ameliorate impacts on water, soil, ecology and archaeology."

A full discussion on alternative design layouts is provided in Chapter 4 and demonstrates that the Oweninny Wind Farm designed is consistent with the strategy outlined.

The design has also been influenced by extensive consultation with stakeholders resulting in the following actions incorporated into the design to minimise potential impacts:

- Piling of turbine foundations in sensitive locations rather than excavation, such as in the vicinity of the Bellacorick Iron Flush and Lough Dahybaun to minimise potential impact on groundwater level as discussed with National Parks and Wildlife Service.
- Avoidance of the Hen Harrier winter roost location as discussed with NPWS
- Relocation of turbine foundations away from bog remnants as advised by the Irish Peatland Conservation council.
- Provision of signal transmission corridors to ensure no interference with current transmission signals across the site.
- Maintaining specific setback distances from dwellings (at least 1,000m), site boundaries, rivers and streams and designated areas.
- Minimising import of construction material through development of an on-site borrow pit with consequential reduction in traffic and transport on the N59
- Minimising the potential for cumulative impact through early engagement with other wind farm developers (Corvoderry, Tawnanasool).

2.11 OTHER DEVELOPMENTS

There are proposed and permitted wind farm developments in the general region and those within 20 km of Oweninny, as shown in Figure 2-12 are as follows:

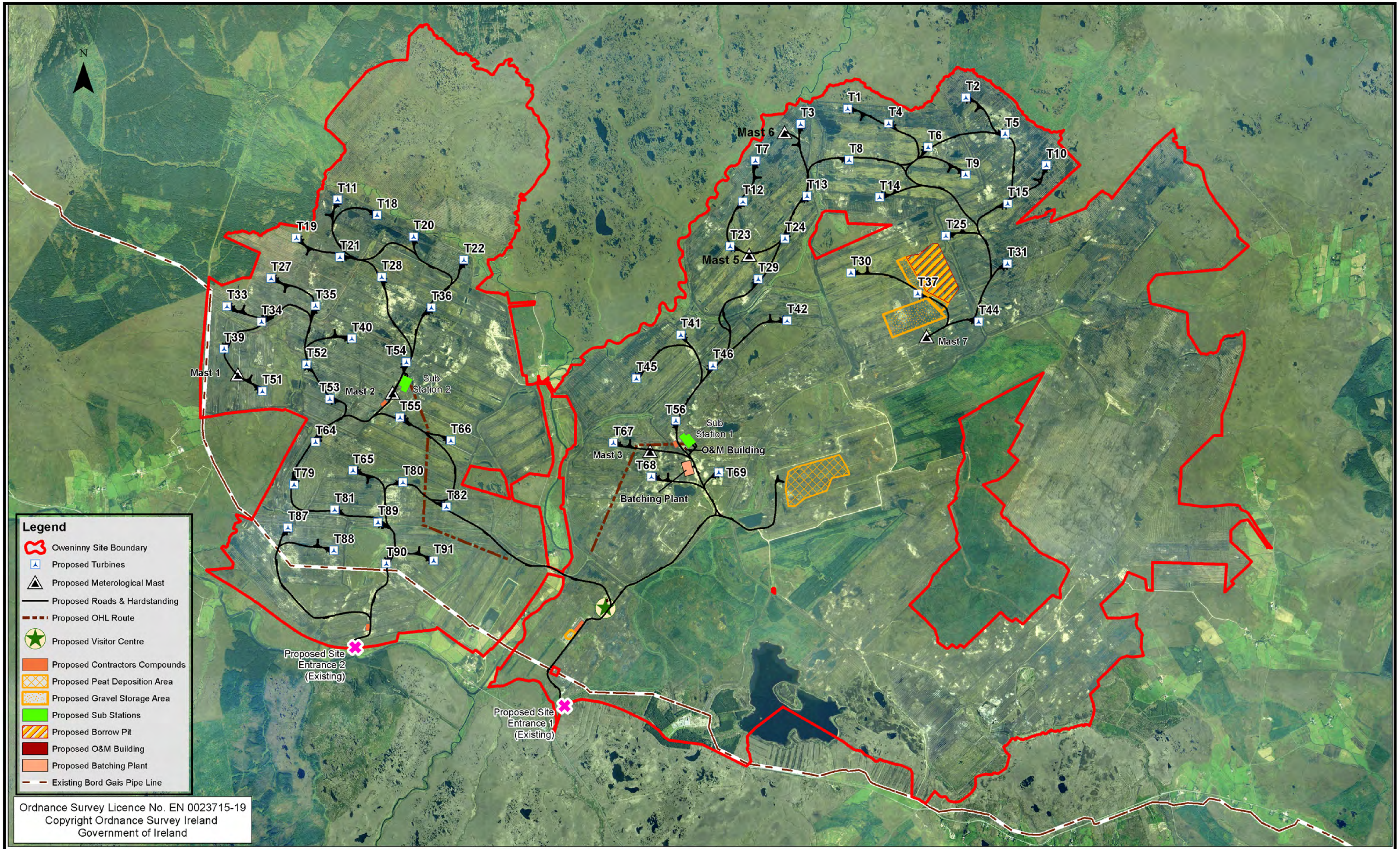
- Corvoderry Wind Development comprising ten wind turbines with 100m overall height (Planning reference 11838). This wind farm is located within the Oweninny site and the developer has a right of way along the existing Bellacorick wind farm access road.
- Planning permission 09/259 for a wind farm development at Dooleeg, Bellacorick (one 2 MW wind turbine) granted on appeal to ABP (PL16.236402).
- Planning permission 09/286 for a conventional 200 MW gas fired peaking plant was granted to Constant Energy along the Srahnakilla road.
- Tawnanasool Wind Development comprising eight wind turbines with 127m overall height (Mayo Planning reference 14666).
- Planning permission has been granted for a temporary three year meteorological mast development in the townland of Sheskin by ABO Wind Ireland Ltd (Planning Reference P15/460)

There are also a number of proposed or permitted other projects in the area as follows:

- EirGrid Grid West Project – not yet in planning but at preplanning consultation stage with Stakeholders.
- EirGrid Uprate of the existing Bellacorick to Castlebar 110kV Overhead Line. Planning permission granted by An Bord Pleanála in August 2015.
- EirGrid Uprate of the existing Bellacorick to Moy 110kV Overhead Line. Notification of grant of by Mayo County Council on 4th August 2015.
- ESB Networks Planning Application to Mayo County Council to refurbish/uprate the existing 38kV Overhead Line between Bellacorick and Bangor Erris.
- EirGrid planning application to Mayo County Council for modifications to the existing Bellacorick Substation.

2.12 GRID CONNECTION

EirGrid has confirmed that Phase 1 and Phase 2 of the proposed development will connect to the existing Bellacorick 110 kV substation and the internal overhead line routes and cables to connect these two phases have been designed and are included in the planning application for the wind farm



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Site Layout - Phasing 1 & 2
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil & Environmental Engineering

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	09/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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MAP REFERENCE

Figure 2.1

Figure 2-2: Typical turbine components (*ESB Curryfree wind farm*)

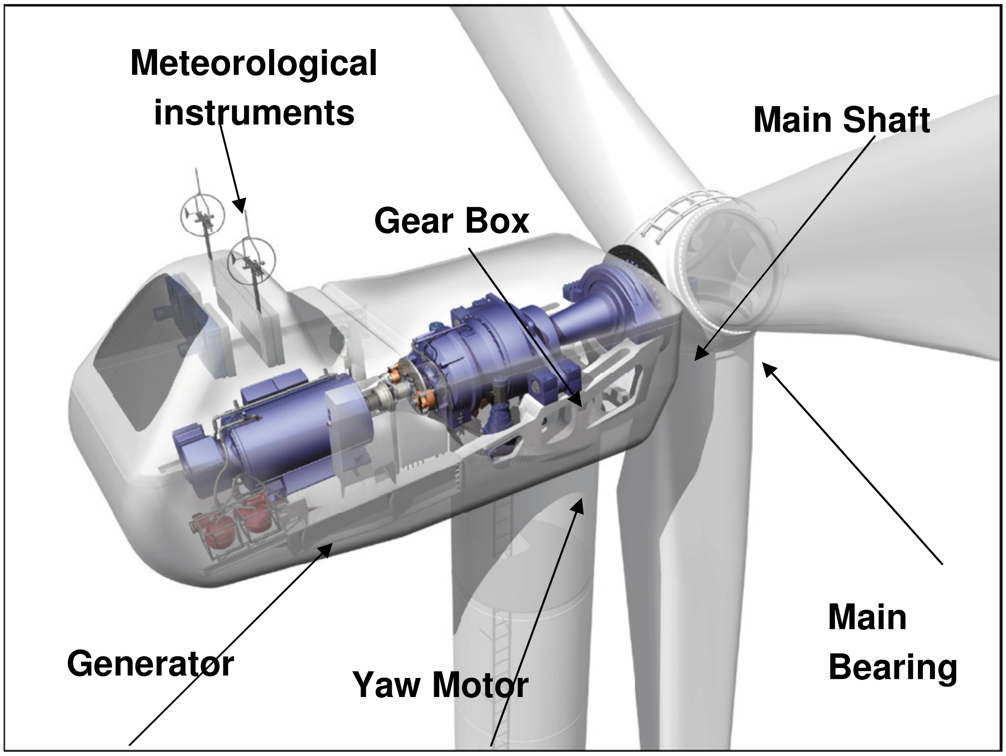
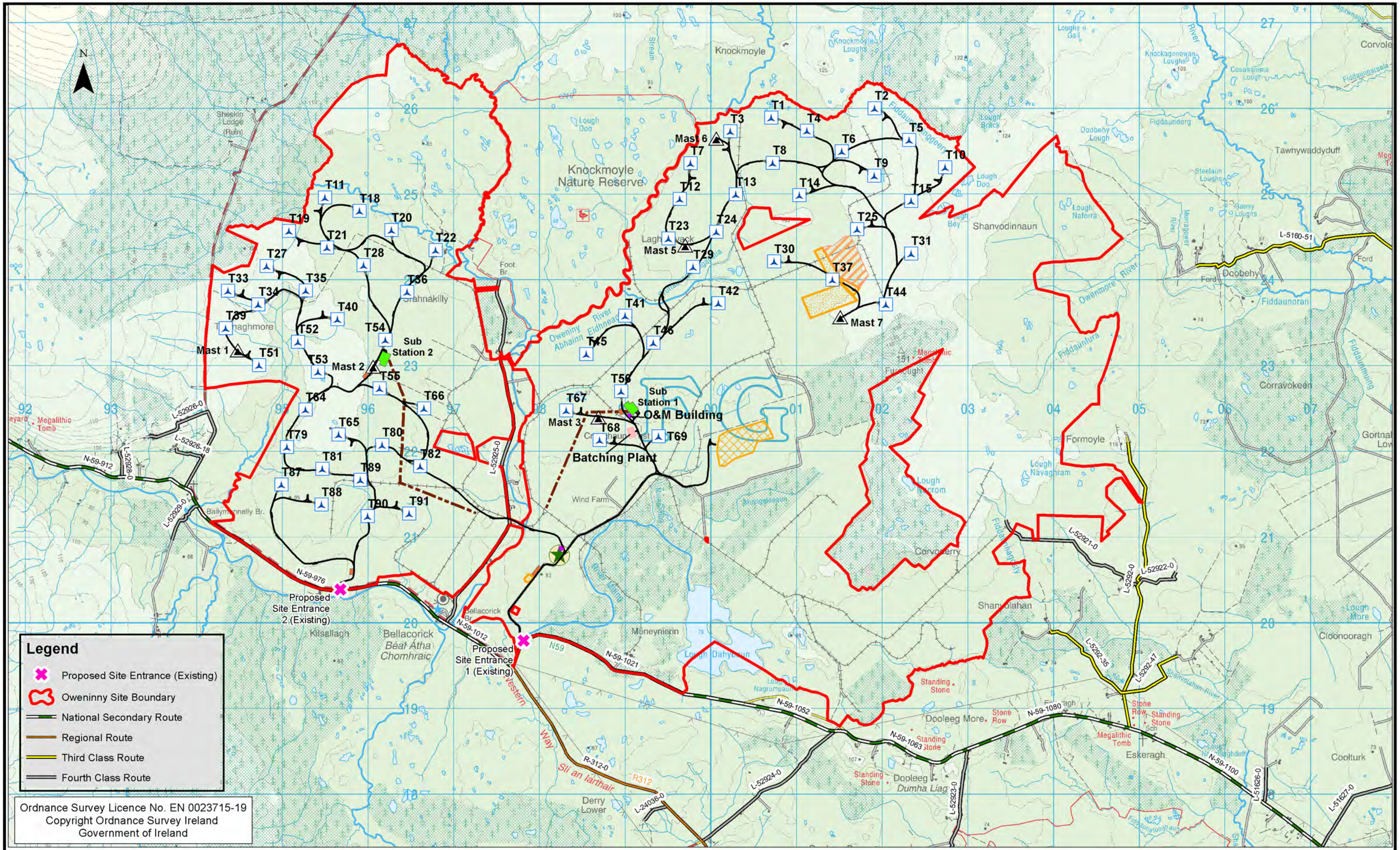


Figure 2-3: Typical Wind Turbine Nacelle (Courtesy of Nordex)



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Access locations to Oweninny site off the N59 - Phasing 1 & 2
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil & Environmental Engineering

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	09/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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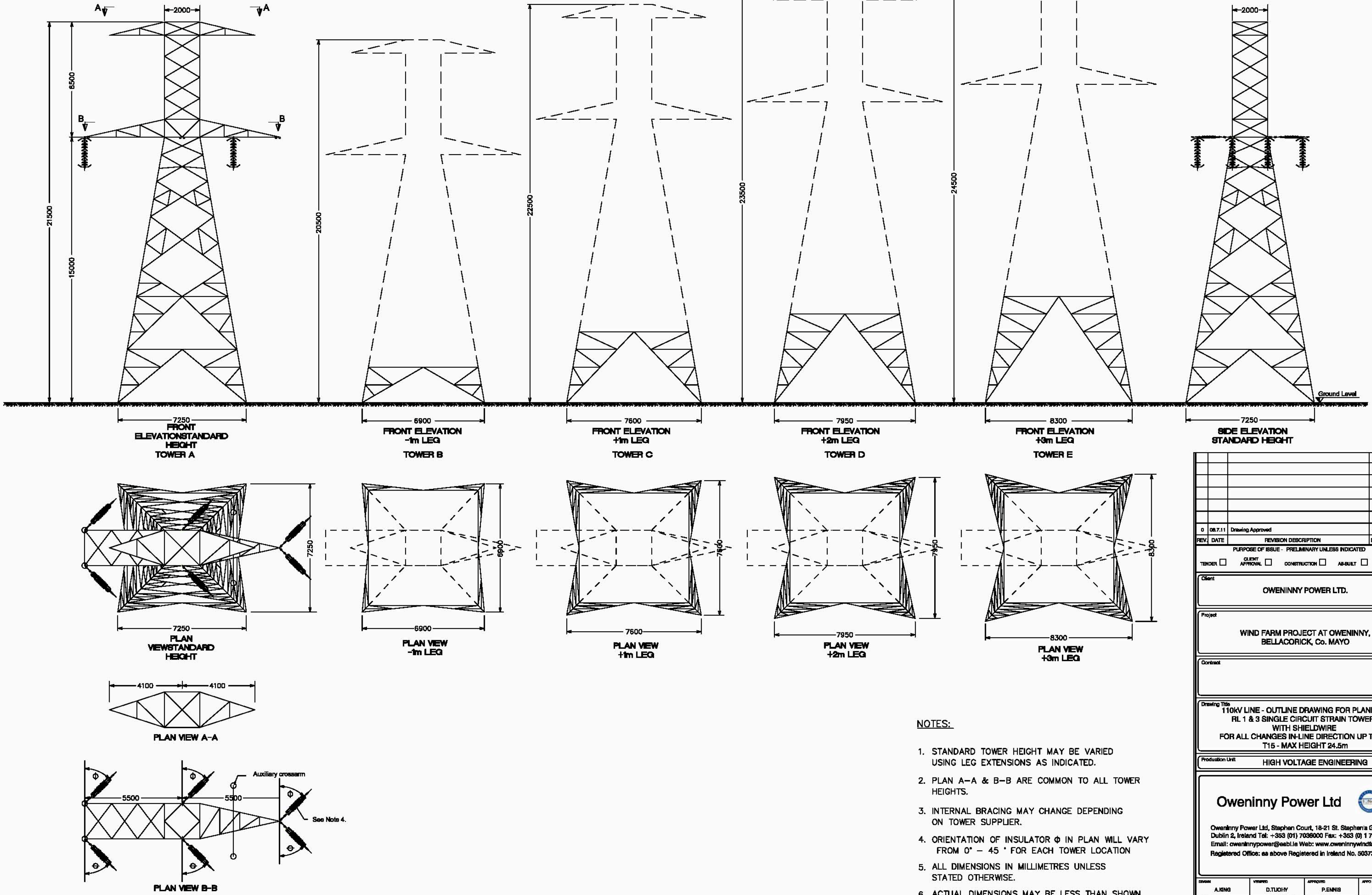
MAP REFERENCE

Figure 2.4



NOTES:

1. STANDARD TOWER HEIGHT MAY BE VARIED USING LEG EXTENSIONS AS INDICATED.
2. PLAN A-A & B-B ARE COMMON TO ALL TOWER HEIGHTS.
3. INTERNAL BRACING MAY CHANGE DEPENDING ON TOWER SUPPLIER.
4. ORIENTATION OF INSULATOR Φ IN PLAN WILL VARY FROM 0° – 45 ° FOR EACH TOWER LOCATION
5. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE.
6. ACTUAL DIMENSIONS MAY BE LESS THAN SHOWN ON DRAWING, DEPENDING ON TOWER SUPPLIER.

REV	DATE	REVISION DESCRIPTION	DRN	VER	APP
0	08.7.11	Drawing Approved	A.K	P.E	P.E

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, Co. MAYO

Contract:

Drawing Title: 110kV LINE - OUTLINE DRAWING FOR PLANNING RL 1 & 3 SINGLE CIRCUIT STRAIN TOWERS WITH SHIELDWIRE FOR ALL CHANGES IN-LINE DIRECTION UP TO 90° T15 - MAX HEIGHT 24.5m

Production Unit: HIGH VOLTAGE ENGINEERING

Oweninny Power Ltd

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Email: oweninnypower@esbi.ie Web: www.oweninnywindfarm.ie
Registered Office: as above Registered in Ireland No. 503730

DRAWN	VERIFIED	APPROVED	APPD DATE
A.KING	D.TUOHY	P.ENNIS	08.03.2012

CLIENT REF	No. of Shts	SIZE	REV	SCALE
	1	A1	0	N.T.S.

DRAWING NUMBER: Figure 2.5

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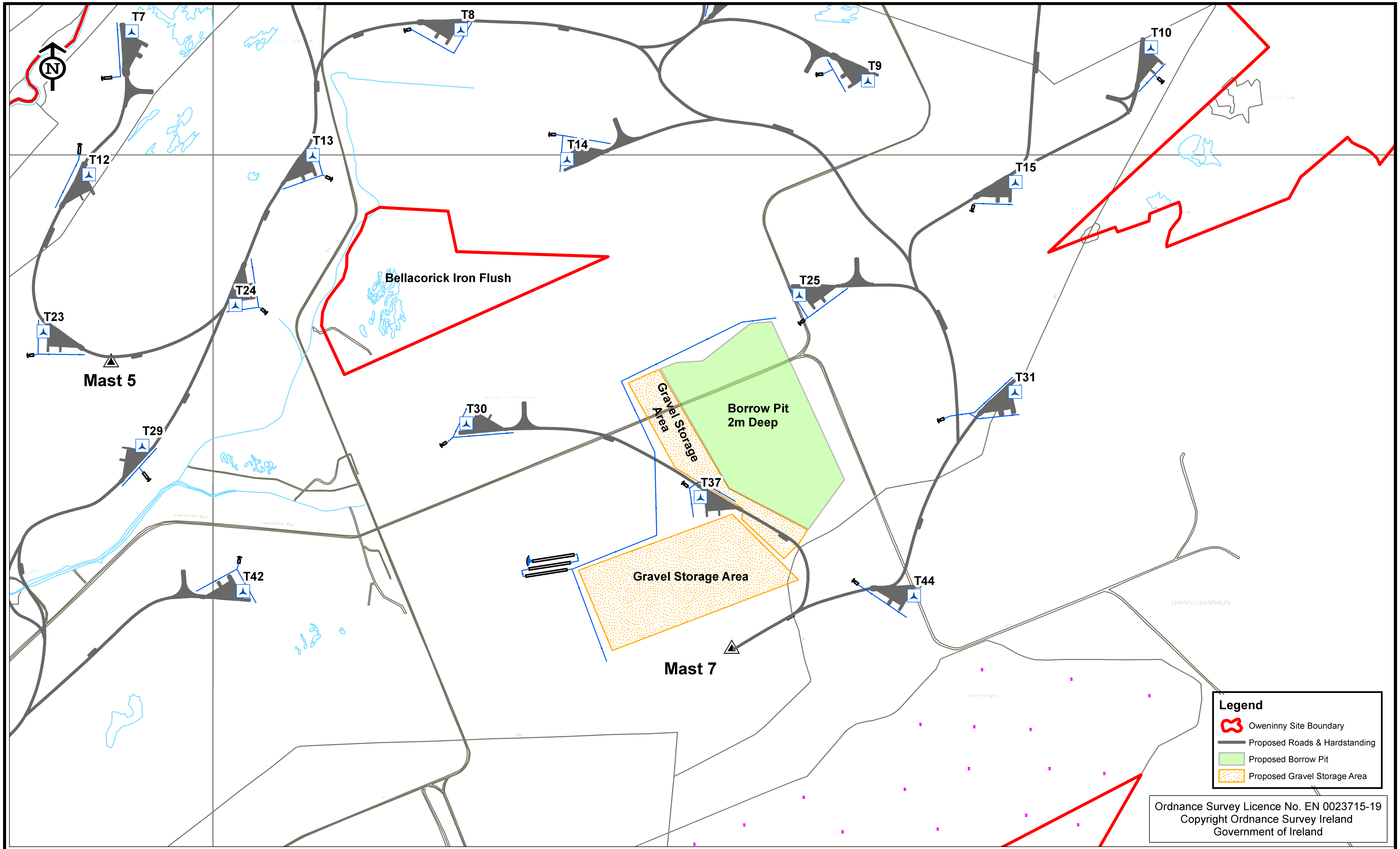

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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Borrow pit and gravel storage area - Phasing 1 & 2

Production Unit
Civil & Environmental Engineering

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	01/10/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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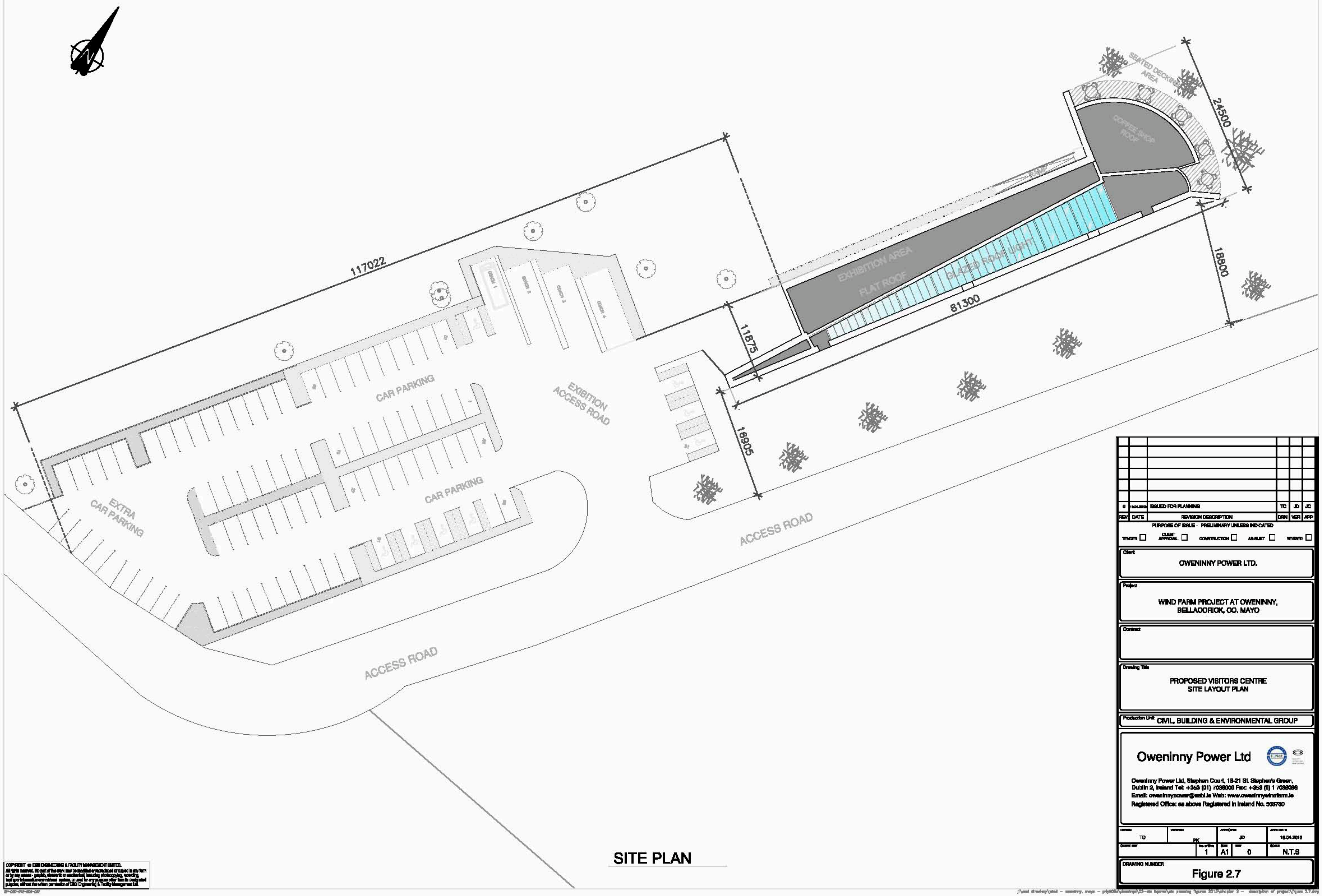
MAP REFERENCE

Figure 2.6



SITE PLAN

REV	DATE	REVISION DESCRIPTION	DRN	VER	APP
0	16.04.2015	ISSUED FOR PLANNING	TC	JD	JC

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, CO. MAYO

Contract:

Drawing Title: PROPOSED VISITORS CENTRE SITE LAYOUT PLAN

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

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Registered Office: as above Registered in Ireland No. 503730

DRAWN	VERIFIED	APPROVED	APPROVED DATE
TC	PK	JD	16.04.2015

CLIENT REF	No. of Shts	SIZE	REV	SCALE
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DRAWING NUMBER: Figure 2.7

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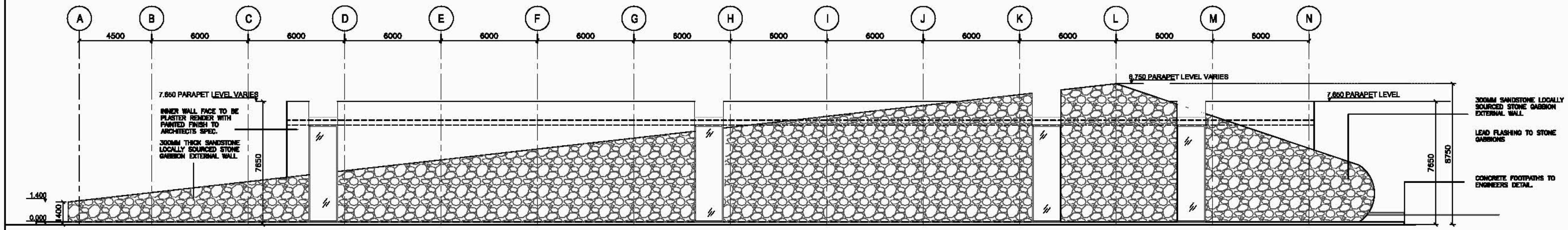
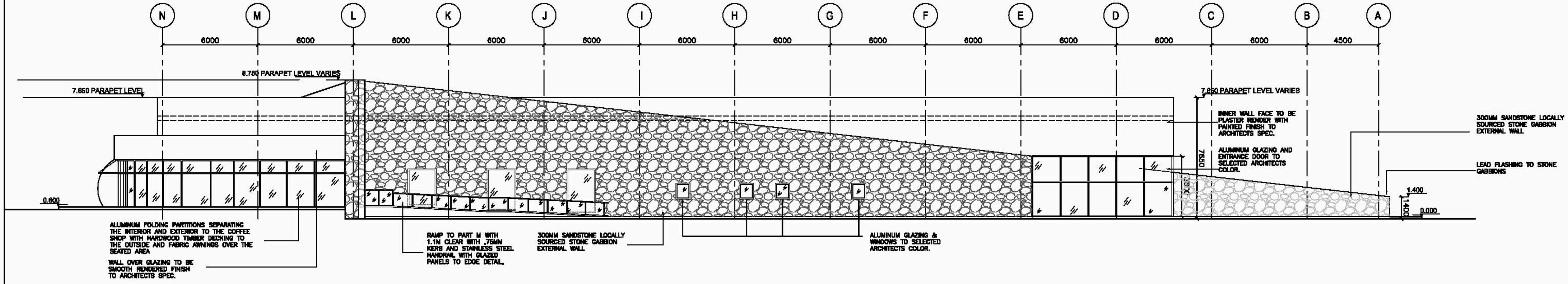
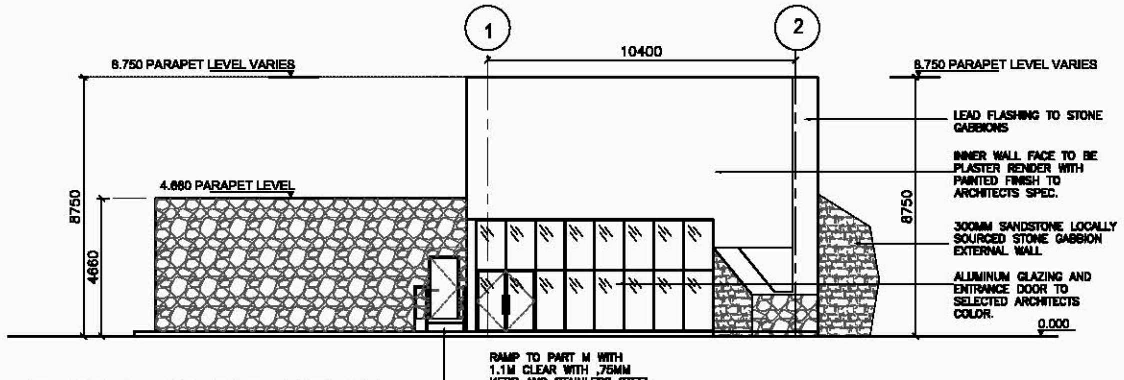


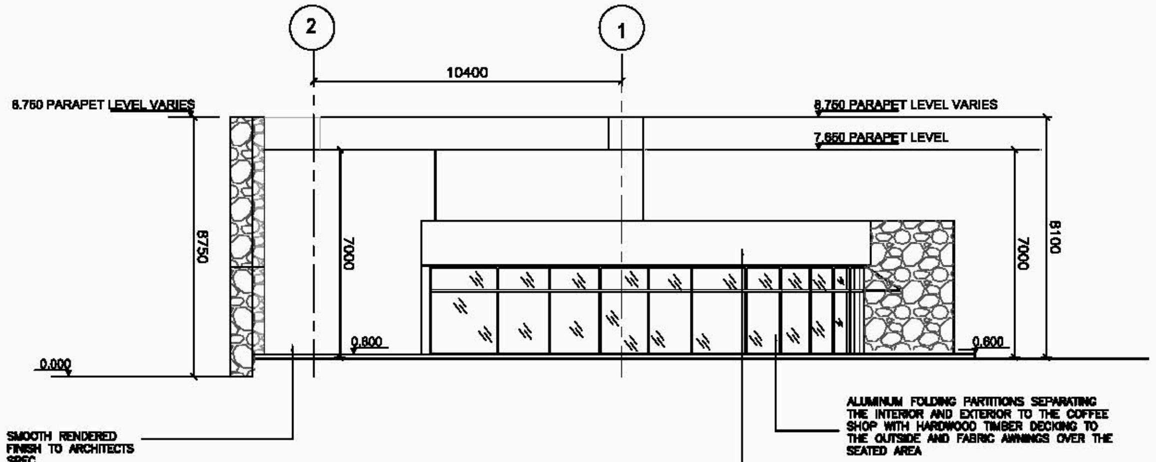
FRONT ELEVATION



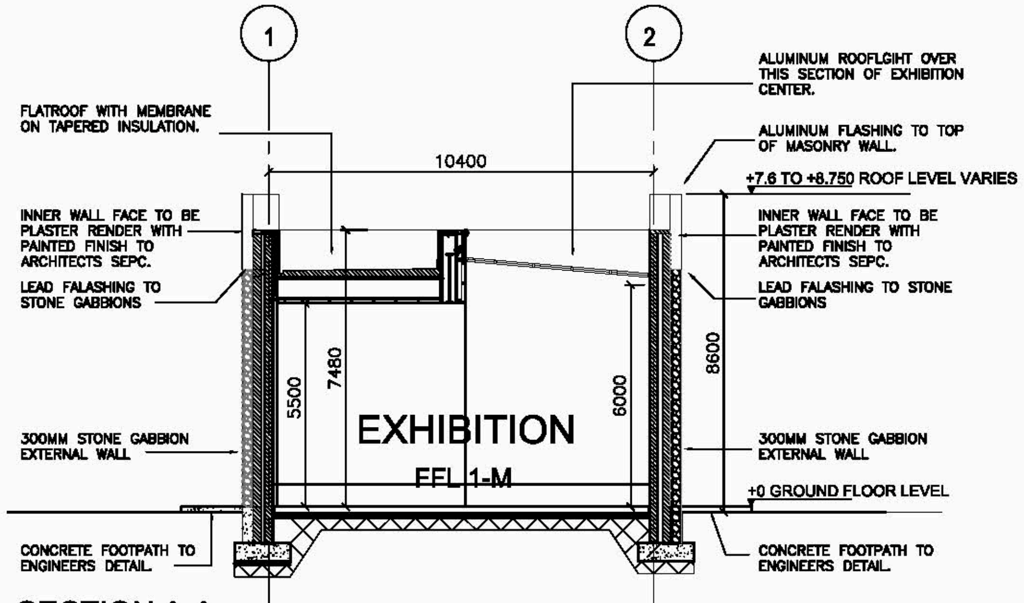
REAR ELEVATION



ENTRANCE ELEVATION



RESTAURANT ELEVATION



SECTION A-A

REV	DATE	REVISION DESCRIPTION	DRN	VER	APP
0	14.03.13	ISSUED FOR PLANNING	RC	TC	JD

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM AT OWENINNY, BELLACORICK,CO. MAYO.

Contract:

Drawing Title: VISITORS CENTRE SECTIONS & ELEVATIONS

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

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DRAWN	VERIFIED	APPROVED	APPROVED DATE
RC	TC	JD	14.04.2013

CLIENT REF	No. of sheets	SIZE	REV	SCALE
	1	A1	0	N.T.S.

DRAWING NUMBER: FIGURE 2.8

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SF-265-212-032-081

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Notes:

For compound locations and drainage see drawings :
QR-320201-P-000-016
QR-320201-P-000-020
QR-320201-P-000-025
QR-320201-P-000-030
QR-320201-P-000-031
QR-320201-P-000-037

Final temporary location may vary depending on construction sequence implemented.

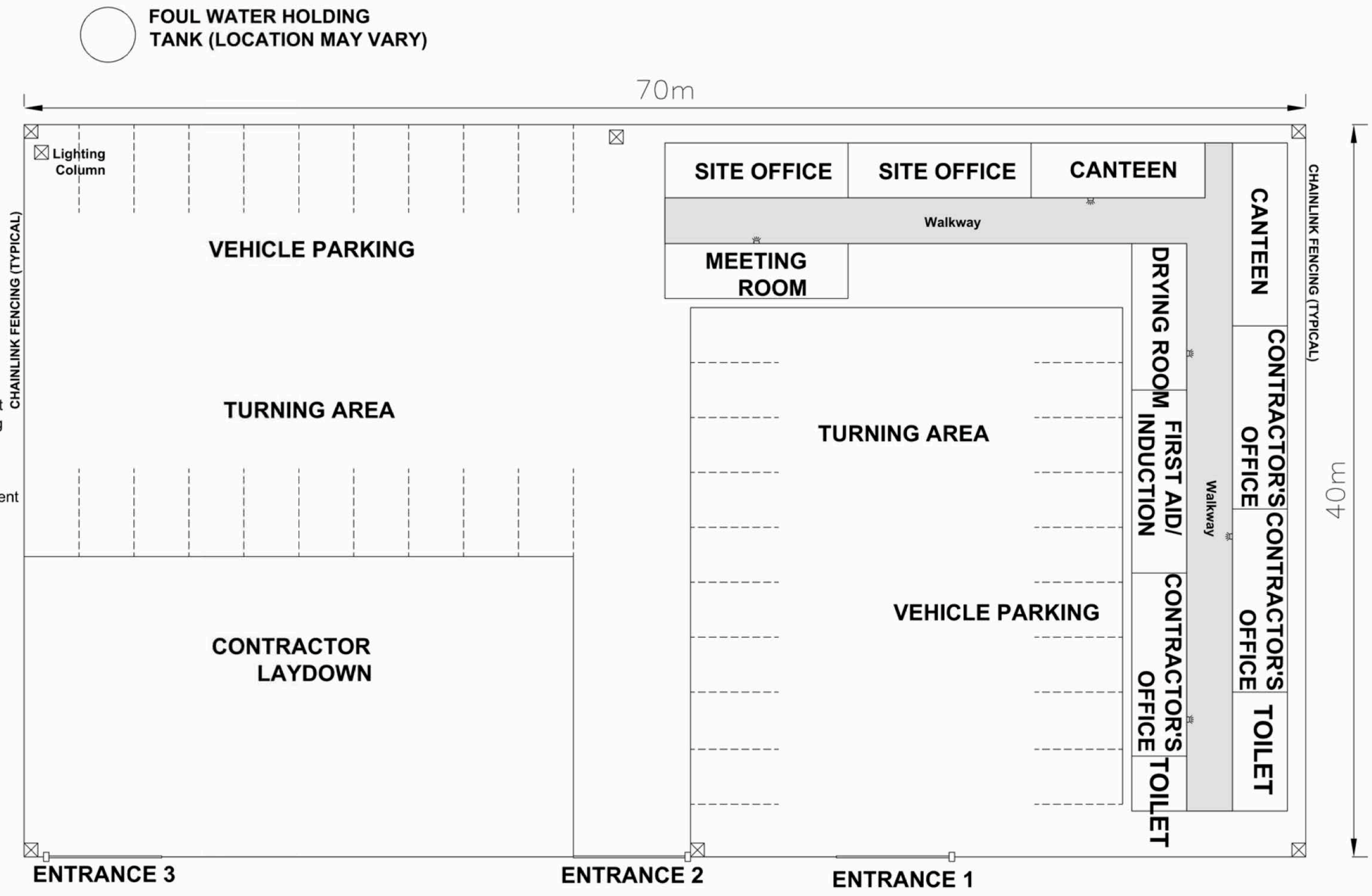
Finished compound level to be selected following detailed site investigation.

Office to be typically cabins / container type facilities.

All foul water will be collected in holding tanks, emtied routinely and disposed of in a licenced facility. The shown location may vary between compounds depending on contractors preferred setup and levels at each location to provide for suitable gradient to holding tank.

Fencing around compound typically chainlink type fencing but may vary depending on security arrangement implemented by different contractors.

Compound typically powered by diesel generator, bunded and re-fuelled in an environmentally safe manner.



Rev.	Date	Revision description	Drn.	Ver.	App.
0	21.03.13	ISSUED FOR PLANNING	PM	PK	JC

Purpose of issue - Preliminary unless indicated

Tender ☐ Client approval ☒ Construction ☐ As-built ☐ Revised ☐

Oweninny Power Ltd

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Email: oweninnypower@esbi.ie Web: www.oweninnywindfarm.ie
Registered Office: as above Registered in Ireland No. 503730

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, CO. MAYO

Contract:

Drawing title: TEMPORARY SITE COMPOUND LAYOUT PLAN

Production unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

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Drawn	Verified	Approved		Approved date
PM	PK	JC		23.03.2013
Client ref.	**No. of sheets**	**Size**	**Rev**	**Scale**
	1	A3	0	1:250

Drawing number: **FIGURE 2.9**

BF-DRG-012-004-001

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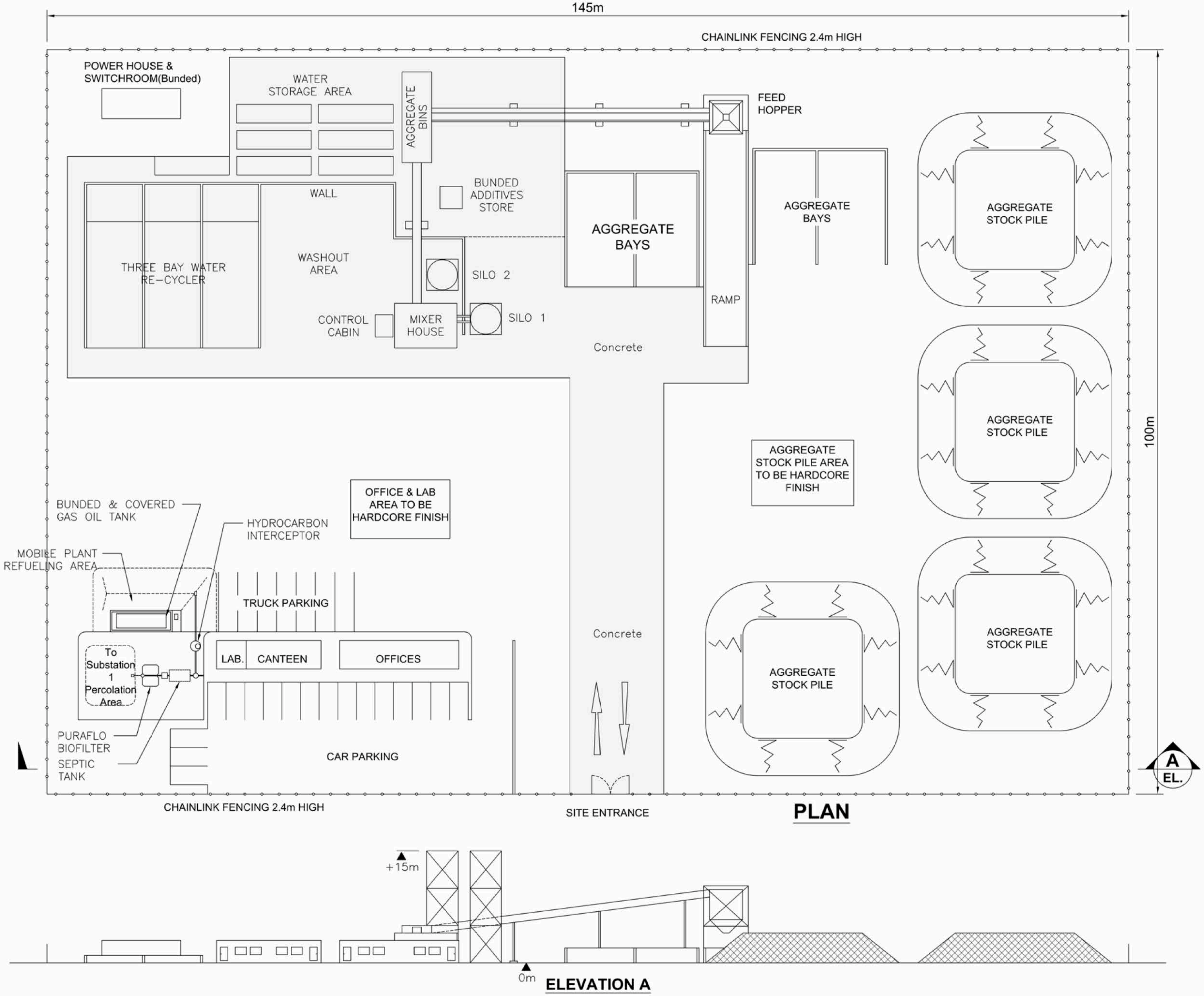

Notes:

Provision of batching plant will be procured by tender process and therefore may differ from type shown.

Final finished level will be determined by plant type and surrounding ground levels.

Area shaded grey around silos, mixer house, washout area and 3 bay re-cycler will be finished concrete surface and graded so that all run-off will be drained towards 3 bay re-cycler.

All other areas will be left as hardcore finish.

Powerhouse room and switchgear if powered by temporary generator will be bunded and have appropriate re-fuelling measures installed to prevent spillages.

For external ring drainage and excess production water discharge see drawing number QR320201-P-000-066

De-sludged material will be removed off site and disposed of in a licensed facility

Fencing will be chainlink 2.4m high or alternative security fencing as required by plant operator.

Foul water will be discharged to treatment unit for substation number 1 or alternatively foul water will be stored in holding tank, emptied routinely and disposed of in a licenced facility

Plant water may be extracted from nearby ponds or a temporary supply may be taken form the proposed well to be installed at Substation Location 1.

REV.	DATE	REVISION DESCRIPTION	DRN	VER	APP
0	01.03.13	ISSUED FOR PLANNING	PM	MB	JC

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER [X] CLIENT APPROVAL [X] CONSTRUCTION [X] AS-BUILT [X] REVISED [X]

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, CO. MAYO

Contract:

Drawing Title: BATCHING PLANT LAYOUT PLANS & ELEVATIONS

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

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DRAWN	VERIFIED	APPROVED	APPD DATE
PM	MB	JC	01.03.2013

CLIENT REF	No. of Shts	SIZE	REV	SCALE
	1	A1	0	N.T.S.

DRAWING NUMBER: FIGURE 2.10

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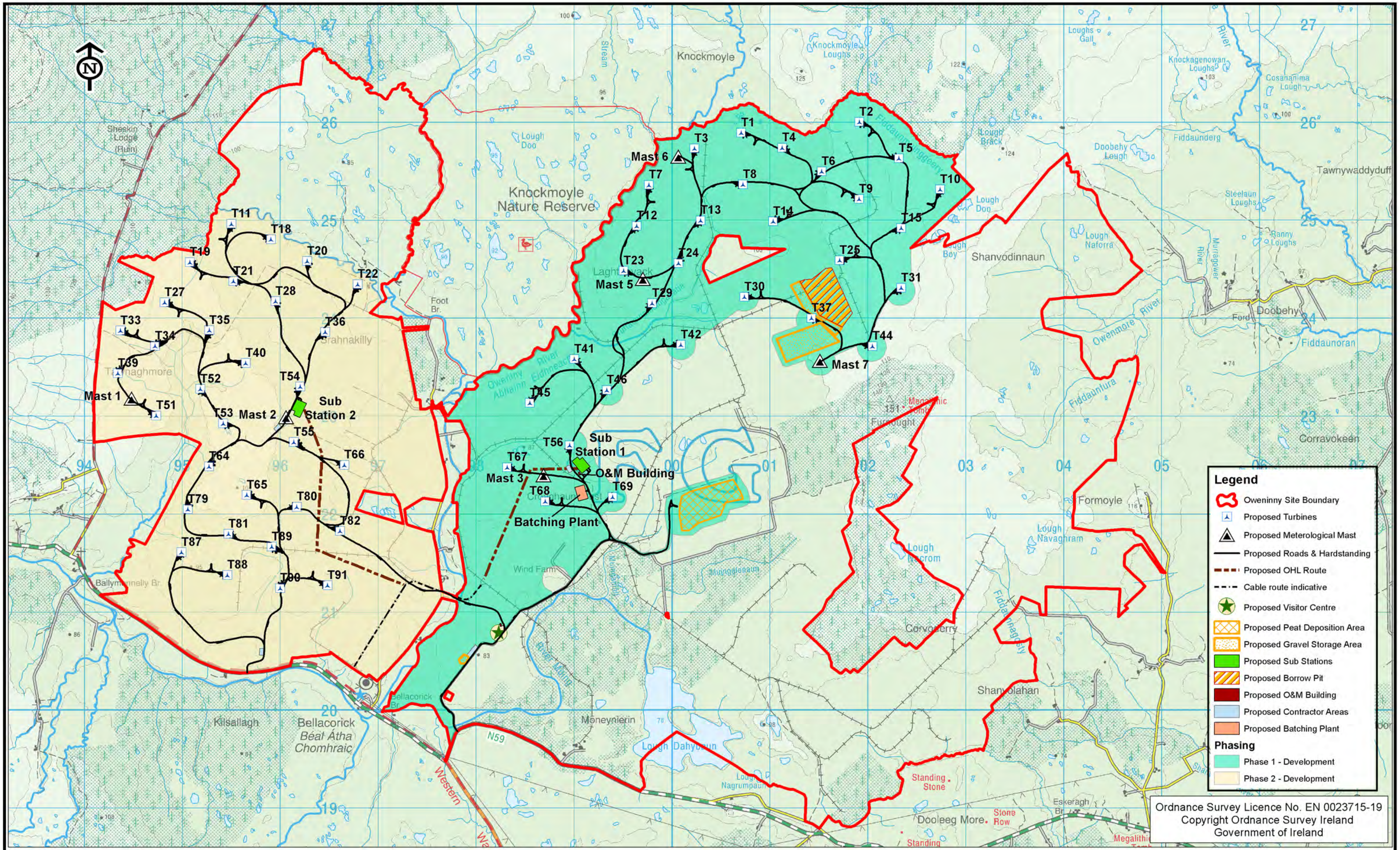

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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Projest Phasing 1 & 2

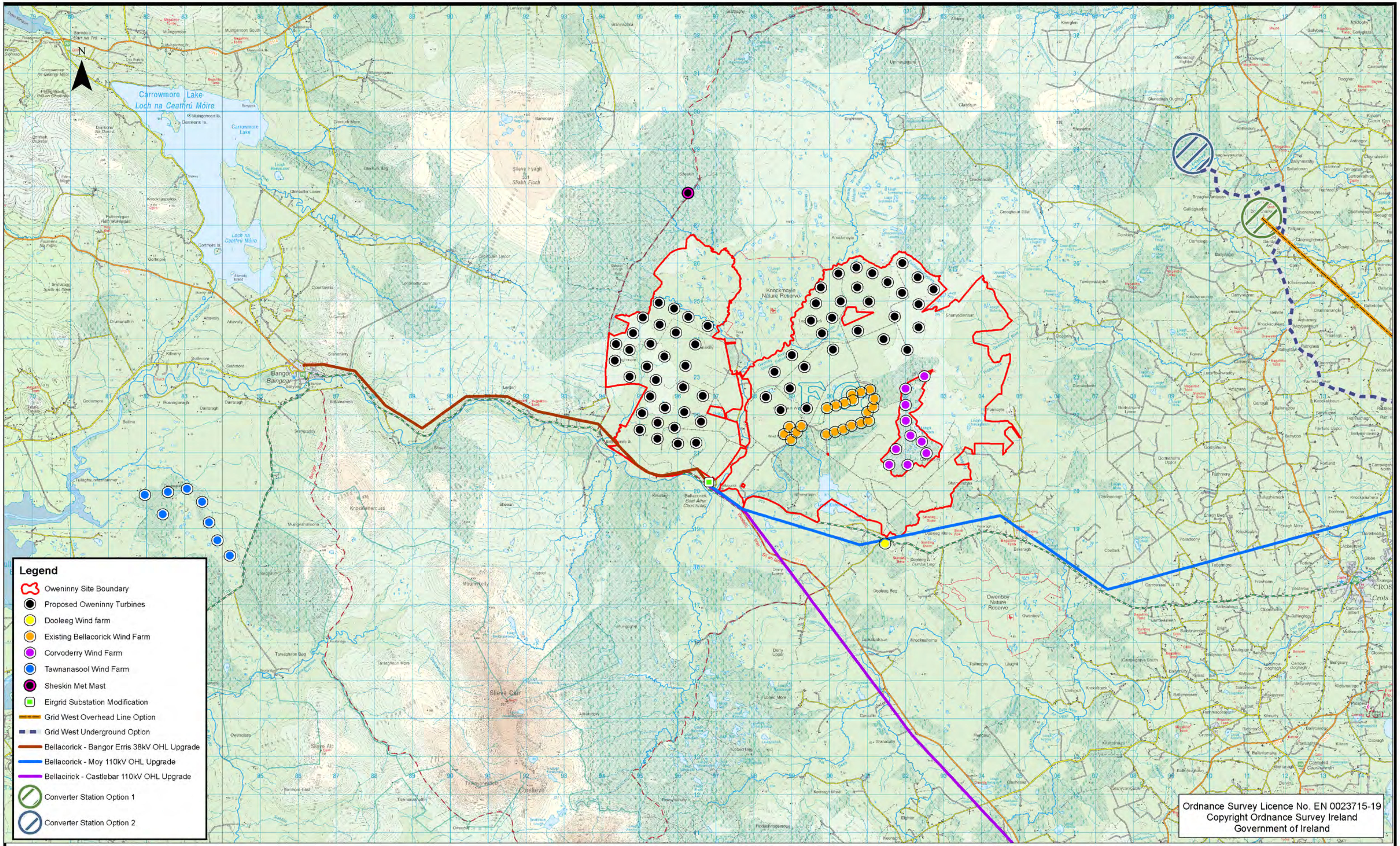
Production Unit
Civil & Environmental Engineering

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	C.F	P.K	N.Q	23/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:35,000

MAP REFERENCE

Figure 2.11



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Location of Other Projects near Oweninny - Phasing 1 & 2
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil & Environmental Engineering

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
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CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:90,000

MAP REFERENCE

Figure 2.12

3 PROJECT IMPLEMENTATION

3.1 INTRODUCTION

This section sets out the likely project implementation schedule, construction equipment and approach to construction that will be followed. Work Method statement for access track construction, foundation construction and piling operations were provided in Appendix 5 of the Oweninny Wind Farm Planning Application – EIS Appendices.

3.2 PROJECT PHASING

3.2.1 Indicative Phasing

The indicative project phase is shown in Table 3.1.

Table 3.1: Indicative Project Phasing

Phase	Rated Output (MW)	Approximate construction period
Phase 1	70 – 90	2016 - 2018
Phase 2	70 - 90	2017 - 2020

3.3 PROJECT CONSTRUCTION

3.3.1 Scope

Construction will principally involve the following:

- Upgrading of two of the three existing site entrances and upgrading and construction of 49 km of access tracks from the N59 throughout the site
- Establishing temporary site facilities including site offices, construction lay down areas, storage and concrete batching facilities
- Earthworks for the provision of access trackways, crane hard standings and turbine foundations, for the four Electrical Substations, six permanent meteorological masts, Operation and Maintenance Building, Visitor Interpretative Centre, temporary batching plant and peat repository
- Piling of on average 30 foundation piles for each turbine base where required
- Stripping of overburden and development of Borrow pit
- Fixing of formwork and steel reinforcement for the turbine foundations.
- Construction of reinforced concrete bases with cast-in steel foundation section for the tower and backfilling around foundations.
- Reinstatement of areas around turbine bases and track edges.
- The erection by crane of the pre-fabricated turbine towers and the installation of turbines and rotor blades.
- Construction of the two Electrical Substations containing the control buildings and substations.

- Construction of the six permanent meteorological masts
- Installation of underground ducts and cabling from each turbine to the respective Electrical Substation.
- Construction of the 110 kV overhead lines from the Electrical Substations to the Bellacorick substation area via cable interface towers and underground cables.
- Installation of drainage sediment control system
- Only limited tree felling to accommodate access track construction (comprising approximately 1.05 hectares) will be required to facilitate construction of phase 1 and no tree felling will be required for phase 2.
- Decommissioning of all temporary facilities

3.3.2 Schedule

The wind farm construction will be undertaken in phases over the period 2017 to 2020, depending on grid upgrading works. Phase 1 and Phase 2 will each require approximately 24 months respectively to complete provided that weather conditions are not unfavourable and the existing 110 kV overhead lines are upgraded by EirGrid. An indicative construction schedule is presented in Table 3.2.

Table 3.2: Construction Schedule and Nominal Time Scales

Activity	Phase 1	Phase 2
Likely time period	2016 - 2018	2017-2020
Rated MW output	70 – 90 MW	70 -90 MW
Number of turbines	30	30
Establish temporary facilities	6 weeks	6 weeks
Site Entrance upgrading	1 month	1 month
Tree felling operation		
Drainage control (settlement ponds, drainage channels)	9 months	9 months
Borrow pit excavation	5 months	3 months
Earthworks and access road construction	9 months	9 months
Earthworks for turbine access, foundation and crane hard stand	6 months	6 months
Steel formwork for turbine construction	6 months	6 months
Concrete base formation for turbines	9 months	9 months
Turbine assembly and erection	5 months	5 months
Electrical Substation access and earthworks	4 weeks	4 weeks
Installation of transformer station	12 months	12 months
Construction of meteorological masts	3 months	3 months
Construction of Operation and Maintenance building	6 months	-

Activity	Phase 1	Phase 2
Construction of Visitor Interpretative Centre	8 months	-
Construction of 110 kV Overhead line	3 months	3 months
Installation of underground cables to Bellacorick	2 months	2 months

For Phase 1 and Phase 2 the main construction elements include:

- Site entrance upgrading and access track construction
- Civil engineering works will take approximately 24 months for each phase.
- Electrical works will take approximately 12 months for each phase and will be carried out in conjunction with the civil works as far as possible.
- Turbine erection will take between 3 and 6 months for each phase depending on weather conditions, and will commence when the bulk of the civil works are complete.
- Reinstatement and landscaping for each phase will be conducted in parallel with turbine commissioning.

The final construction programme will be developed in consultation with the turbine manufacturer, based on availability of turbines and projected delivery dates.

3.3.3 Construction Plant and Machinery

The estimated type and number of items of construction plant and machinery that will be used during the course of construction are provided in Table 3.3.

Table 3.3: Estimated Typical Construction Plant and Equipment*

Phase 1 Plant	Phase 2 Plant
15 - 20 No. hydraulic excavators 2 Rubber tired excavators	15 – 20 No. hydraulic excavators 2 Rubber tired excavators
5 - 10 No. 25 – 40 ton dump trucks 30 No 8 wheeler truck – stone delivery	5 - 10 No. 25 – 40 ton dump trucks 30 No 8 wheeler truck – stone delivery
2 x Piling Rig Pile transport – 4 x 40 ft. trailers and 3 x Concrete lorries.	2 x Piling Rig Pile transport – 4 x 40 ft. trailers and 3 x Concrete lorries.
1,200t capacity crane (x1)	1,200t capacity crane (x2)
300 - 500t capacity crane (x2) 100t capacity crane x1 MEWP x 2	300 – 500t capacity crane (x2) 100t capacity crane x1 MEWP x 2
Concrete Batching Plant	Concrete Batching Plant
Concrete pump (truck mounted) 10 x concrete trucks	Concrete pump (truck mounted) 10 x concrete trucks

Phase 1 Plant	Phase 2 Plant
10 No. 8 t dumpers, 2 x teleporters.	10 No. 8 t dumpers, 2 x teleporters.
150 mm Dewatering pumps	150 mm Dewatering pumps
Site generators and fuel bowsers	Site generators and fuel bowsers
15 -20 No. Four-wheel drive vehicles	15 -20 No. Four-wheel drive vehicles
Miscellaneous power tools	Miscellaneous power tools
Deliveries to site – rebar and other materials.2 x low loaders	Deliveries to site – rebar and other materials. 2 x low loaders
Deliveries to batching plant – 10 No 8 wheeler or Artic trucks. Water tanker delivery. Bulk cement delivery.	Deliveries to batching plant – 10 No 8 wheeler or Artic trucks. Water tanker delivery. Bulk cement delivery.

* Note: The estimated plant is indicative and will be dependent on the contractor(s) appointed to undertake construction

3.3.4 Construction and Environmental Management Plan

All site activities will be provided for in a Construction and Environmental Management Plan (CEMP) prepared prior to commencement of on-site operations. The Plan will outline the work practises, environmental management procedures and management responsibilities in relation to construction of Oweninny Wind Farm.

The Plan will set out all measures necessary to ensure the works are carried out in accordance with the specified contractual, regulatory and statutory requirements, as well as the mitigation measures set out herein. Amongst the items to be addressed will be the following:

- Control of fuels and oils
- Control of concrete
- Management of spoil storage areas
- Waste management
- Construction monitoring
- Traffic management
- Pollution contingency plan
- Forest harvesting operations
- Drainage control measures

All site personnel will be required to be familiar with the CEMP’s requirements as related to their role on site. The CEMP will be a controlled document, which will be reviewed and revised as necessary.

As part of the oral hearing further clarification was provided and an Outline Construction and Environmental Management Plan provide to the An Bord Pleanála Inspector. This outline plan incorporated as an appendix a complete schedule of all mitigation described in the Environmental Impact Statement Submitted and the Natura Impact Statement Submitted. The CEMP plan will be finalised by Contractors appointed to construct Oweninny Phase 1 and Phase 2.

3.3.5 Site Management

A full construction management team will be deployed on site in accordance with routine site construction procedures. This team will consist of a Resident Site Manager and Assistant Engineers as appropriate.

The limited forest plantation felling operations will be carried out in accordance with Forest Service Guidelines.

All construction works will be carried out under appropriate supervision. Works will be carried out by experienced contractors using appropriate and established safe methods of construction. All requirements arising from statutory obligations including the Safety, Health and Welfare at Work Act and associated regulations will be met in full.

3.4 TEMPORARY SITE FACILITIES

3.4.1 Contractor's Compound

A number of suitably surfaced contractor's compounds, which will be approximately 70 m x 40 m in plan, will be provided for offices, equipment storage and construction staff welfare facilities at the location identified in Figure 2.1 for the duration of the site works. It is anticipated that up to four separate contractors will be involved. In addition a number of potentially suitable locations for temporary site compounds have been identified adjacent to substation 2, close to entrance on the western side and in close proximity to the existing Bord na Móna maintenance workshops. The use of these areas and the main compound area will be a decision for the construction contractor.

Portable cabin structures will be used to provide temporary site offices and self-contained chemical-type toilets will be installed. These will be managed and serviced on a weekly basis or more frequently if required, and will be removed from the site on completion of the construction phase.

Container storage units will be provided for holding tools and materials and lay down areas will be provided for major components.

Each compound will be fenced with chain link fencing and will have a lockable gate.

Potable water supply will be provided via the local group water scheme connection point which has been taken over by Mayo County Council and to which both ESB and Bord na Móna have connections or alternatively by water tanker or bored well.

Temporary direction notices will be erected for construction traffic.

All temporary facilities will be fully removed upon project completion and the respective areas will be reinstated or modified for use in the operation of the development if appropriate.

3.4.2 Temporary Concrete Batching Plant

A temporary concrete batching plant will be established for the duration of the construction phase, (see Planning Drawing QR320201-P-000-053). This will comprise aggregate and binding materials storage, water storage, batching plant, concrete silos, water recycling area and temporary administration structures. The concrete batching plant including material storage will be established for the duration of the works adjacent to Electrical Transformer Substation No.1. The proposed location is situated on thin peat overlying sandy subsoil.

The site will be cleared and levelled and a concrete platform and hard core areas constructed. The concrete apron will be sloped towards a three bay water recycler. This will provide settlement of suspended solids from surface water flow. The three bay water recycler will be cleaned periodically and the fines stored upslope. The fine material recovered will be reused in the concrete production.

Water will be extracted from nearby existing water sources (10m^3 per hour required) on site and will be stored in a designated water storage area (approximately 500m^3).

Aggregate material will be brought to the material storage areas within the concrete batching plant compound from external quarry sources. Each of the four material storage areas will be capable of holding up to 5,000 tons of aggregate material, i.e. a total of 20,000 tons. Stockpiling of aggregate will take place over a prolonged period to minimize cumulative impacts on traffic on the N59 and other roads in the area.

Coarse and fine aggregates will be stored in separate bins. Aggregates will be transported from the bins to an aggregate hopper by conveyor belts. A weigh hopper is situated directly beneath the overhead storage hopper, where aggregate is weighed and transferred to the mixer house.

Cement and fly ash will be stored in separate overhead silos. These components are fed into the mixer house. The correct proportion of water is added, along with any required admixtures and the concrete is mixed, ready for final slumping, inspection and transportation to the construction site.

The batching plant will be capable of producing 50 m^3 of concrete per hour with an hourly requirement of 10 m^3 of water and 20 tons of aggregate and 5 tons of cement.

Concrete will be batched on site on a demand basis mainly for turbine foundation construction. During the operation of the concrete batching plant external concrete suppliers will be on standby to deliver the required concrete.

Drainage control including sediment control and settlement and pH neutralization will be provided at this location.

The batching plant compound will be fenced with a 2.4m high chain link fence.

For the wind turbines, the concrete pouring operation is critical to the structural integrity of the turbine base as once the pour commences it must be completed in one operation to ensure correct formation of the base. The presence of the batching plant on site with adequate store of materials will provide an alternative to delivery of concrete by vehicles providing security of concrete pouring operation.

Conversely, an external concrete batching plant will be on standby during turbine foundation pour to provide concrete in the eventuality that the batching plant suffers an unexpected breakdown. Concrete deliveries would be called in to complete a turbine base pour if necessary.

The proposed concrete batching plant will be constructed for two main purposes

- to partially meet the concrete demand on site.
- to provide a backup concrete production facility in the event of an external plant being unable to meet the required concrete demand flow. This would be critical to the pouring of concrete foundations which must be completed in continuous fashion to ensure foundation integrity.

The provision of the batching plant will have major operational and some environmental benefits. It will allow for redundancy in concrete production essential to wind farm construction. It will also reduce the peak volume of traffic on the N59 for instance as concrete will be batched on site and not transported in. The materials required can be imported to the site over a prolonged period. This will have knock on effects on peak emissions of air pollutants such as SO2, NOx and dust associated with transport.

The location of the concrete batching plant within the Oweninny site has been carefully selected to minimise potential impacts on the environment. The proposed location is adjacent to Substation number 1, (see Figure 2-1) and is considered the best site in terms of operational aspects and in terms of environmental and visual impacts. It is located more than 1.28 kilometres from the nearest occupied dwelling, which is situated along the central road passing northwards through the site and adjacent to the Oweninny/Owenmore river. The batching plant is also located a distance of approximately 550 metres from the nearest stream, a first order tributary of the Oweninny/Owenmore river and about 117 metres distance from a small lake (Lough Nagappul) adjacent to the stream.

Within the batching plant site area the main concrete batching, wash out and truck loading facilities will be constructed on top of a concrete base slab which separates the plant from existing ground. The internal roadway to the batching plant area will also be concreted.

Site offices, control building and staff parking will be located on hard core areas.

3.4.3 Other temporary facilities

The contractor may provide temporary storage and sanitary facilities at turbine hardstands and other construction areas during the construction period.

Portable generators will also be provided to facilitate commissioning of the site.

3.4.4 Emissions and emission control

Batching plants can give rise to potential emissions including dust, wastewater and waste materials. Given the distance to the nearest occupied dwelling and surface water the potential impact of any such emissions are likely to be insignificant. Major construction works associated with the setting up of the temporary batching plant include formation of foundation, erection of carbon steel supports and metal works including welding and assembly of fabricated metal sheets. Atmospheric dust would be the principal air contaminant generated during construction. The excavation requirements are very small and the amounts of dust and other emissions that will be generated will be relatively minor. Bare areas of soil will be quickly covered with hardcore and hard surfaces during construction minimising potential for dust and silt runoff from the site.

The main potential for emissions from the batching plant site will occur during the operational phase and will be intermittent in nature. For example for turbine foundation pour the batching plant would produce concrete on 30 days and 31 days during each of the development phases 1 & 2. Similarly foundation pours for the visitor centre and O&M building would be on a campaign basis over a number of weeks.

3.4.4.1 Dust emissions.

Dust emissions can arise from materials delivery and fugitive emissions from silos, conveyor belt system and batching plant operation. The most effective means of reducing dust emissions at batching plants is to hard-surface roadways and any other areas where there is a regular movement of vehicles. The batching plant area itself within the site will consist of a concrete apron which will be cleaned on a regular basis to remove any spilled materials.

Suppression of dust emissions from unsealed yards and roadways, will be achieved by hard coring the stockpile areas and access tracks to these and regular light watering when required

Dust emissions due to vehicles will be minimised by provision of a hard surfaced access road within the batching plant site to the batching plant area. Wheelwash facilities will be provided at the Oweninny site main exits.

The batching plant site will be operated in accordance with best practice with good maintenance practices, including regular sweeping to prevent dust build-up. To ensure that dust emissions are minimised the following additional actions will be implemented:

- Aggregate material will be delivered in a damp condition, and water sprays will be applied to reduce dust emissions. Given the distance of the batching plant site to the nearest occupied dwelling it is proposed to store aggregate on hard core rather than in contained areas.
- Aggregate will be stored on site in stockpiles
- The Conveyor will be designed and constructed to prevent fugitive dust emissions. This may include covering the conveyor with a roof, installing side protection barriers and equipping the conveyor with spill trays, which direct material to a collection point. Belt cleaning devices at the conveyor head may also be used to reduce spillage.
- Before loading into a concrete truck, materials will either be premixed in a totally enclosed concrete mixer or if the batching plant is the dry mixer type loaded into trucks for subsequent mixing.
- The mixer loading area will be enclosed and water sprays and a robust curtain of suitable design, or an effective air extraction and filtration system will be installed to suppress dust generated during mixer truck loading.
- Concrete trucks will be loaded in a way that minimises airborne dust emissions
- Weigh bins and hoppers will be enclosed.
- Any raw material spills will be removed promptly by dry sweeping. Water will not be used in the process of cleaning up spills except where the area drains to a wastewater collection point where washing down would be preferable to

generating dust by sweeping. Where dry materials are recovered they will be recycled into the concrete batching process.

- Cement storage silos will have an approved fabric filter incorporating a fabric-cleaning device installed on each cement storage silo. The fabric filters will be serviced and maintained in accordance with the manufacturer's recommendations. Regular inspection and maintenance will be undertaken.
- To prevent overfill and subsequent filter damage, storage silos should be fitted with high-level audible and visual alarms in addition to an automatic delivery shut-down.
- If visible emissions are observed their source will be identified and corrective action taken immediately
- All filter systems will be inspected on a daily basis to identify when cleaning/replacement is necessary. The inspection will include for checks for tears or leaks in fabric/cartridge filter systems.

During the oral hearing process for the Oweninny Wind Farm An Bord Pleanála requested an assessment of the potential for air borne cement dust impact on the Bellacorick Iron Flush cSAC should an accidental loss of such material occur from the batching plant. Calculations and impact assessment were provided as part of the witness statement of Dr,. Paddy Kavanagh relating to Air and Climate. This predicted that no significant impact on the Bellacorick Iron Flush cSAC would occur.

3.4.4.2 Water

Water quality impact can occur both during the construction and operational phases of the proposed concrete batching plant. Construction impacts can include:

- construction run-off and drainage;
- sewage effluent produced by the on-site workforce.

The site has been designed and will be constructed such that clean surface water, including roof runoff, is diverted away from contaminated areas and directed to a surface water discharge system. Any liquids stored on site, including admixtures, fuels and lubricants, will be stored in accordance with EPA Guideline, Bunding and Spill Management (2007). The drainage control system will be constructed in advance of any ground clearance works or site preparation and will control potential discharges to surface waters.

Temporary welfare facilities will be provided at the concrete batching plant site for both the construction and operational phases. A holding tank will be used to collect wastewater from sanitary facilities. Wastewater will be removed from site by a licensed waste contractor.

During the operational phase wastewater including cement, sand, aggregates, chemical admixtures, fuels and lubricants could gain access to surface and ground waters from the site. Turbid and highly alkaline wastewaters are the key potential aquatic impacts associated with concrete batching plants.

To control potential impacts on the environment good construction practices and site management measures will be observed to ensure that solid waste, fuels and solvents do not enter the nearby waters. These practices will include the following:

- All runoff from the concrete batching area, washout area and concrete truck loading facilities will be directed to a three stage water recycler.
- Water from this recycler will be recycled back into the concrete batching plant process or used for washout facilities.
- Fines and solids from the water recycler will be removed and reused in the concrete batching plant process.
- Any excess surface water from the concrete slab and water recycler area will be directed towards the drainage control system and will pass through a sediment control pond before being directed to overland flow across the site. There will be no direct discharge to any receiving water.
- Wastewater from the water recycler will only be discharged to the settlement ponds between the pH limits of pH 6 to pH 9.
- All fuel and chemical stores will be bunded in accordance with the requirements of EPA Guideline, Bunding and Spill Management (2007)
- Routine inspections of the water recycler and bunds will be undertaken.
- Areas where spills of oils and chemicals may occur will be equipped with easily accessible spill control kits to assist in prompt and effective spill control, according to the EPA Guidelines, Bunding and Spill Management. Staff should be familiar with spill response and notification procedure.

3.4.4.3 Waste Materials

The main solid waste generated by batching plants is waste concrete. Waste minimisation is the preferred approach to dealing with this material.

- Where possible, waste concrete will be used for construction purposes at the batching plant or project site (e.g. bunker blocks or paving unsealed areas). Alternatively, waste concrete will be directed to a suitable washout area where it becomes gravel, sand and sludge, which can subsequently be collected and reused.
- Any dust arising on site and from the filter system will be recycled into future concrete batches

3.4.4.4 Noise

No specific noise controls are expected to be required for the concrete batching plant as the site is located at a distance of greater than one kilometre from any residence and will operate intermittently.

3.4.5 Decommissioning

The temporary batching plant is likely to remain in situ during the construction of Phases 1 and 2. With the implementation of environmental controls as indicated above and given the batching plant location with respect to occupied dwellings and the public road no significant environmental impacts are foreseen during its construction, operation and decommissioning.

3.4.6 Control of Oils & Fuel

Oils and fuels will be used during the construction phase and the following procedures will be implemented for on-site storage of fuels, lubricants and hydraulic fluids for equipment used on the construction site:

- Storage of fuels, lubricants and hydraulic fluids will occur mainly at the contractors' compound(s), which will be fenced with chain-link fencing and will have a lockable gate, thereby ensuring that the area in which fuels, lubricants and hydraulic fluids are stored will be properly secured against unauthorised access or vandalism.
- Outside the contractors compound there will be short term storage of fuels for diesel generators use don site.
- An area within the compound will contain a small bund lined with an impermeable membrane in order to prevent any contamination of the surrounding soils and vegetation and of groundwater.
- Selection of the location for storage of fuels, lubricants and hydraulic fluids will be based on the following:
  - It will be remote from surface drains and watercourses.
  - It will be readily visible for supervision and inspection.
  - It will be readily accessible for filling and maintenance.
  - It will be protected against accidental impact.
- Bunds will have capacity of at least 110% of the largest tank accommodated or 25% of the total maximum capacities of all tanks, whichever is the greater, where more than one tank is installed and will be constructed and managed in accordance with the EPA Guideline, Bunding and Spill Management (2007).

The following procedures will be implemented during construction operations:

- Fuels and oils will be carefully handled to avoid spillages.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained and the contaminated soil removed from the site and disposed of appropriately.
- Any waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling.
- As a minimum, simple spill protection equipment that will be held locally will include specialist absorbent mats/pillows and granules for containment/clean-up of oil. Adequate quantities should be held in stock and be available for immediate use.
- Appropriate spill control equipment, such as oil soakage pads, will be available on site to deal with any accidental spillage and emergency response procedures will be put in place.
- Designated contractors' personnel will be trained and certified in oil spill control and clean up procedures and in the proper and safe disposal of any waste generated through such an event.

3.5 PUBLIC ROADS

It is recognised that the N59 used in delivery of construction materials and turbine components may require upgrading to facilitate the project. Any road improvements that are undertaken will ultimately be of long-term benefit to the local community.

It is proposed that a condition survey of public roads be carried out by Oweninny Power Ltd. in agreement with the Local Authority prior to commencement of the project to identify any improvement works, such as road widening at bends, provision of passing bays, etc., that may be required and for agreement with the Local Authority.

While the surface of the public roads will be maintained for the duration of the works, the above survey will also form a basis for agreeing any remedial works that may be necessary following completion of the construction.

Additionally it is noted that a Road and Bridge survey was conducted along the N59 as part of the Corrib Gas discharge conditions. The adequacy of this existing Road and Bridge survey in terms of assessing existing infrastructure and the potential impact of the Oweninny wind farm construction activities on it will be discussed with the Local Authority at an early stage. If required an updated Road and Bridge survey will be conducted by Oweninny Power Ltd for agreement with the Local Authority prior to commencement to identify any improvement works that maybe required.

3.6 TURBINE ACCESS AND CRANEPADS

3.6.1 Access tracks

An access track network is required through the site to facilitate construction of the turbine bases and erection of the turbines. Approximately 49 km of access tracks will be required in total. It is anticipated that upgrading of existing tracks will provide approximately 6 km of the overall required length.

In addition a network of now disused internal railway beds exists on the site. These formed part of the original peat harvesting operations and the decommissioned trackways are used for general vehicular access to the overall site. In some cases the railway network may be surface upgraded to allow continued use by light vehicles to the overall site.

The network of access tracks will utilise up to 6 km of trackways provided for the existing windfarm.

The proposed felling of 1.05 ha of forest plantation areas is required to allow for access track widening on the site to access turbine locations. There are no turbines in Phase 1 and Phase 2 within forest plantation areas. Trees will be harvested using traditional harvester and forwarder equipment and stockpiled on site prior to removal by truck to appropriate commercial operations. Felling will be carried out in accordance with the Forest Service Guidance documents and under a felling licence. Silt ponds will be installed for roadside drainage following tree clearance.

Improvements to existing tracks within the site will comprise the following:

- Widening: Excavate an approximate 1.5 m strip next to one side of the track, into glacial till / weathered rock. Place approved stone along the strip, tying into existing track structure, to leave a 6 m wide completed track.
- Strengthening: Excavate weak / sub-standard sections of the existing wind farm access trackway and replace with approved stone.
- Bend improvements: Excavate strip / area to the side of the existing track, into cohesive soil or weathered rock, to create a bend which complies with the

turbine supplier's delivery specification. Place approved stone along the strip / area tying into existing track structure.

Access tracks will be to standards that meet the criteria for load carrying capacity of the ground over which the tracks will pass, for the axle loads of the vehicles and the total number of vehicles during the construction period.

The site is characterised by the presence in places of areas of relatively deep peat. However, the proposed layout has been developed by avoiding such areas wherever possible and it is anticipated that the required formation strength will be achieved in the majority of areas (90%) without deep excavation.

The tracks will generally be formed by excavating the existing overburden and placing a layer of coarse granular fill followed by a 100 mm layer of fine gravel. An overall minimum thickness of 800 mm is envisaged.

The use of floating access tracks will be considered as an alternative to deep excavation in areas where this construction type may be appropriate

To facilitate internal access to turbines for maintenance purposes within the site short sections of floating road are proposed which would effectively close off potential loops in the trackway structure. This will allow small and light maintenance vehicles to traverse short distances between adjacent turbines which would not otherwise be linked by construction tracks reducing journey time within the site.

If localised pockets of deeper peat are found that do not warrant adopting floating road construction and excavations are necessarily deeper, a layer of quarry rock will be placed to raise levels and aid drainage.

Crossings of drains and minor watercourses will be by culverts. These will be suitably designed for base flows and peak flows, with a minimum size to avoid occurrence of blockages and build-up of discharges and to avoid increased flow velocities with the potential to cause erosion. They will also be designed in accordance with the requirements of Inland Fisheries Ireland "Requirements for the Protection of Fisheries Habitats during Construction and Development works at River Sites".

3.6.2 Cranepads

Cranepads, which comprise level hard-standings, are required adjacent to each turbine base for the operation of a heavy lifting capacity crane and a smaller service crane used for assembly of the turbine components. These areas will be to the same general specification as the turbine access tracks that they adjoin, but a slightly greater depth of construction is envisaged. Trackside drainage will be provided within the excavated width and will discharge into stilling ponds at regular intervals. The resulting discharge will be directed to overland flow to existing wetted areas of the bog to ensure appropriate water quality for release into the general drainage of the site. Details of the site hydrology and drainage management are provided in Section 19 of this document.

3.7 WIND TURBINES

3.7.1 Turbine Bases

Foundations for wind turbines may be of the gravity, rock anchored or piled type. Pile based foundations are more likely to be proposed at Oweninny and depths of piling will depend on site conditions that are established by detailed geotechnical investigations. Exploratory boreholes have been undertaken and this indicates that piles averaging 17m in length will be required. Piles will be of the reinforced concrete type and the average number of piles per turbine base will be 30. Additional geotechnical investigations will be undertaken as necessary at each turbine location with associated sampling and laboratory testing to confirm piling requirements.

While sizes will depend on site conditions, it is envisaged that turbine bases will consist of reinforced hexagonal, (or similar equivalent shape) concrete pad footings measuring 22 m across x 3 m deep, similar to those shown in the submitted Planning Drawing number QR320201-P-000-042. Foundations will be either excavated or founded on the piles about 0.5m below existing ground level and will incorporate an upstand / plinth into which a tower insert or fixing bolts will be embedded. At each turbine base the completed foundation will be covered with soil leaving only the concrete upstand / plinth outstanding. The upstand / plinth will be approximately 4-5 m in diameter, depending on the final choice of turbine model.

The exact dimensions of foundations will be determined by pre-construction structural design calculations incorporating appropriate factors of safety. These will be based on detailed geotechnical investigations, which will include trial pit excavation and exploratory boreholes as necessary at each proposed turbine location with associated sampling and laboratory testing. The depth of individual foundations will vary according to the depth to rockhead or other competent subgrade.

Design of foundations will be undertaken by qualified structural engineers who have successfully designed foundations in similar environments for similar structures.

In design terms the substrata encountered at Oweninny are neither unusual nor problematic. In design terms, neither the ground conditions at the site nor the structural loads arising from wind turbines are particularly unique. Wind farm developments have been successfully designed for environments where bases are founded on strata that are similar to those at Oweninny.

The general method of construction of the turbines will be as follows:

- Marking out of the location of the foundation established from the construction drawing
- Construction of the crane hardstand and piling platform area
- Piling of up to 30 concrete piles where required to an average depth of 17m. Piles will most likely be constructed by coring and inserting a steel sleeve which will be filled with reinforced concrete prior to sleeve removal. Piling at each turbine foundation location will take approximately 1 week.
- Where piling is carried out excavating soil to a depth of up to 1m with provision of a surrounding working area to allow placing of shuttering, etc.

Excavators will be conventional and long reach machines, which will initially sit on the cranestand and / or bogmats or the adjoining access track. Depending on the depth and type of peat encountered the peat will be benched until formation level is reached or large boulders will be punched through the peat to retain the sides of the excavation

- Placing of concrete will generally be in two phases, namely the base pour which will be a single continuous phase and the pedestal pour, using pumps and compaction using vibrating pokers to the levels and profile indicated on the drawings. Upon completion of the concreting works the foundation base will be covered and allowed to cure. The steel reinforcement framework will be prepared in advance of the concrete pour. The base pour, comprising the base of the foundation will be poured continuously over a one day period. An estimated 550m3 of concrete will be required for the first pour requiring approximately 50 concrete deliveries. The concrete base will be allowed to cure for a period of between 30 – 45 days. The first pour will only take place at one turbine base at a time. The pedestal pour will take place after the curing period comprising 100 m3 of concrete approximately.
- Where concrete piles are not required the turbine foundations will be excavated to a depth of c. 3.0 m and the excavated material will be side cast adjacent to the work area to a depth of no more than1.0m. Steel and formwork will be as described above and the concrete will be poured in two operations as described above.
- The concrete will be protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from directly entering surface water drainage.
- Fixing of high tensile steel reinforcement will be in accordance with the designer's drawings and schedules. The foundation anchorage system will be installed, levelled and secured to the blinding using steel box section stools.
- Installation of ductwork as required and erection of formwork around the steel cage and propping as required.
- Checking of the foundation anchorage system both for level and line will be conducted prior to the concrete being installed in the base. These checks will be passed to the turbine manufacturer for their approval.
- Following a curing period, where the foundation base will be covered to assist curing, formwork will be stripped off and stored for re-use.
- Backfilling the foundation with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set-aside during the excavation.

Depending on the choice of turbine manufacturer, the turbine transformer may be contained within the tower base or installed externally. In the event of a requirement to install the transformer outdoors, its foundation base will be about 2.5 m x 2.5 m x 0.3 m deep and will be constructed of lightly reinforced concrete and situated adjacent to the turbine on backfill material.

An earthing mat or electrode will be installed at each turbine base. It will comprise earthing rods and up to three concentric rings of bare stranded copper conductor. The extent of the earthing will be determined by testing of electrical resistivity.

3.7.2 Turbine Installation

Construction contractor's may adopt a "Just in Time" system of delivery to site with a number of turbines delivered in advance of erection or an early delivery system with storage of wind turbine components on site. Equipment will be shipped to Ireland either to an intermediate location, such as a shipyard, where it will be stored until required or for direct delivery to site. For just in time type delivery equipment will arrive on site the week it is required and turbine components will be delivered to the site on specialised long transporter vehicles.

Each turbine will be constructed by in-situ assembly of components carried out with the aid of a heavy lifting capacity main crane and a smaller capacity crane working in tandem.

Use of cranes will generally be as follows:

- A regular or crawler type crane of approximately 100 - 300 t capacity will be used for rotor builds, unloading hubs and parts stacking and single blade lifts.
- A 300 - 500 t capacity crane will be used for rotor builds when extra boom length required due to terrain / location problems. It will be used as a tail crane for tower sections and rotor lifts.
- A main lift crane of approximately 1,200 t capacity will be used for nacelle, bottom and top tower sections and rotor lift.

Each turbine will be erected over a 2-3 day period.

3.7.3 Commissioning

All individual wind turbine components and all electrical equipment will be the subject of factory testing prior to delivery to site. Following assembly of turbines and installation of all equipment, a period of commissioning and testing will follow.

The full duration of commissioning will vary with the development phase and is expected to be approximately 10 weeks for each phase, subject to suitable weather conditions, and this will be followed by fine tuning during the first three months of operation.

3.8 ELECTRICAL SUBSTATION

Each Electrical Substation in which Control Buildings and substations will be located will occupy a hard-standing area of approximately 8,432m². Each will include plinths to support electrical equipment including transformer and end-pylon cable ducts and other ancillary equipment. Each compound will be enclosed by a security fence, on which warning, project description and interpretation signage will be attached.

The Control Buildings will be single storey and will consist of a pitched roof supported on blockwork cavity walls on reinforced concrete strip footings. Hard finishes will be provided for the majority of floor areas throughout the buildings. These will provide durable surfaces that enhance the building environment and are easy to clean.

Protective floor finishing will also be provided. External doors and escape doors will generally comprise metal flush doors and mild steel frames.

The Grid Transformer will be delivered to the Electrical Substation on a multi-axle special purpose tractor and trailer transport that will distribute this load over eight or more axles, which results in acceptable loads.

Drainage arising from paved surfaces within the Electrical Substation and from transformer bunds will be discharged through an appropriate oil interceptor before entering the site drainage management system. Drainage from the station will pass through a settlement pond before discharge to overland flow.

Electrical Substation 1 will be constructed in Phase 1 and Electrical Substation 2 in Phase 2 of the development.

3.9 OPERATION AND MAINTENANCE (O&M) BUILDING

The operational and maintenance building will be constructed in Phase 1 of the project and will comprise a portal frame steel building on a concrete foundation approximately 31.2 m x 21.3 m with an external concrete storage area. Walls will consist of a 100mm block work outer leaf rendered to a smooth finish, cavity and 215mm internal block work leaf. External cladding will comprise Kingspan insulated panels or similar material. Windows will comprise powder coated double glazed aluminium. The O&M building will be located within a compound measuring 50.1m x 35.3 m surrounded by a 2.5m high palisade fence. Its construction is expected to take approximately six months. The construction will require:

- Excavation of foundation to a depth of 1.0m or suitable bearing stratum and pouring of concrete foundations
- The concrete will be protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from directly entering surface water drainage.
- Fixing of high tensile steel reinforcement will be in accordance with the designer's drawings and schedules. The foundation will be installed, levelled and secured to the blinding using steel box section stools.
- Installation of ductwork as required and erection of formwork around the steel cage and propping as required.
- Checking of the foundation both for level and line will be conducted prior to the concrete being installed in the base.
- Following a curing period, where the foundation base will be covered to assist curing, formwork will be stripped off and stored for re-use.
- Erection of the steel framework and construction of external and internal walls
- Backfilling the foundation with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set-aside during the excavation.
- As indicated in Chapter 2 (Section 2.5.13) a septic tank followed by a proprietary wastewater treatment system discharging to a raised percolation

bed will be provided to treat foul effluent from sanitary facilities provided within the O&M building.

3.10 VISITOR CENTRE

The Visitor Centre will also be constructed during Phase 1 of the development. It has been designed to cater for groups of up to 50 people with other occasional users of up to an additional 100 people. The building itself will reflect the shape of a wind turbine blade in its roof structure linking the centre to the site. It will consist of a building 76.5m in length and 10.5 metres in width along its main axis and will occupy a space of 762m2. The height of the building will vary between 7.65m and 8.75 m along its length. The outer walls will be clad with gabions of locally sourced rock with internal plaster rendered block walls.

It will provide exhibition areas, administration and sanitary facilities and a coffee shop and elevated coffee dock which will provide extensive views of the wind farm site. The coffee shop area will allow views ranging from the northeast to northwest through double glazed aluminium folding glass partitions allowing access to an external hardwood decked area. Above the coffee shop, the coffee deck on the roof will provide similar views and will be accessible both internally and externally. Parking for the visitor centre will be located to the southwest of the visitor centre and will provide bus, car and disabled parking facilities.

Construction of the visitor centre will entail the following:

- Excavation of foundation to a depth of 1.0 m and pouring of concrete
- The concrete will be protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from directly entering surface water drainage.
- Fixing of high tensile steel reinforcement will be in accordance with the designer's drawings and schedules. The foundation will be installed, levelled and secured to the blinding using steel box section stools.
- Installation of ductwork as required and erection of formwork around the steel cage and propping as required.
- Checking of the foundation both for level and line will be conducted prior to the concrete being installed in the base.
- Following a curing period, where the foundation base will be covered to assist curing, formwork will be stripped off and stored for re-use.
- Erection of the steel framework and construction of external and internal walls
- Backfilling the foundation with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set-aside during the excavation.
- Car parking area development using hardcore and or gravel
- As indicated in Chapter 2 (Section 2.5.13) a septic tank followed by a proprietary wastewater treatment system discharging to a raised percolation bed will be provided to treat foul effluent from sanitary facilities provided within the Visitor Centre

- A rainwater harvesting system will be constructed to provide general usage water for the visitor centre
- Construction of the visitor centre is expected to take approximately 12 months to complete.

3.11 METEOROLOGICAL MASTS

A total of six permanent meteorological masts will be erected on site. These will comprise a concrete foundation base 4m x 4m dimension and 2m deep. Lattice steel masts to a height of up to 120m to correspond with the hub height of the selected turbines for the project, will be erected on the foundation base. The works will include:

- Excavation of foundation to a depth to a depth of 3m and construction of a blinding layer.
- Fixing of high tensile steel reinforcement will be in accordance with the designer's drawings and schedules. The foundation will be installed, levelled and secured to the blinding using steel box section stools.
- Concrete pouring (32m3) and levelling. The concrete will be protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from directly entering surface water drainage.
- Following a curing period, where the foundation base will be covered to assist curing, formwork will be stripped off and stored for re-use.
- Erection of the steel lattice framework tower and installation of the meteorological equipment.
- Backfilling the foundation with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set-aside during the excavation.
- Commissioning of the meteorological mast equipment.

Three meteorological masts will be erected during Phase 1 of the development and three in Phase 2. Construction of each individual meteorological mast will take approximately four weeks.

3.12 SITE DRAINAGE

A comprehensive drainage and sediment control plan has been prepared for the development. The development will have a minimal impact on the hydrological regime of the catchment in which it is located. This is discussed in greater detail in Chapter 19.

The design principle on which drainage from the site will be managed is on the basis of flow separation, whereby separate surface water discharge from other areas on site outside the wind farm construction and construction / operational related drainage systems will be employed. The clean system will capture and manage runoff from areas of the site unaffected by the works and the construction / operational (C/O) system will accommodate runoff from the working areas of the site.

The key purpose of the drainage network will be to minimise the risk of the ingress of silt laden runoff from the construction and operational areas of the wind farm from entering the local streams. Drainage from construction and operational areas will be directed to settlement ponds before discharging to surface water flow. Interceptor drains will be put in place to divert surface water from areas where no construction activity is occurring away from the construction locations.

To maximise the effectiveness of the separation of clean and C/O flows, the clean drainage works, including diverter drains, drainage off the construction sites and settlement ponds will be installed immediately prior to the main earthworks activities related to the construction of site tracks, turbine foundations, crane hard stands, substations, operation and maintenance building, temporary concrete batching plant and visitor centre.

The design of the trackway construction is such as to minimise the impact on the natural drainage patterns by allowing surface drainage to pass under the new track at closely placed intervals, corresponding with existing natural drainage lines where possible.

To intercept the clean surface water run-off before it reaches the construction and operational parts of the site, cut-off drains will be installed on the up-gradient side of the access tracks and hard-standings. These will generally follow the natural contour of the ground at relatively low gradients and convey drainage to nearby low points where it will be culverted beneath the site tracks or area of hard-standing. The size of the cut-off drainage channel and associated culverts will reflect the respective catchments and rates of run-off to be found on the Oweninny site.

The Construction / Operational surface water system will incorporate the following features as appropriate:

- Vegetation filter strips
- Swales
- Settlement ponds
- Check dams
- Surface cross drains

The planned drainage design is presented in the Oweninny Wind Farm Planning Application Drawing Numbers QR32-0201-P-000-059 to QR320201-P-000-064.

3.13 ASSOCIATED WORKS

3.13.1 Tree Felling

Only limited tree felling (1.05 ha) will take place in Coillte forest plantation. This is required to facilitate widening of existing access tracks access to wind turbine sites

The tree felling will be the subject of an application for a Felling licence (LFL) to the Forest Service, whose policy requires that planning permission for the development be submitted in support of the application.

All tree felling will be undertaken by experienced operators using modern harvesting and forwarding machinery. Each tree will be cut at its base, as close to the ground as possible. It will then be debranched and processed into optimal lengths of log dependent on tree diameter and overall length to minimise wastage. Logs will be formed into piles based on size and will subsequently be removed to the existing forest road network prior to onward transport off site. Tree stumps will be removed as part of the excavation of e foundations and access track construction.

Recognised work practices as outlined in the following will be adopted:

- Forestry Harvesting and Environment Guidelines (Forest Service, 2000)
- Forestry and Water Quality Guidelines (Forest Service, 2000, updated 2009)

3.13.2 Borrow Pit

One borrow pit will be developed. Its location is shown on Figure 2.1. The borrow pit comprises an area of approximately 17 hectares and will be excavated to an approximate depth of 2m with an approximate volume of 340,000m3 of material for access track and crane hard stand construction. The soils on site are mostly cutover and cutaway peats broadly ranging in depth from 0 mm to 3 m. The borrow pit area is covered by a thin veneer of peat, ranging from 0mm to less than 100mm. This material will be scraped away and stockpiled adjacent to the borrow pit during material excavation. It will subsequently be disposed of within the borrow post excavation.

The proposed method of extraction will be wet excavation, and the water table in the borrow pit will not be pumped down to minimise the potential for impact on the overall site water table.

Excavated material will be stockpiled for dewatering to the southwest near the borrow pit as shown on Figure 2.1. Truck loading will occur immediately adjacent to the borrow pit area for transport to the stockpile area where they will subsequently be reloaded for construction requirements. Drainage control will be put in place around the stockpile area to minimise the impact of suspended materials entering water courses.

Use of the borrow pit will be strictly limited to meeting project needs. There is no intention that it be used on a commercial basis for other purposes during the project or afterwards. The use of the borrow pit is considered to be advantageous compared to drawing aggregate from an operational quarry in the local area since it reduces potential impacts on the local road network.

It is recognised that it is not possible to meet the project requirements from this borrow pit alone and it will be necessary to source additional materials externally and stone will be imported from suitable quarries.

The borrow pit will be dealt with as follows:

- Remove any existing vegetation, soil / peat and subsoil and stockpile separately beside the borrow pit, taking care that living vegetation is preserved by careful placement and that the various materials are not mixed.
- Following extraction of the material required for track construction, the borrow pit will be left as a pond in the area to naturalise.
- Appropriate works such as grading of the borrow pit sides will be carried out to form a natural low sloping edge which will allow natural revegetation to occur. This will also reduce the potential health and safety risk associated with water features of this nature.

- Warning signs will be erected with regard to the water depth and hazard posed by the pond.
- Health and Safety equipment will be provided at the ponds

The potential impact of the borrow pit excavation on the groundwater hydrogeology and its effect on the Bellacorick Iron Flush cSAC was a key concern raised by NPWS in its submission to An Bord Pleanála and at the oral hearing. On foot of the concerns raised additional clarification site investigation was undertaken prior to the oral hearing. This demonstrated that the proposed borrow pit is not connected to the flush recharge area or flush discharges and its development cannot alter the hydrochemistry of the water flowing towards the iron flush. Hence, there will be no impact on the iron flush from the borrow pit operation. This and similar issues were dealt with in detail in the Witness Statement of Michael Gill of Hydro-Environmental Services Ltd submitted to the board at the oral hearing.

3.13.3 Material import

3.13.3.1 Fill and aggregate

In addition to the material available from the on-site borrow pit crushed stone and other aggregates will be required for the access track construction, hardstands, concrete batching plant operation and the other major elements of the project. Approximately 403,000 m^3 of stone in total will be required to complete construction of phase 1 and Phase 2 of the wind farm. The excess requirement not met by the borrow pit will be imported to the site spread over the three project phases and is likely to be provided by local quarries in the area.

3.13.3.2 Concrete

It is unlikely that the proposed temporary batching plant would meet all of the construction needs and import of concrete from external sources is likely to be a construction requirement. In the event of breakdown of the proposed concrete batching plant concrete will be imported from local suppliers to the site along the N59. In the worst case scenario all of the concrete would need to be imported to site.

3.13.3.3 Steel

Steel reinforcing bar will be imported to site for concrete piles, turbine and building foundations from external suppliers.

3.13.3.4 Miscellaneous

Blocks, bricks, glass sand and general construction materials will be imported to site for construction of substations, O&M building and Visitors Centre

3.14 CONSTRUCTION WASTE

On a project of this scale it is not unusual to generate waste materials which must be disposed of in a proper and safe manner. Construction waste will arise during each construction phase of the project and can arise from activities associated with project construction such as concrete use to temporary material use such as contractors' site compounds. Wastes can arise during construction, operation and decommissioning also. The main items of construction waste and their sources are set out in Table 3.4.

Table 3.4: Construction Waste and their Sources

Waste	Source
Canteen and office waste	Staff welfare facilities and site offices including foul water storage facilities
Excess fill material	Temporary surfaces to facilitate construction such as contractors temporary compounds and the temporary batching plant hardcore areas
Concrete	Remaining from turbine or pile construction or arising from the batching plant operations and building construction
Concrete blocks and miscellaneous building materials	Remaining from construction of the Visitor Centre, O&M building, control buildings and temporary office accommodation
Timber	Temporary supports, shuttering and product deliveries. Remaining from building construction and temporary works.
Steel	Steel that is unused in reinforced concrete structures
Fuel, Oils Greases and Hydraulic Fluids	Unused quantities at end of construction period or arising from clean-up of spill incidents
Electrical waste such as waste cables, excess conductor and electrical fittings	Excess materials from overhead line and underground cable construction and other building construction on site.

All wastes will be managed in accordance with applicable legislation and recognised best practice within the construction industry. Where possible, waste materials will be recycled on site into alternate construction areas. Where this is not possible waste materials will be dealt with as follows:

- Non-hazardous Office & Canteen Waste: A licensed waste disposal contractor will transport this waste to a licensed landfill.
- Construction Waste: This waste will be stockpiled on site and will be transported to a licensed landfill for final disposal.
- Steel: All waste steel reinforcing bars will be stockpiled. Unused material may be gathered for reuse elsewhere and scrap items will be collected for recycling by a scrap metal merchant.
- Timber: Timber waste will be minimised through reuse of shuttering, etc. throughout the project. At completion it is expected that the majority of timber will be gathered for re-use elsewhere at a different site.
- Fuel, Oils Greases and Hydraulic Fluids: Waste will be stored on site in labelled containers and will be collected by a licensed oil recycling contractor as necessary.

- Electrical waste: All electrical waste will be stored on site in labelled containers and will be collected by a licensed recycling contractor as necessary.

Records will be maintained of the quantity of waste generated.

3.15 REINSTATEMENT

The process of backfilling the excavated soil and restoring surface vegetation along access track margins, over the margins of hard-standing areas, adjacent to turbine foundations and for landscaping purposes around the Visitor Centre, O&M building and electrical transformer compounds, will commence as soon as the imperative tasks in the construction process are complete.

Soil will be backfilled outside the drainage channels along track-sides and vegetated sods replaced over the surface, bedded-in, re-graded, etc., to re-constitute a stable and settled ground surface on which the natural vegetation can recover and will be resistant to erosion.

3.16 MITIGATION OF IMPACTS

Incorporation of measures to mitigate environmental impacts is inherent in the planning and design of wind farms such as at Oweninny. This extends to all phases of the wind farm project from site selection and the concept phase, including consideration of alternatives, through development, pre-planning and design phases to construction, operation and decommissioning.

The hierarchy in mitigating environmental impacts in the Oweninny Wind Farm project has been avoidance, reduction and remedy. The objective of the development has been to maximise the sustainable wind energy capture of what is a very suitable site for wind energy development without causing significant adverse environmental impacts. The design of Oweninny Wind Farm meets the primary objective of avoidance of impacts on environmental resources.

A consideration in all projects is to manage the scope of project activity necessary to achieve the project objectives in a manner that is environmentally responsible. At Oweninny impacts on all aspects of the environment have been minimised by selection of the proposed scheme over the multiplicity of possible alternatives.

Key mitigating actions during design, construction and operation of the wind farm include the following:

- Siting and design of construction of turbines to avoid potential impact on the designated areas of the Bellacorick Iron Flush and Lough Dahybaun.
- Siting of turbines, access tracks, substations and other buildings to avoid intact bog remnants and minimise impact on bog remnants previously drained as part of the peat harvesting operations.

- Siting of turbines outside communication corridors between telecommunication and other transmission masts to ensure no interference with these signals.
- Siting of turbines at least one kilometre from the nearest occupied dwelling
- Integration of the development into the existing bog rehabilitation works already completed on the site
- Design of foundations for the wind turbines will be undertaken by qualified structural engineers who have successfully designed foundations for wind farm developments in similar environments.
- A full construction management team will be deployed on site in accordance with routine site construction procedures. This team will consist of a Resident Site Manager and Assistant Engineers as appropriate.
- All construction works will be carried out under appropriate supervision. Works will be carried out by experienced contractors using appropriate and established safe methods of construction. All requirements arising from statutory obligations, including the Safety, Health and Welfare at Work Act and associated regulations, will be met in full.
- All forest felling will be carried out in accordance with the Forest Service Guidelines.
- The batching plant operation will be carried out in a strictly controlled manner with regular maintenance of dust control systems and aqueous discharges.

Bord na Móna has a long history of peat management in Ireland and of its contribution to the energy needs of the country. It is mindful of its obligations to protect the environment and the wellbeing of the local people within its operational area.

ESB has had a long history of responsible operation of power plants throughout Ireland and is mindful of its obligations in regard to environmental protection also.

3.17 EMERGENCY RESPONSE PLAN

Due care and precautions will be taken as prescribed in the EIS in the construction, operation and decommissioning of the wind farm. However, in addition to this an emergency response element is being included.

The emergency response process makes clear how and who will be alerted in the event of clear and immediate risk, or serious incidents, and will ensure that appropriate mitigation can take place quickly. An emergency point of contact is provided and it is intended that this will be manned by appropriately qualified personnel during all times of the site’s construction, operation and decommissioning.

An Emergency Response Plan has been prepared and was included as Appendix 6 of the Oweninny wind farm application. A copy of this Plan will be provided to the construction contractors, site supervision personnel and operational personnel. It will be updated on annual basis to allow for changes in personnel in relevant organisations.

4 ALTERNATIVES

The development of Phase 1 and Phase 2 only constitutes one alternative option to the proposed Oweninny wind farm. It would occupy a portion of the same site and would require the erection of 61 wind turbines with a rated output of 172 MW which would be exported via the existing Bellacorick substation and existing overhead lines. Alternatives to this option that are considered should be capable of successfully achieving the objectives of the development within a reasonable period of time, taking into account economic, social, environmental and technological factors.

4.1 Alternative Electricity Generation

4.1.1 Benefits of Renewable Energy

Current demand for electricity generation capacity in Ireland still remains predominantly supplied by fossil fuel plants and this is likely to continue into the short term

However, renewable and alternative sources of power continue to play an increasingly important role in meeting power needs in the future. The development of renewable sources of energy is in line with EU and Government policies, which have strong public support.

The Strategy for Renewable Energy 2012 – 20207 states that

"the development of renewable energy is central to overall energy policy in Ireland. Renewable energy reduces dependence on fossil fuels, improves security of supply, and reduces greenhouse gas emissions creating environmental benefits while delivering green jobs to the economy, thus contributing to national competitiveness and the jobs and growth agenda"

Onshore wind power is recognised as one of the most promising renewable energy sources for electricity generation in Ireland. Wind energy currently represents by far the most significant viable option for electricity generation from renewables. The Government's (Department of Communications, Energy and Natural Resources) consultation paper (Renewable Electricity Support Scheme - Technology Review Consultation – July 2015) on support to renewable energy states

"In terms of progress to the 2020 target, in 2014, provisional figures indicate that 22.6% of electricity, 6.7% of heat and 5.2% of transport, were met from renewable sources. To

date wind energy has been the largest driver of growth in renewable electricity in Ireland. In 2013, 18.2% of Ireland's electricity demand was met by wind generation".

This is also evident in Grid 25, EirGrid's strategy for the balanced and sustainable development of Ireland's transmission system, between now and 2025. The strategy will facilitate independent power production and renewables helping to secure Ireland's energy needs into the future.

An independent study[2] of the Irish public's attitude towards the development of wind energy indicated a high level of support for developing more sources of renewable energy in Ireland, making it the preferred option among energy policies considered within the study.

More recently, The National Social and Economic Council (NESC) published its report[3] on building community engagement and social support for wind energy in Ireland:

"Ireland faces an extraordinary challenge to move its energy system from one primarily based on fossil fuel to one dominated instead by renewable energies. There is potential for wind energy to play a central role in Ireland's transition to a low-carbon economy by 2050. With 180 wind farms currently in operation with 2080MW of installed capacity from over 1,300 turbines, wind energy in Ireland has developed considerably over the last twenty years.

Irish people have generally been supportive of wind-energy growth and of electricity infrastructure, but recently there has been a more critical public mood. This signals something of a sea change in social support for wind energy and related infrastructure."

There is a clear need to increase community engagement at national level to ensure that the importance of wind energy in achieving Irelands renewable energy target of 40% for electricity is achieved, a key element in combating dangerous climate change. There are few viable alternatives available that underpin the Irish Government policy leading towards decarbonisation by 2050.

Ireland's dependence on a finite supply of imported fossil fuels raises questions over the security of supply in future years as reserves of fossil fuels are depleted or costs rise significantly. This brings the need for locally generated renewable energy even more sharply into focus.

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[2] Attitudes Towards the Development of Wind Farms in Ireland, SEI (now SEAI), 2003

[3] Wind Energy in Ireland, Building Community Engagement and Social Support, National Economic and Social Council, July 2014 - http://www.nesc.ie/en/publications/publications/nesc-reports/wind-energy-in-ireland-building-community-engagement-and-social-support/

The main benefits of developing alternative energy sources are seen as reducing air emissions from burning fossil fuel with consequent climate change effects as well as complying with international agreements on limiting such emissions. The utilisation of indigenous resources is also considered of primary importance.

The above are now reflected in Ireland's energy policy and it is evident that the renewable energy sector is strongly supported by Government policy.

4.1.2 Project Context

Wind power has become an important source of energy worldwide, mainly due to the following: environmental considerations; the search for energy alternatives and for a reduction in energy dependence; the increasing costs of oil and other fossil fuels and the impacts of climate change coupled with the need to decarbonise world economies.

The evolution of modern wind turbines is a story of engineering and scientific skill, coupled with a strong entrepreneurial spirit. In the last 20 years, turbines have increased in size by a factor of 13 (from 300 kW to 4,000 kW and beyond), the cost of energy produced has reduced by a factor of more than five and the industry has moved from an idealistic fringe activity to an acknowledged component of the power generation industry. At the same time, the engineering base and computational tools have developed to match machine size and volume.

4.1.2.1 Scenario Worldwide

As shown in Figure 4-1 rapid developments in technology have led to turbines of up to 4,500 kW capacity and greater now being available worldwide. The deployment of larger wind turbines is reflected in countries having well established wind energy networks, where new, more efficient and higher rating turbines are replacing older turbines. There is also a general industry trend to equip turbines with increasingly larger rotors.

Worldwide wind generating capacity continues to increase and stood at approximately 369.6GW in 2014, more than 51GW of wind energy was grid connected in 2014 alone. Worldwide growth is shown in Table 4.1.

Table 4.1: Global Deployment of Wind Power

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Installed Capacity (MW)	74,100	93,900	120,300	158,700	198,000	238,000	282,000	318.644	369,600
Annual Growth	25.4%	26.7%	28.1%	31.9%	24.5%	20.2%	18.5%	12.9%	15.9%

Source Global Wind Report Annual Market Update 2014 (Global Wind Energy Council) http://www.gwec.net/GWEC_Global_Wind_2014_Report_LR

An amount of 11,791 MW of new wind energy was installed in the EU in 2014 representing an investment of up to €18.6 billion. There is now 128.8 GW of installed wind energy capacity in the EU: approximately 120.6 GW onshore and just over 8 GW offshore (February 2015).

The wind power capacity installed by the end of 2014 would, in a normal wind year, produce 284 TWh of electricity, enough to cover 10.2% of the EU's electricity consumption.

Alta Wind Energy Center in California, USA is the world's largest with a total installed capacity of 1,320 MW.

The Fântânele-Cogealac Wind Farm is Europe's largest at 600 MW.

4.1.2.2 Irish Scenario

Ireland's first commercial wind farm at Bellacorick, Co. Mayo is now more than 23 years old and there has been sustained growth since then in the deployment of wind power in Ireland. Growth over the past decade is shown in Figure 4-2.

EirGrid, the Irish transmission grid operator, has reported that the installed wind capacity in Ireland was 2,230 MW at end March 2015 with a further 627 MW installed in Northern Ireland (SONI) giving a total installed capacity of 2,857 MW on the island.[4]

The highest recorded wind power output peaked on 21st December 2014 with a total of 2,315 MW on an all island basis, sufficient to provide electricity to some 1,500,000 homes (based on IWEA estimates of 1 MW meeting demand of 650 homes).

The Irish target for the renewable energy share of gross electricity consumption is 40% by 2020, estimated as being equivalent to about 5,100 MW of installed wind energy capacity. By June 2015, Ireland and Northern Ireland jointly had approximately 3,025 MW of installed renewable energy capacity, enough renewable generation to supply 1.97 million homes.

The share of electricity generated in the Republic of Ireland (RoI) from renewable energy sources (RES-E) in 2013 was 20.9%5 of gross electricity consumption. Over 80% of renewable electricity generated came from wind power, with installed generating capacity reaching 1,941 MW. Wind energy accounted for over 13% of all electricity generation in 2011, hydro accounted for 2.6% and the remaining 2% was from bio-energy sources (mainly biomass co-firing and landfill gas).

Wind power installed capacity in Ireland reached 2,230MW in March 2015[6].

Renewable electricity generation avoided the combustion of approximately 963 thousand tonnes of oil equivalent of fossil fuels, displacing imports of €300 million.

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[4] http://www.eirgrid.com/media/All-Island_Wind_and_Fuel_Mix_Report_March_2015.pdf
[5] SEAI, Energy in Ireland, Key Statistics 2014
[6] EirGrid, All Island Wind and Fuel Mix Report, March 2015

Some 2.9 million tonnes of CO_2 emissions were avoided through renewable energy use in all sectors, of which 60% (1.74 million tonnes) was due to wind.

The fuel mix for electricity supplied to the All-Island electricity market in 2014 is presented in Table 4.2. These represent the latest published figures from the CER[7]. The fuel-mix of suppliers in Ireland is calculated as required by Regulation 25 of S.I. No. 60 of 2005 which transposes Article 3.6 of Directive 2003/54/EC.

Table 4.2: Fuel Mix for All-Ireland Electricity Generation 2014

Fuel	Coal	Gas	EU Fossil	Peat	Other	Renewables
Contribution	16%	42%	0%	7%	0%	35%

Ireland has an abundant wind energy resource and almost the entire country has either an excellent or very good wind energy resource, as indicated in Figure 4-3. Ireland has the potential to generate the cheapest wind energy in the whole of Europe.

Apart from a small area in the south of France, only Ireland, Denmark and Scotland have substantial areas of land where the wind speeds at 50 m above ground level, on open plains, are above 7.5 m/s. However, Denmark is relatively flat, and so derives minimal benefits from the enhanced wind speeds on hilltop sites. Wind farm capacity factors in the range 30-36%, or above, may be expected in Ireland. At Oweninny the capacity factor is predicted to be in the range 30 to 35%.

Mayo County Council was a leader in the establishment of the Mayo Energy Agency in 1998 and has been supporting it ever since. The Agency's aim is to support the development of sustainable energy in Co. Mayo and beyond.

4.1.3 Other Renewable Energy Resources

Wind is the world's fastest growing source of energy. Other renewable energy resources include hydro, solar, biomass, tidal, wave and geothermal. The current status of these is reviewed briefly here.

Hydro - There are no further suitable large and medium-sized impoundment hydro generation resources that could be developed in Ireland based on natural rivers and lakes. While a number of small such resources remain, it is not possible that their development could ever present anything other than a minor increase in power generation capacity. Pumped storage such as that operated by the ESB at Turlough Hill

[7] Fuel Mix Disclosure and CO_2 Emissions 2014, Commission for Energy Regulation, Aug 2015

and as proposed at Glinsk mountain in North Mayo could offer storage capacity for both renewable and conventional energy during off peak periods but are not themselves primary power producers.

Solar - Solar power may be used in either direct heating applications or direct conversion of radiation to electricity by the use of photo-voltaic cells. However, for large applications, its costs remain very high. Feasibility studies continue in areas of high insolation and it would be reasonable to expect commercial development for significant energy outputs to occur first in such areas. This has not yet happened and at present solar power is not a serious option for significant electricity generation in Ireland.

Biomass - Biomass energy can be obtained from the combustion of any organic material that is grown and harvested on a regular basis. Suitable materials include forestry and saw mill waste and specially grown short rotation forestry. Edenderry Power Station, owned by Bord na Móna, is already co-firing biomass with peat and is targeting having a 30% co-firing rate by 2015. A proposal by Mayo Renewable Power exists to build a 50 MW (net) biomass High Efficiency CHP plant located on the former Asahi site in Killala, Co. Mayo. When developed it would be Ireland's largest independent biomass power plant. In operation, this plant would propose to use virgin biomass (i.e. untreated and uncontaminated clean wood and willow). The fuel would be supplied from a variety of sources including locally grown willow, spruce from local forestry and forestry thinnings along with imported supplies. Biomass use in Ireland is mainly for heat production associated with industry. Although importation and use of biomass for energy production is increasing globally there is significant debate centred on the sustainability of biomass for energy production.

Tidal - The generation of electricity from tidal power has been under assessment for more than 50 years and various schemes are proposed from time to time. ESB International, which is part of the ESB group of companies, was an investor in a pioneering energy project that installed the world's first commercial scale tidal power generating device, Seagen, in Strangford Lough, Northern Ireland. Locations with naturally high tidal ranges are required and those available in Ireland are generally 2 - 4m, which is considered modest. Such schemes are highly capital intensive and further developments at Irish locations will await successful operational data from this pilot installation. The Department of Communications Energy and Natural Resources Offshore Renewable Energy Development Plan (OREDP) identifies zones around Ireland suitable for ocean energy. The plan indicates that the tidal resource is very limited in contrast to wind and wave[8].

Wave - There has been considerable research on wave power and several wave energy test sites have been constructed internationally, e.g. the European Marine Energy Centre (EMEC) in the Orkneys. To obtain appreciable power outputs, installation in the most active and open sea areas is needed. These areas present very challenging environments to structures and to mechanical and electrical equipment and significant testing of devices at differing scales is required before commercial scale developments can occur. Prototype wave energy converters have been deployed in Scotland, Spain, Portugal and Ireland (Pelamis, Oyster, Wavebob and Ocean buoy for example) for short duration periods. However, to date, wave power has not been demonstrated to be technically feasible or commercially viable on a large scale. ESB has worked closely with the ocean energy team in the Sustainable Energy Authority of Ireland (SEAI) and the Marine Institute to develop a full scale wave energy test site off the west coast of Ireland at Belmullet in County Mayo. Termed the Atlantic Marine Energy Test Site (AMETS) it will provide a grid connected wave energy converter test facility for full scale devices. The draft foreshore lease for this facility was issued in 2014 and the final lease is expected in 2015[9]. Significant research continues as evidenced by the extent of interest at the recent International Conference on Ocean Energy 2012 (ICOE) hosted by SEAI in the Convention Centre in Dublin. The ESBI Ocean Energy Group is also active in this field, through the Westwave Project - a proposal to develop a pilot wave energy array off the west coast of Ireland10. While test installations are being further deployed and wave energy converter testing continues, it is not expected to contribute significantly to power generation in the immediate future.

Geothermal - Geothermal power is exploited in many locations throughout the world, where reservoirs of hot or superheated water exist beneath the earth's surface. Most of these systems are installed at locations having reservoirs of water at temperatures in excess of 100 °C. Such high temperature reservoirs have only recently been identified in Ireland and commercial exploitation of these resources is still at the concept stage.

[8] Department of Communications, Energy and Natural Resources, Offshore Renewable Energy Development Plan, February 2014
[9] http://www.seai.ie/Renewables/Ocean_Energy/Belmullet_Wave_Energy_Test_Site/
[10] http://www.westwave.ie/

4.1.4 Role and Benefits of Wind Energy

Climate change, security of electricity supply, and price stability are amongst the factors supporting the main rationale underpinning the need for renewables.

The case for renewable energy development in Ireland is heightened by the high dependency on fossil fuel sources for primary energy consumption. More than 88% of Ireland's total energy requirement is still supplied in the form of fossil fuel.

In Ireland, wind energy, because of its developed technology and the large resource available, is seen as making the most significant contribution to renewable energy developments. Ireland has a large offshore and onshore wind resource. Onshore wind is only effectively constrained by the amount of non-firm power the National Grid can accept. This picture will undoubtedly change with the development of Grid 25 by EirGrid post 2020.

Both onshore and offshore wind farms will have roles to play in renewable energy developments. Offshore wind farms remain considerably more expensive to construct than their onshore equivalents with average capital costs of installation being greater by a factor of more than two, and have higher average operating costs by a factor of approximately 50%[11], due to the obvious difficulties of access for maintenance, etc. In time, problems associated with offshore wind will be solved. However, a need to develop wind farms at suitable onshore sites remains.

Wind is the world's fastest growing source of energy. In terms of available technology, it is one of a few viable renewable energy sources currently available in Ireland. This, rather than being a disadvantage, plays to the country's strengths, as it has some of the highest mean average wind speeds in Western Europe.

Wind power provides more benefits than just affordable clean energy. The prices of wind-generated electricity are stable and not subject to the price volatility of fossil fuels. Additionally, since it is inexhaustible, wind offers long-term energy security that electricity derived from non-renewable fossil fuels cannot.

A frequent misunderstanding related to wind is the implication of its variability. In fact, with modern meteorology, wind is very predictable over the time scales relevant for balancing the electricity system.

It is also important to distinguish between capacity and production. Capacity is the amount of installed power in a region, and is measured in MW. Production is how much

[11] Renewables 2015 Global Status Report; REN21 Renewable Energy Policy Network

energy is produced by that capacity, and is measured in MWh. While wind power does not replace an equal amount of fossil-fuel capacity, it does replace production – for every MWh that is produced by a wind turbine, one MWh is not produced by another generator.

The carbon penalty for having additional conventional plant on reserve duty to compensate for the variability of wind (which is in any case usually predictable) is very small.

Increasing the proportion of wind power in the electricity system does not require greater back-up capacity, as is often believed, but it does slightly increase the cost. The greater the proportion of wind on the grid the lower its capacity value and the lower the quantities of conventional technology it displaces. Nevertheless it continues to reduce carbon emissions.

4.2 ALTERNATIVE SITES

4.2.1 Context

The criteria applied in determining site suitability for wind energy development include wind resource, established and future land use, environmental conservation designations, ease of access, proximity to electricity grid and ease of site development.

A number of siting criteria are applied. These are generic in nature but are intended to be flexible in relation to location of a proposed project, i.e. the acceptability of scale and type of development is dependent on location and land use characteristics of the area. The general criteria for sites considered suitable for wind farm development are as follows:

- Estimated wind speed of at least 7.5 – 8.5m/s at hub heights up to 100m
- Proximity to a connection point with the national electricity grid.
- Reasonable road access.
- Terrain and ground conditions suitable for construction.
- Low potential for electromagnetic interference.
- Sufficient distance from residences to minimise amenity impacts.

In pursuit of ESB's policy on renewable sources of energy, its companies engaged in wind energy development have identified and evaluated many sites in different counties throughout Ireland for their suitability for wind energy development.

Some of the wind energy projects for which planning applications have been made over the past number of years and which are additional to Oweninny are identified in Table 4.3.

Table 4.3: Planning Applications for Wind Farms – Republic of Ireland

Location – Republic of Ireland	
• Ballinvully, Co. Mayo	• Grouselodge, Co. Limerick
• Boolynagleragh, Co. Clare	• Grousemount, Co. Kerry
• Bradlieve, Co. Donegal	• High Street, Co. Clare
• Bunkimalta, Co. Tipperary	• Moanmore, Co Clare
• Cappawhite, Co. Tipperary	• Moneypoint, Co. Clare
• Castlepook, Co. Cork	• Raheenleagh, Co. Wicklow
• Coolberrin, Co. Monaghan	• Rossacurra, Co. Carlow
• Croaghbrack, Co. Donegal	• Tullynahaw, Co. Roscommon
• Garvagh Glebe, Co. Leitrim	• Woodhouse, Co. Waterford
Location – Northern Ireland	
• Carrickatane, Co. Derry	• Eglish, Co. Derry
• Clunahill, Co. Tyrone	• Gortmonly, Co Derry
• Crockdun, Co. Tyrone	• Meenakeeran, Co. Tyrone

A key component of Bord na Móna's corporate strategy is to actively diversify into renewable energy particularly into wind energy generation development. It was involved in developing Ireland's first commercial wind farm at Bellacorick in 1992 and is the majority shareholder in this farm since 1997. It continues to operate and maintain this farm as it has done since its commissioning.

Bord na Móna recently constructed two wind farms in the Midland region with installed capacities of 80 MW and 40 MW. The sites for these farms consist of cutaway and cutover peatland and site conditions, both of the peat and underlying soils, are similar to those at Oweninny. The turbines being installed in both sites are 3 MW capacity and have blade tip heights of 150m.

Bord na Móna has other sites with significant electricity generating capacity in the grid connection application process and with its landbank of some 80,000 ha has identified further sites that can contribute to either the domestic electricity market for renewable energy or the emerging export market. These sites are spread in particular throughout the midland counties where the majority of the Bord na Móna landholding is located.

4.2.2 Site Suitability

4.2.2.1 Wind Speed

Wind speed, on which the power achieved is highly dependent, is critical to the viability of wind farm developments. The power available from the wind is a function of the cube of the wind speed. All other things being equal, a turbine at a site with an average wind speed of 5 m/s will produce nearly twice as much power as a turbine at a location where the wind averages 4 m/s. Doubling the wind speed increases the power output eightfold, whereas doubling the turbine site area only doubles the power. In this regard, the windiness of the site is a key development parameter.

Wind classes determine which turbine is suitable for the normal wind conditions of a particular site. These are mainly defined by the average annual wind speed (measured at the turbine's hub height), the speed of extreme gusts that could occur over 50 years, and how much turbulence there is at the wind site.

The three wind classes for wind turbines, are defined by an International Electrotechnical Commission standard (IEC), and correspond to high, medium and low wind.

Table 4.4: Wind Classification

Turbine Class	IEC I	IEC II	IEC III
Annual average wind speed	10 m/s High Wind	8.5 m/s Medium Wind	7.5 m/s Low Wind
Extreme 50-year gust	70 m/s	59.5 m/s	52.5 m/s
Turbulence Classes	A 18%	A 18%	A 18%

Monitoring of wind speed has shown that long-term wind speeds at Oweninny classify the site as falling within IEC Class II at a high level. Thus, subject to adequate turbine height, an economically viable wind farm is feasible at this site.

4.2.2.2 Size and Topography of Site

The site must be of sufficient size to accommodate a wind energy development that is commercially viable to the developer. A large open site is required for the siting of wind turbines and wind turbines require sufficient distance between each other to ensure that the blades of one operating turbine will not interfere aerodynamically with the wind take of adjacent turbines.

In addition, proximity of residences in the context of protection of residential amenities is a significant factor in site selection. At Oweninny, turbines are a minimum of 1 km from any residence.

The local topography at any wind farm site should be such that the wind that crosses the site does not become overly turbulent.

The site at Oweninny is suitable on grounds of its size and local topography.

4.2.2.3 Other Factors

The other favourable characteristics of the Oweninny site in relation to wind energy generation include the following:

- Ground Conditions: The ground conditions are suitable for civil engineering construction.
- Established and Future Land Use: The site is already the location for the country's first commercial wind farm. Furthermore it also already has planning permission for a wind farm layout of 180 wind turbines. The land comprises cutover and cutaway bog with some areas undergoing

rehabilitation to enhance ecology on the site. Existing land uses will not be affected and the proposed development will not compromise alternative future land uses.

- Environmental Impacts: While some minor impacts are inevitable, the construction of a wind energy project is fully compatible with the existing heavily modified environment at the site. The site has also been designated for wind energy development in the Mayo County Council Renewable Energy Strategy

4.2.2.4 Renewable Energy Strategy

The site is designated as Priority Area for wind energy development in the Mayo Renewable Energy Strategy

4.2.3 Previous Assessments of Site Suitability

The Planning Permission granted on appeal by An Bord Pleanála indicates that this site is suitable for wind energy development.

4.2.3.1 Mayo County Council

The Planning Consent on the previous application (Planning Register Reference P01/2542) noted as follows:

- Having regard to:
  a. National Policy with regard to development of sustainable energy sources;
  b. The general suitability of the site for a wind powered electricity generating facility due to the wind resource available;
  c. The nature and extent of existing land use and the proposed re-use of industrialised peat workings;
  d. The Guidelines for Windfarm Development published by the DoEHLG, September 1996,
  e. The nature of the landscape;
  f. The proximity of a number of European sites as defined in the Planning and Development act 2000 and
  g. The need to ensure adequate separation distance of the proposed turbines from any inhabited dwelling.
- It is considered that, subject to compliance with the conditions set out in the Second Schedule, the proposed development would not be unduly detrimental to the area, would not adversely affect the integrity of European Sites in the vicinity, would not seriously injure the visual amenities in the area, would not seriously injure the amenities or values of residential properties or farms in the vicinity or be otherwise contrary to the proper planning and development of the area.

4.2.3.2 An Bord Pleanála

The Inspector’s Report on the previous application (An Bord Pleanála Reference R 131260) recommended as follows:

- Having regard to:
  a. The national policy with regard to development of sustainable energy sources;

b. The guidelines issued by the Department of the Environment, Heritage and Local Government in 1996 on Windfarm Development
c. the nature of the landscape;
d. the location of suitable ESB apparatus for power connection
e. the available infrastructure associated with the existing windfarm and
f. the separation distance of the proposed turbines from any inhabited dwelling.

It is considered that, subject to compliance with the conditions set out in the Second Schedule, the proposed development would not seriously injure the visual amenities or landscape character of the area, would not seriously injure the amenities or property values of residential properties or farms in the vicinity, would not be prejudicial to public health or be otherwise contrary to the proper planning and development of the area.

The Inspector's assessment was upheld by the Board.

4.2.4 Summary

The site at Oweninny is a suitable site for wind energy development and is designated within the Mayo Renewable Energy Strategy as a Priority Area for wind energy development.

4.3 ALTERNATIVE CONFIGURATIONS AND LAYOUTS

4.3.1 General Approach

The objective of the development is to maximise the sustainable wind energy capture of what is a very suitable site for wind energy development without causing significant adverse environmental impacts. It is not just sufficient to capture the wind energy, it must also be exported to the national grid. Energy generated by the Phase 1 and Phase 2 only option can be exported directly to the grid via the existing Bellacorick substation and the existing 110kV overhead lines in the area. Only minor modifications to the Bellacorick substation are required. Hence, this option will allow the wind potential of this site to be utilised to the maximum potential of existing grid availability in the area.

Wind turbine technology offers a range of power ratings from a few kilowatts (kW) up to several Megawatts (MW or thousands of kW). The possibility of installing a larger number of these smaller turbines exists as the site holds planning permission for a wind farm development comprising 180 wind turbines of a size that would produce between 1.5 and 2.5 MW each. However, it is believed that an arrangement of a greater number of smaller capacity machines offers no significant advantages in visual impact terms and that visual impact is minimised by installing larger but fewer wind turbines. From an aesthetic point of view, larger wind turbines offer an advantage in the landscape because they generally have lower rotational speed than smaller turbines. Large turbines therefore do not attract the eye in the way that faster-moving objects generally do.

Wind turbines have generally grown taller and more powerful. Rapid developments in technology have led to turbines of up to 7.5 MW capacity (Enercon -126) now being commercially available. The deployment of larger wind turbines is also reflected in countries, such as Denmark, that have well established wind energy networks. New, more efficient and higher rating turbines are replacing older turbines. There is also an industry trend to equip turbines with increasingly larger rotors, e.g. Siemens have developed a 3.6 MW turbine with 120m rotor diameter and a 6MW turbine with 150m rotor diameter for offshore wind farms.

Turbines of approximately 2.5 - 3.5MW capacity as proposed are now readily available and many manufacturers are now offering turbines of this size. They are intrinsically more efficient than smaller machines and are usually able to deliver electricity at lower cost. This is because the costs of foundations, access tracks, electrical grid connection plus a number of components in the turbine, e.g. electronic control systems, are largely independent of the size of machine. Key advantages are as follows:

- The minimum number of turbines is deployed to generate the highest energy output.
- The minimum development footprint is required as fewer turbines need to be deployed to fulfil grid connection capacity.

A development of lower capacity , which would not match the grid availability, would be wasteful of resources at a site capable of sustaining a project of the proposed size with minimal increased impact on the local environment.

4.3.2 Alternative turbine heights

Different turbine heights have also been assessed as part of the landscape and visual impact assessment, see Chapter 11. Zone of Theoretical Visibility (ZTV) maps provided as part of the Oweninny Wind farm application were used as a tool to compare the visual effects of two different turbine height options within the study area. The following turbine dimensions were compared:

- 120m hub height
- 176m blade tip height

and

- 100m hub height
- 150m blade tip height

Very little difference between these two options in terms of the extent of visibility was observed. The larger turbines will appear slightly taller than the smaller turbines in short to middle distance views within a radius of up to 15km from the wind farm site. The taller turbine option will result in slightly more areas experiencing visibility of the wind farm in middle and long distance views to the east, north and west of the wind farm site.

Therefore in conclusion, the taller turbine option results in slightly more areas experiencing visibility of the wind farm. However, where views are available, there would be no significant difference in the visual effects of the two options that were assessed. Similarly, there is no significant difference in the landscape effects of the two assessed turbine height options.

The ZTV maps have been amended to reflect the Phase 1 and Phase 2 development only and are discussed in more detail in Chapter 11 the Landscape and Visual Assessment.

4.3.3 Approved and Proposed Layout

4.3.3.1 Approved Layout

The arrangement of the turbines on the entire Oweninny site initially envisaged a development comprising 210 wind turbines in a fixed grid layout and this was the basis for the application for Planning Permission (Ref.01/2542) to Mayo County Council in 2003. This layout arose from consideration of a number of criteria, as follows:

- Existing linear uniform drainage network on the site
- Land ownership boundaries and locations of residences within the surrounding area,
- Critical spacing and accepted good design practice, taking into account site topography, predicted wind speeds and prevailing wind direction, wind turbulence and wake effects of one turbine on another.
- The turbines must be a minimum distance apart and this accounted for the extent of the land area required to accommodate the number of turbines of the size and type proposed. Spacing of turbines takes into account the direction of the prevailing wind, which is from the quadrant south-west through north-west. There are different separation requirements in relation to the alignment of turbines with a greater separation being necessary in the direction of the prevailing wind as opposed to perpendicular to it.

The layout adopted represented a compromise between the above factors, taking into account the necessary separation of turbines to minimise energy losses through wind shadowing of upwind turbines and the grid connection location. Ecology, noise and shadow flicker were also assessed and were primary considerations in turbine siting.

This lead to a layout comprising 210 turbines, subsequently reduced to 180 turbines, which was the basis on which planning permission was granted on appeal by An Bord Pleanála in 2003.

4.3.3.2 Development of Proposed Layout

The proposed layout of 61 wind turbines in a non-uniform pattern was arrived at following an extensive consultation phase for the overall wind farm development and taking into account the constraints identified as a result of the previous planning process on the site.

Initial modelling indicated a wind farm layout that would accommodate 117 larger wind turbines. A constraints map (see Figure 4-4) was prepared showing set back distances from site boundaries and ecological features and this was subsequently used in the modelling of the wind farm to determine an initial optimum layout for wind energy capture. The initial constraints map was based on consideration of the planning history of the site. A revised layout comprising 112 wind turbines was developed based on the following

- Planning history at Oweninny and the conditions of permission (Ref PL16.131260)

  - Minimum distance of 1,000 m from wind turbines to the nearest occupied dwelling
  - Minimum distance of 100m from wind turbines to the Oweninny River, the Owenmore River and their primary tributaries on the ground,
  - Minimum distance of 100m from wind turbines to designated SAC, SPA, NHA and pNHA area
  - Minimum distance of 100m from wind turbines to the site boundary
- Initial consultations with local stakeholders and Mayo County Council
- Technical advances in wind turbine technology that have seen larger turbines becoming the industry standard.
- Analysis of site specific wind data to determine the wind rose for the site and consideration of the prevailing wind direction based on four temporary meteorological masts on the site
- Noise modelling to ensure compliance with a noise level of 43 dB LA_{90} at the nearest noise sensitive receptor, see Chapter 7.
- Site visits by the project team.
- Historical bird monitoring on the site by the ecological team

The alternative proposed Phase 1 and Phase 2 only option is a subset of the layout for 112 wind turbines and also takes account of the actual grid connection point (Bellacorick Substation) and available grid capacity (172MW).

4.3.3.3 Field Survey influence on the design

Ecological, Noise, Cultural Heritage and geotechnical assessments were also undertaken at all structure sites to identify additional constraints on the ground. These included:

- Results of avifauna surveys undertaken at the site.
- Results of habitat surveys undertaken on site
- Result of the hydrogeology study on the Bellacorick Iron Flush as requested by NPWS
- Results of geotechnical investigations and field testing that determined peat depths and bearing capacity within the site.
- Cultural Heritage evaluations on site

Geotechnical investigation and ecological assessment of access track routes also resulted in minor realignment of these routes to areas of lower peat depth and to avoid wet ground.

Proposals were refined on an iterative basis to ensure that areas of deeper peat were avoided and the layout was progressively modified to identify final locations of turbines, access tracks substation, O&M building and Visitor Centre locations

Figure 4-5 shows the original planning approved layout of 180 wind turbines and the modelled layout proposed at the scoping stage of the development. This initial layout of the wind farm has evolved by taking account of various constraints as they arose during the design.

This layout of 112 wind turbines, of which the 61 wind turbines in Phase 1 and Phase 2 are a subset, formed the basis of a scoping exercise to key stakeholders and the public to obtain their views and identify any issues of concern.

4.3.3.4 Scoping Exercise influence on design

The original scoping exercise included a Scoping Report indicating the draft layout comprising 112 wind turbines was issued to statutory bodies and stakeholders and was also made available on the project website (see Section 1). Its purpose was to elucidate any constraints or issues which should be taken into account in the wind farm design. Key consultation with Mayo County council, Inland Fisheries Ireland, NPWS, An Taisce and the Irish Peatland Conservation Council were held. The proposed layout provided in the Scoping Report is shown in Figure 4-6. Comments received from stakeholders led to some minor modifications of the proposed layout with respect to some turbine locations. For example the Irish Peatland Conservation Council (IPCC) raised issues with respect to the proximity of turbines to bog remnants and water courses as per Table 4.5. Relocation was identified as necessary to minimise potential significant impacts on bog remnants, flush areas on the site and at one petrifying spring location.

The proposed Phase 1 and Phase 2 only option comprised a subset of the layout issued for consultation and all comments received were addressed in the preparation of the final layout design for each phase.

Table 4.5: Wind turbine locations in Phase 1 and Phase 2 identified by IPCC as potential issues

IPPC Turbine and issue	Distance to Bog Remnant /River (Approx.) m
T1 – Beside remnant	17
T11 – Beside remnant/river	66
T18 – Beside remnant/river	8
T20 – Beside remnant/river	39
T22 – Beside remnant/river	45
T34 – Beside remnant/river	7
T42 – Beside remnant	24
T52 – Beside remnant/river	53

A number of wind turbines were relocated by up to 50m as a result of consultation with the Irish Peatland Conservation Council and following ecological assessment at the turbine and crane hardstand footprints.

4.3.3.5 Communication signal corridors

Consultation with communication signal providers identified the communication signal corridors across the site. Where turbines were identified within a communication corridor buffer zone they were relocated outside this zone, see Figure 4-7.

4.3.3.6 Impact of Trees

Forest plantation dominates in a small number of areas within the overall Oweninny site but only very limited felling (1.05 ha) will be required associated with access track widening for the Phase 1 and Phase 2 only option .

4.3.3.7 Final wind farm design

The final Phase 1 and Phase portions of the wind farm design were arrived at taking into account the setback distances constraints identified at the Oweninny site see Figure 4-8., field survey work to identify further ecological, cultural heritage and geotechnical constraints and in response to issues raised through consultation with key stakeholders, public consultation, the scoping exercise and consideration of potential cumulative effects with other potential wind farm developments in the area. This resulted in the wind farm layout as described in Chapter 2.

4.3.3.8 Micrositing

As noted in the DoEHLG Planning Guidelines 2006 (Section 7.3), the precise locations of some turbines may need to be modified as a result of detailed geotechnical investigations. Should this arise full details will be provided to An Bord Pleanála for approval before commencement of construction.

Any minor changes to the layout will take full account of the self-imposed constraints regarding minimisation of impacts and set back distances from dwellings, protected areas, streams and rivers and ecologically sensitive areas on the site.

4.3.4 Proposed Arrangement – Other Components

4.3.4.1 Electrical Substation

The locations of the electrical substations 1 and 2 were chosen in the context of an optimum location in respect of the expected method of grid connection. This was balanced by the requirement to minimise the amount of 110 kV overhead lines to connect the substations to the existing Bellacorick 110 kV station, taking account of separation distances from wind turbines and underground cabling needed to connect the turbines to them.

The physical orientation of the Electrical Substation 1 and 2 was also considered in respect of the various possibilities for grid connection, resulting in a layout agreed with EirGrid.

4.3.4.2 Meteorological Masts

The five permanent masts were positioned to provide representative data from different parts of the site, taking into account the direction of the prevailing wind.

Individual locations for each were chosen to minimise the distance between the mast and the most remote turbines from it. Positioning also took account of proximity to the nearest mast to avoid wind turbulence effects.

4.3.4.3 110 kV overhead Transmission Lines

Initially four 110kV overhead line route options between the existing Bellacorick 110kV station and the proposed two new electrical substations, serving Phase 1 and Phase 2, in the Oweninny wind farm development were considered. The following constraints criteria were considered in the identification of route options:

- Large scale objects such as mountain ranges, large lakes, towns etc., which would obstruct line routing and will thus give a broad indication of likely route options
- SACs are protected sites under the EU Habitats Directive www.npws.ie.
- SPAs are protected sites under the EU Birds Directive www.npws.ie.
- NHAs are legally protected from damage under the Wildlife Amendment Act (2000) www.npws.ie.
- Ecological features on the ground as identified by the project ecologist
- The existing transmission and distribution line networks (400kV to 38kV).
- The line termination points i.e. the start and end point of the line may already be fixed by existing substations. Where this is not the case the new substation site location should be determined from alternative sites taking account of possible environmental impact.
- A study of the Local Authority Development Plan to identify protected views, scenic and tourist routes, protected landscape categories and areas of high amenity. A study of the plan should also reveal policies and planning guidelines that refer to electrical infrastructure within the county.
- Archaeological Sites identified from the Sites & Monuments Records (SMR), Department of Environment, Heritage and Local Government (DEHLG) and based on site visits by the project archaeologist.
- Local landscape impact

Two route options (1a and 1b) from electrical substation 1 and four route options (2a, 2b, 2c and 2d) for the overhead line route from electrical substation 2 to Bellacorick and were assessed, see Figure 4-9.

Based on the criteria route options were categorised as being “Most Suitable”, “Suitable” or “Least Suitable” as set out in Table 4.6.

Table 4.6: Suitability of 110 kV Overhead line route

Code	Suitability
(green)	Most Suitable. From initial review, this line route best avoids all constraints identified.
(orange)	Suitable. From initial review, this line route is somewhat less preferred, as some effects on identified constraints may occur.
(purple)	Least Suitable. From initial review, this line route is the least preferred of the options, as some direct effects on identified constraints are likely to occur.

For electrical substation 1 both line routes 1a and 1b were assessed as being viable options, see Table 4.7. However, line route 1a crosses larger sections of bog remnants and also runs close to a water course which adds additional complexity to construction in this area. Line route 1b crosses only one narrow section of bog remnant. This makes line route 1b the more preferable option. Approximately 1.5 km from Bellacorick 110kV station line route 1b would terminate on a cable interface mast and will be cabled underground to the substation to minimise potential visual impact on neighbouring dwellings.

Table 4.7: Evaluation of potential Line Routes from Substation 1 against Assessment Criteria.

Evaluation Criteria	Line Route 1a	Line Route 1b
Ecology		
Landscape		
Geology/Water		
Settlements		
Cultural Heritage		
Infrastructure/Utilities		

For electrical substation 2, line route 2a is the preferred route in terms of the assessment criteria, see Table 4.8 below. This line route was deemed the most suitable as the line is located behind the wind turbines and it is the furthest option from the settlements on the Srahnakilly road. Approximately 1 km from Bellacorick 110kV station Line Route 2 would terminate on a cable interface mast to minimise visual impact potential.

Line Route 2b is also a viable option and appears to be a similar option to 2a. It crosses one narrow section of bog remnant. However it does run closer to the settlements on the Srahnakilly Road and for this reason is less preferable.

Line Route 2c and 2d are similar options. They would be the least preferred options as they cross wider sections of bog remnants and some water bodies that would cause access difficulties. Line Route 2c and 2d also run in close proximity to the Srahnakilly Road.

Table 4.8: Evaluation of potential Line Routes from Substation 2 against Assessment Criteria.

Evaluation Criteria	Line Route 2a	Line Route 2b	Line Route 2c	Line Route 2d
Ecology				
Landscape				
Geology/Water				
Settlements				
Cultural Heritage				
Infrastructure/Utilities				

The most suitable line route to the existing 110 kV substation at Bellacorick identified for substation 1 is route 1a and identified for electrical substation 2 is route 2a. Both line routes terminate 1.5 km and 1 km from the Bellacorick substation where they will be cabled undergrounded to minimise visual impact potential in the area, a cause for concern raised by local people.

4.3.5 Summary

The layout of the Phase 1 and Phase 2 wind farm components were considered in the context of the overall Oweninny site development in three phases and evolved by taking account of various constraints as they arose during the design.

At the same time, the wind turbines and access tracks will occupy an even smaller proportion of the overall lands at the site than in the currently permitted development and the remainder will be available for existing or other uses.

The proposal represents the most sympathetic arrangement feasible for a wind energy development of 61 turbines for Phase 1 and Phase 2 on this site taking account of the constraints applying.

4.3.6 Planning (Wind Energy) Guidelines

The Department of Environment, Heritage and Local Government's (DoEHLG's) Planning Guidelines 2006 (Section 6.9) notes that landscape character types provide a useful basis for practical application of siting and design guidelines in relation to wind energy development.

In that context six landscape character types were selected to represent most situations, as follows: Mountain moorland, hilly and flat farmland, flat peatland, transitional marginal land, urban / industrial, and coast. Flat peatland is the landscape character type that best describes the site at Oweninny

The siting and design guidance for flat peatland address the issues of Location, Spatial extent, Spacing, Layout, Height and Cumulative effect.

The characteristics of the revised proposal for Oweninny are in line with the Guidelines.

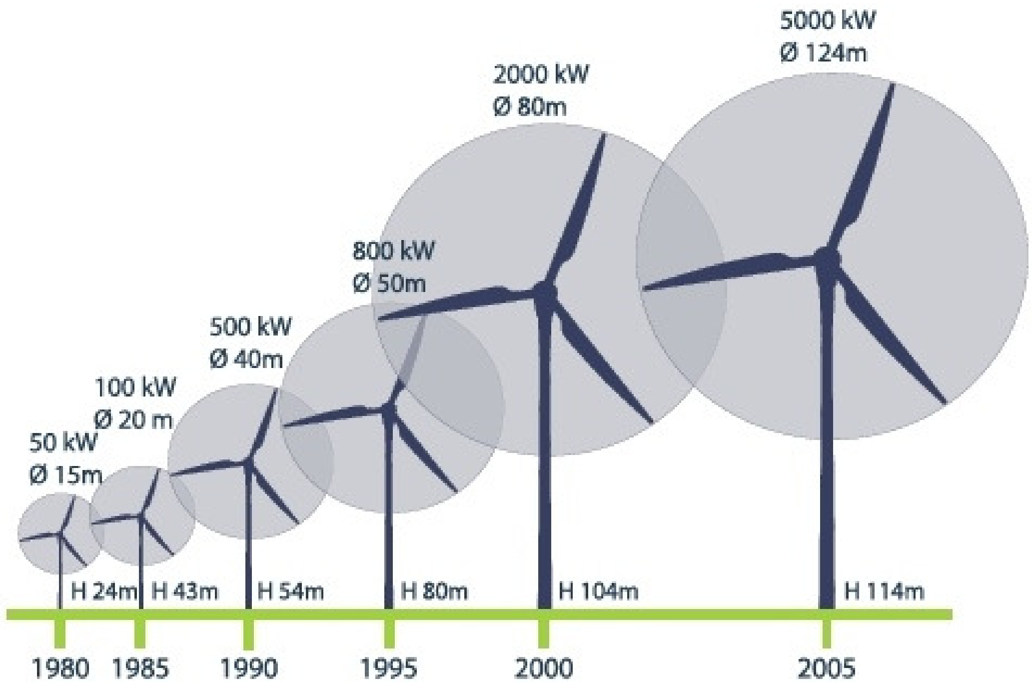


Figure 4-1: Trend in Wind Turbine Sizes

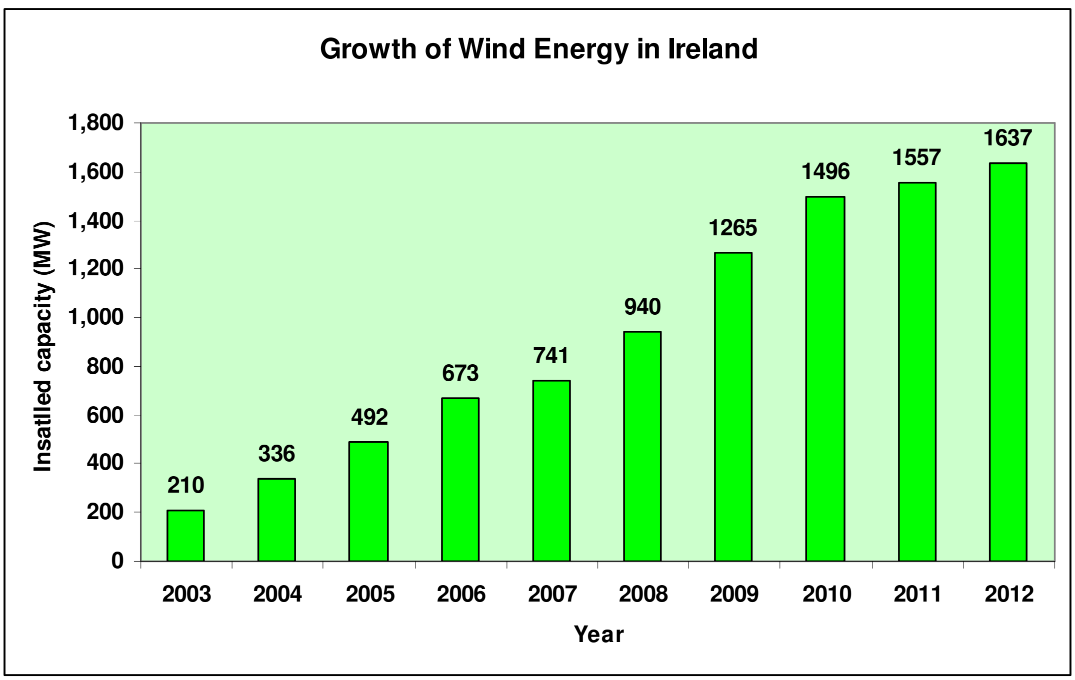
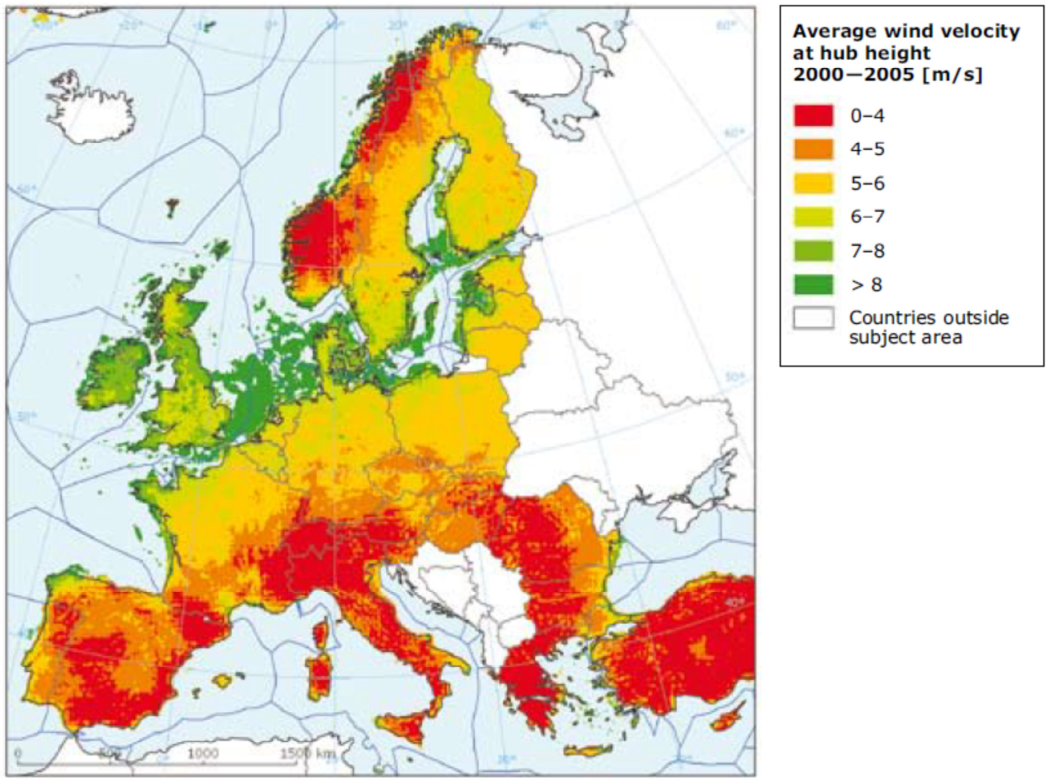


Figure 4-2: Growth of Wind Energy in Ireland

Map 2.2 ECMFW wind field data after correction for orography and local roughness (80 m onshore, 120 m offshore)



Source: EEA, 2008.

Figure 4-3: Average wind velocity at hub height across the EU.

(Extracted from Europe's onshore and off shore wind energy potential. An assessment of economic and environmental constraints. European Environment Agency 2009).

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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Oweninny Initial Constraints Map - Phasing 1 & 2
Project	Wind Farm Project at Oweninny, Bellacorick, Co. Mayo
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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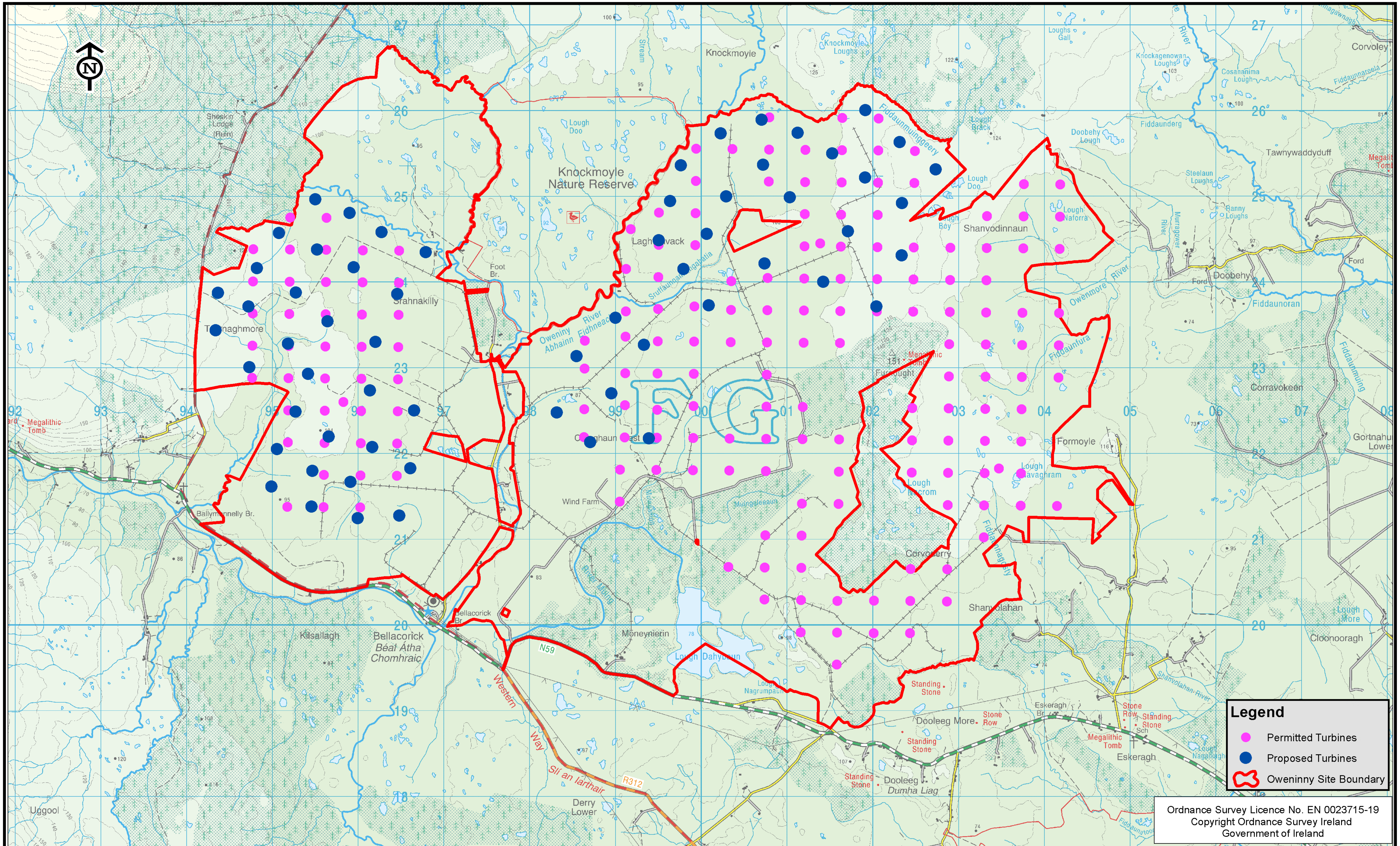
MAP REFERENCE

Figure 4.4



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Planning Approved and Proposed Wind Farm Layout - Phasing 1 & 2

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
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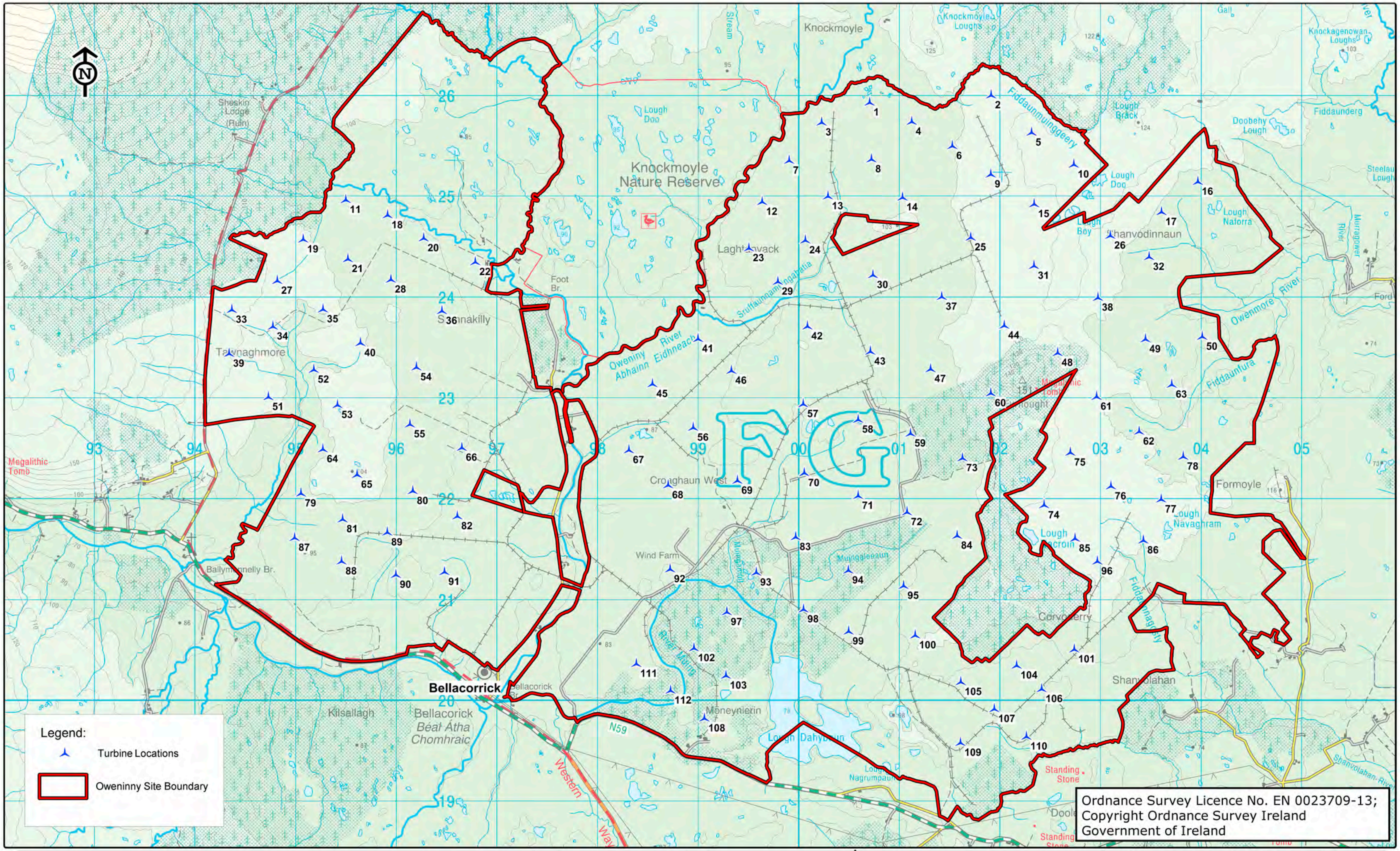
MAP REFERENCE

Figure 4.5



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CURRENT REVISION DESCRIPTION:
Revision

CLIENT:	OWENINNY POWER LTD
PROJECT:	WINDFARM AT OWENINNY, CO. MAYO
DRAWING TITLE:	Proposed wind farm layout issued for Scoping Report

DRAWN	CHECKED	APPROVED	APPD DATE
R.W	P.K	J.C	14/08/2012

CLIENT REF	No. of Shts	SIZE	SCALE
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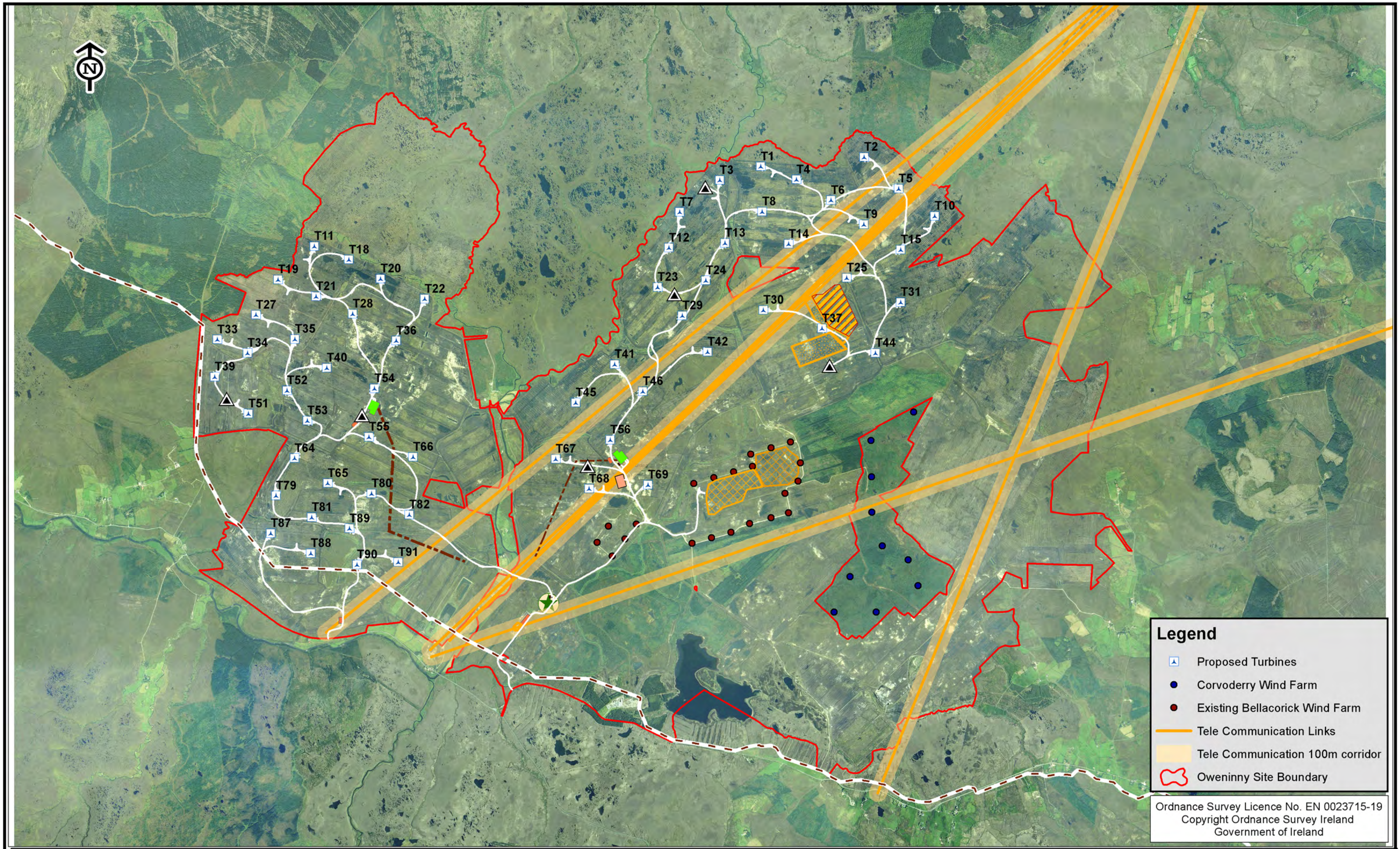
FIGURE NUMBER: FIGURE 4.6
SHEET REV



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Communication signal corridors with final proposed layout - Phasing 1 & 2

Production Unit
Civil, Building & Environment Group

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MAP REFERENCE

Figure 4.7

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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Final Constraints Map - Phasing 1 & 2
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil, Building & Environment Group

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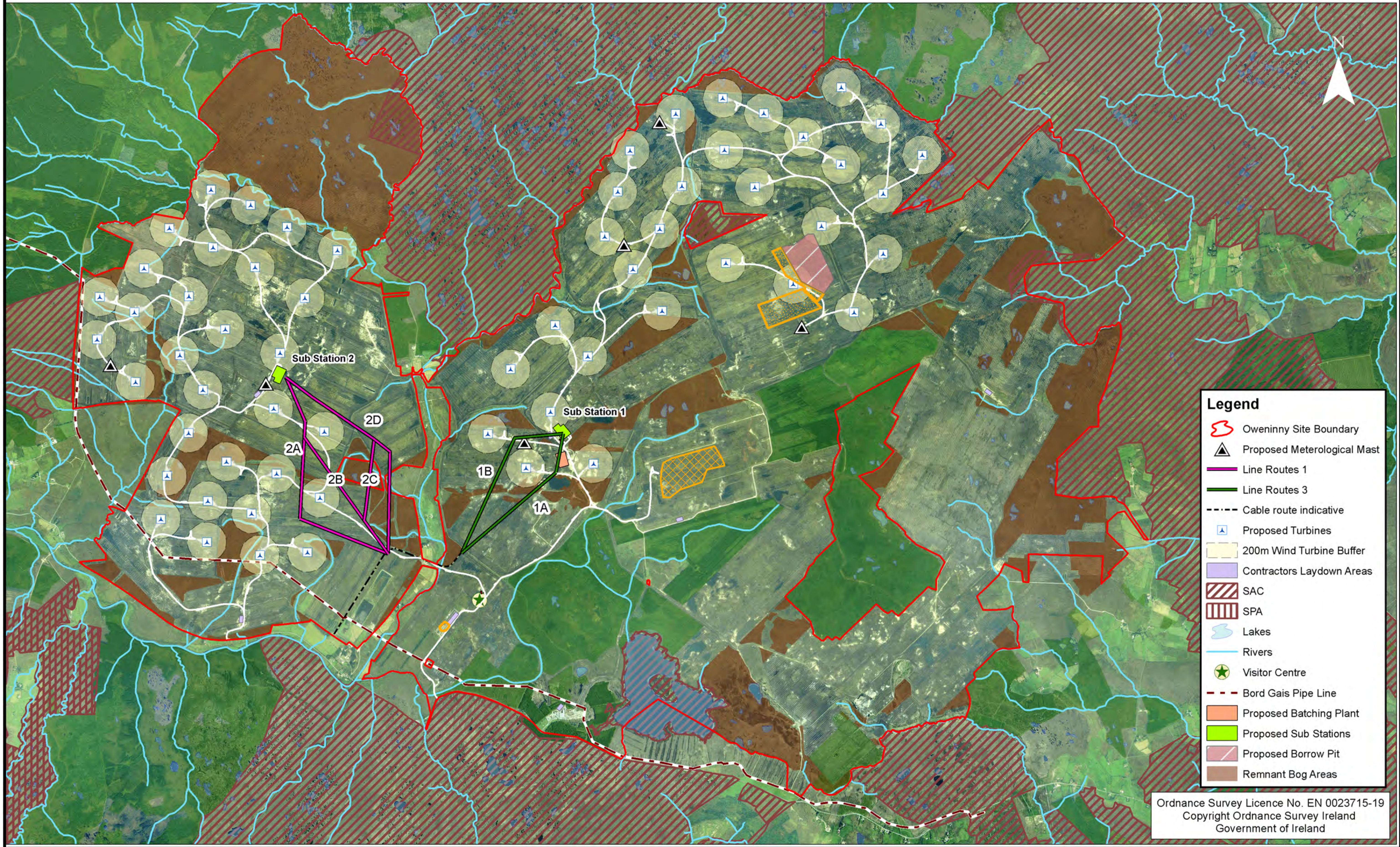
Figure 4.8



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
110kV Line Route Options - Phasing 1 & 2

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	C.F	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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MAP REFERENCE

Figure 4.9

5 POLICY & PLANNING

5.1 INTRODUCTION

This section reviews the policy and planning context relating to the development of renewable energy in Ireland within which the proposed Phase 1 and Phase 2 of the Oweninny wind farm is proposed for development. Renewable wind energy has developed in response to European Union policies and directives and the road map set out by the EU towards achieving targeted reductions in greenhouse gas emissions. The requirements of the EU have in turn been integrated into national policy with clear targets set for the energy sector as to the level of penetration of renewable energy into the overall energy mix for the country to be achieved by 2020. Wind energy is recognised nationally as the option most likely to contribute maximally towards achieving these targets which are essential to meet the requirements of Ireland's national climate change strategy. The Oweninny Phase 1 and Phase 2 proposed development is fully in line with national, regional and county development policies and guidelines and will be located in a priority area for wind development identified in the Mayo Renewable Energy Strategy 2011 - 2020. The development, when operational, will contribute significantly to a reduction in Ireland's greenhouse gas emissions.

5.2 ENERGY POLICY – EUROPEAN CONTEXT

EU renewable energy policy is considered relatively young, having started with the adoption of the 1997 White Paper. It was initially driven by the need to de-carbonise the energy sector and address growing dependency on fossil fuel imports from politically unstable regions outside the EU. However, the focus has shifted in the intervening period from the promotion of renewable energy through indicative targets for the electricity and transport sectors to the definition of legally binding targets supported by a comprehensive legislative framework. More recently focus has been on a reorientation of European energy infrastructure policy that facilitates renewable energy growth.

5.2.1 White Paper on Renewables

Development of renewable energy has been a central aim of EU energy policy for some time with the first step towards a strategy for renewables being the adoption by the EU of a Green Paper in November 1996. This sought views on setting an indicative objective of 12% for the contribution by renewable sources of energy to overall energy consumption by 2010.

This target was subsequently established in 1997 in the EU Commission's Energy for the Future: Renewable Sources of Energy - White Paper for a Community Strategy and Action Plan. The purpose of the White Paper was to contribute, by promoting renewable energy, to the achievement of overall energy policy objectives: security of supply, environment and competitiveness, and to improve and reinforce environmental protection and sustainable development.

The overall EU target of doubling the share of renewables by 2010 implied that Member States had to encourage the increase in renewable energy sources according to their own potential. The setting of targets was recognised as providing a stimulus to efforts towards increased exploitation of available potential and an important instrument for attaining carbon dioxide (CO2) emissions reductions, decreasing energy dependence on fossil fuels, developing national industry and creating jobs.

5.2.2 Green Paper on Security of Energy Supply

Amongst the tools supporting the EU strategy and instruments for promoting renewable energy sources is its Green Paper on the security of energy supply from November 200012. EU resources are limited with respect to reserves of oil and gas and costs of coal production are a multiple of the world market price. Correspondingly, there is a potential abundance of renewables.

The aim was to put forward proactive strategies to attenuate, if not counteract, the dependence on imported energy supplies. Future priorities include managing the dependence on supply by development of less polluting energy sources.

New and renewable forms of energy are the first options for action in relation to security of supply, the environment and local populations.

5.2.3 Renewable Energy Directives 2001 & 2009

The EU Renewables Directive 2001/77/EC adopted in 2001 introduced for the first time a legislative text aimed at promoting the production of energy from renewable sources. It obliged Member States to set indicative targets. It committed Ireland to the production of 13.2% of electricity demand from renewable energy sources by 2010.

Based on this target the Irish Government introduced a range of measures to increase the deployment of renewables in the production of electricity.

Outlining a long-term strategy the EU Commission’s Renewable Energy Roadmap13 called for a mandatory target of a 20% share of renewable energies in the EU's energy mix by 2020. The target was endorsed by EU leaders in March 2007.

The Commission's Energy 2020 Strategy[14] highlights how EU infrastructure and innovation policies are supporting the renewable energy sector's development, ensuring that renewable

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[12] European Union, Green paper, Towards a European Strategy for the security of energy supply, COM 2000 (769), November 2000

[13] Commission Communication of 10 January 2007: "Renewable Energy Road Map. Renewable energies in the 21st century: building a more sustainable future" [COM(208. 06) 84

energy sources and technologies become economically competitive as soon as possible, thus supporting the growth of renewable energy to achieve our goals.

The EU Renewable Energy Directive 2009/28/EC, which amended and subsequently repealed Directives 2001/77/EC and 2003/30/EC, requires each member state to increase its share of renewable energies - such as solar, wind or hydro - in the bloc's energy mix to raise the overall share to 20% by 2020. To achieve the objective, every nation in the 27-member bloc is required to increase its share of renewables by 5.5% from 2005 levels, with the remaining increase calculated on the basis of per capita gross domestic product (GDP).

Ireland’s share of renewables is required to increase to 16% by 2020. The Directive set a series of interim targets, known as 'indicative trajectories', in order to ensure steady progress towards the 2020 targets. Each Member State has flexibility to set targets across the heating, transportation and electricity sectors to meet the overall renewable energy targets, subject to a minimum of 10% of energy use in transport being renewable sourced by 2020.

The Renewable Energy Directive provides a strong and stable regulatory framework for the development of the renewable energy sector in Europe.

5.2.4 European Commission Energy Roadmap 2050

On 15 December 2011, the European Commission adopted the Communication "Energy Roadmap 2050"[15]. This roadmap commits the EU to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 in the context of necessary reductions by developed countries as a group. This implies that Europe’s energy production will have to be almost carbon-free in order to reach the Commission’s latest target over the next 37years.

Existing EU policies and measures to achieve the Energy 2020 goals and the Energy 2020 strategy are ambitious and will continue to deliver beyond 2020. However, they will achieve only less than half of the decarbonisation goal set for 2050.

The Energy Roadmap 2050 examines seven scenarios, two “Current Trend” and five “Decarbonisation” that could reduce emissions while ensuring that each country retains its security of supply and competitiveness.

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[14] COM(2010)639/3 Energy 2020: A strategy for competitive, sustainable and secure energy

[15] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions, Energy Roadmap 2050

The high renewable energy sources decarbonisation scenario would see renewable energy systems with a 75% share of final energy consumption by 2050 and 97% of electricity consumption indicative that renewable energy will be central to energy policy going forward.

Ireland's Energy Minister Pat Rabbitte is quoted by Energy Ireland as saying that the roadmap "shows the importance of a fundamental shift away from fossil fuels" and added that Ireland's "abundance of onshore and offshore wind resources" means it is "well placed to feature prominently in the euro-wide energy sector."

5.2.4.1 Updates on EU Policy and Commitments

Further to the Renewable Energy Directives binding targets to 2020, the European Commission acknowledged the growing concerns and clear message of the Intergovernmental Panel on Climate Change (IPPC) Assessment Report 5 (AR5)[16]. In October 2014 EU leaders agreed a 2030 climate & energy framework that will see a domestic EU greenhouse gas reduction target of at least 40% compared to 1990 to drive continued progress towards a low carbon economy in the European Union. To achieve this target it is estimated that:

- the sectors covered by the EU Emission Trading Scheme (ETS), including energy, would have to reduce emissions by 43% compared to 2005.
- emissions from the non-ETS sectors would have to reduce by 30% compared to 2005 levels. The effort needed to meet these targets will be shared equitably between Member States.

In addition, an EU-level 2030 target for renewable energy is proposed with, at least, 27% of EU energy consumption to come from renewable sources. This renewable energy target does not, however, place binding targets on Member States and is to be reached by the EU as a whole. Renewable energy will therefore play a key role in the transition towards a competitive, secure and sustainable energy system for the EU.

In relation to energy efficiency, the European Commission proposed a 30% energy savings target for 2030, following a review of the Energy Efficiency Directive. The European Council, however, endorsed an indicative target of 27% to be reviewed in 2020 having in mind a 30% target.

[16] IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

The Environment Council of the EU approved the EU's intended nationally determined contribution in March 2015 which is to achieve at least 40% domestic reduction in greenhouse gas emissions compared to 1990 levels by 2030. This translates the agreement by EU leaders in October 2014, referred to above, on the EU 2030 climate and energy framework.

A new global international climate change agreement is currently being negotiated under the UN Framework Convention on Climate Change (UNFCCC). It is expected that this will be agreed by the 21st Conference of Parties (COP21) which will be held in Paris in December 2015. Such agreement will come into effect in 2020. The 40% reduction in greenhouse gases agreed by the EU Leaders is the EU proposed contribution to this new international agreement.

5.2.5 Climate Change

The Inter-Governmental Panel on Climate Change (IPCC) report, "Climate Change 2013: The Physical Science Basis", referred to as the Fifth Assessment Report (AR5), presents clear and robust conclusions in a global assessment of climate change science. The report clearly indicates with 95 percent certainty that human activity is the dominant cause of observed warming since the mid-20th century. The Working Group 1 Report Approved for Policy Makers has also been published in 2013 and summarises the main findings of the AR5. The AR5 Report confirms that warming in the climate system is unequivocal, with many of the observed changes unprecedented over decades to millennia: warming of the climate system is occurring with increased atmospheric and sea temperatures, reduction in snow and ice cover, sea level rise and increasing greenhouse gas concentration in the atmosphere. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since.

Tackling climate change is a key element of the European Commission's energy road map going forward to 2050.

Historically, in response to international concerns, under the UN Framework Convention on Climate Change (UNFCCC), industrialised countries were to stabilise their greenhouse gas emissions at 1990 levels by the year 2000. The EU met this commitment. The Kyoto Protocol to the UNFCCC committed the 15 countries that were EU members at the time to reduce their collective emissions in the 2008-2012 period to 8% below 1990 levels.

Recent statistics show that the level of the EU 28's greenhouse gas emissions had fallen to 4.7 Billion tons by 2012, a 17.9 % compared to 1990[17], see Figure 5-1.

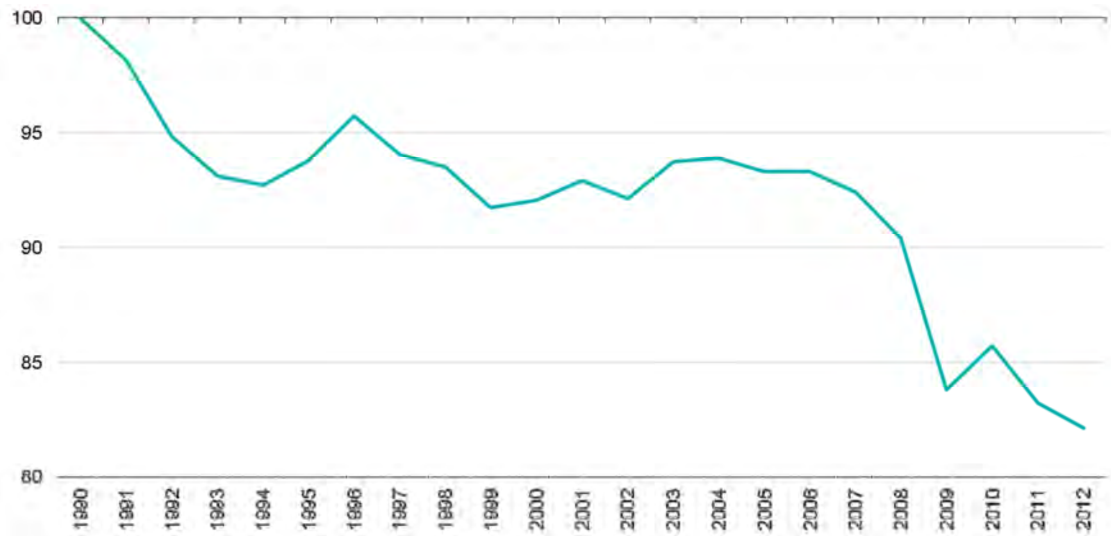

Figure 5-1: Greenhouse gas emissions (including international aviation and excluding LULUCF) trend, EU-28, 1990–2012

(Index 1990=100)

Source: Eurostat (online data code: env_air_gge), European Energy Agency, European Topic Centre on Air and Climate

Achieving the targets aspired to in the 2050 Roadmap would reduce the emission of greenhouse gases by 80 – 95% by mid-century.

In the National context the Irish Environmental Protection Agency also highlights its concerns around climate change[18] and Ireland's ability to achieve its targets:

"What is distinctive about the current period of global warming, compared to previous cycles of climate change, is the extent and rate of change, which exceeds natural variation. The impacts of climate change present very serious global risks and threaten the basic components of life, including health, access to water, food production and the use of land. As the earth gets warmer the damage from climate change will accelerate".

[17] Eurostat, Greenhouse Gas Emission Statistics 2015
[18] http://www.epa.ie/whatwedo/climate/

In its report "Ireland's Provisional Greenhouse Gas Emissions"[19] the EPA also indicates that

For 2013, total national greenhouse gas emissions are estimated to be 57.81 million tonnes carbon dioxide equivalent (Mt CO_2 eq) which is 0.7 % lower (or 0.41 Mt CO_2 eq) than emissions in 2012 (58.22 Mt CO_2 eq). This reverses the 1.0% increase in emissions reported for 2012.

Agriculture remains the single largest contributor to the overall emissions at 32.3% of the total. Energy and Transport are the second and third largest contributors at 19.6% and 19.1% respectively. The remainder is made up by the Industry and Commercial at 15.4%, Residential sector at 11.1% and Waste at 2.5%. Figure 2 shows the contributions from each of the sectors in 1990 and 2013.

The EPA's 2015 Report on Ireland's Greenhouse Gas Emission Projections 2014 – 2035[20] provides an updated assessment of Ireland's progress towards achieving its emission reduction targets set down under the EU Effort Sharing Decision (Decision No 406/2009/EC) for the years 2013-2020. Although this report identifies key challenges in the non-emission trading sectors of agriculture, transport and heating it also predicts two possible scenarios for the energy sector as follows:

- *Under the With Measures scenario, total energy sector emissions are projected to increase by 11% over the period 2013 – 2020 to 13 Mt CO2eq12. The increase is driven by increased demand for electricity with coal-fired power generation being maintained and gas-fired generation increasing by over 20%. By 2020 22% of electricity generation is projected to come from renewable sources.*
- *Under the With Additional Measures scenario, total energy sector emissions are projected to decrease by 14% over the period 2013 – 2020 to 10 Mt CO2eq. In this scenario, energy demand is lower than the With Measures scenario as a result of improved energy efficiency and also renewable energy is assumed to reach 40% penetration by 2020. The largest renewable energy contribution comes from wind, which is estimated to be significantly higher than in the With Measures scenario in terms of generation input.*

To achieve Ireland's commitments to 2030 and to continue to decarbonise the economy to 2050 greenhouse gas reductions across all sectors must be achieved. This is in line with the EU Effort Sharing Decision (No. 206/2009) which requires all sectors to contribute to achieving emission reductions. The importance of achieving a 40% renewables penetration

[19] EPA, Ireland's Provisional Greenhouse Gas Emissions in 2013, 3rd December 2014
[20] EPA, Ireland's Greenhouse Gas Emission Projections, 2014 – 2035, 18th May 2015.

in the energy sector is a key component of this, with wind energy contributing most significantly.

5.2.6 Summary

The development of renewable energy, particularly energy from wind, waver, solar power and biomass, is a central aim of the European Commission's energy policy. There are several reasons for this:

- Renewable energy has an important role to play in reducing CO2 emissions, which is a major Community objective.
- Increasing the share of renewable energy in the energy balance enhances sustainability. It also helps to improve the security of energy supply by reducing the Community's growing dependence on imported energy sources.
- Renewable energy sources are expected to be economically competitive with conventional energy sources in the medium to long term.

It is evident that this proposed wind farm development at Oweninny is strongly supported by policy at European level.

5.3 ENERGY POLICY – NATIONAL CONTEXT

5.3.1 Policy Evolution

It is Government Policy to promote the development of renewable energy sources. Sustainable energy policy includes maximising the efficiency of generation and emphasising the use of renewable resources.

Ireland's Green Paper on Sustainable Energy was launched in September 1999, the policy indicating how Ireland will progress towards meeting its energy requirements in an environmentally and economically sustainable way. It concentrated on Ireland's need to limit energy-related carbon dioxide (CO2) emissions under the Kyoto Protocol. An additional major justification of this strategy on renewable energy is to reduce Irish dependence on imported fuels for the purpose of security of supply.

The Renewable Energy Strategy Group was formed in November 1999 on foot of the Green Paper. In its report 'Strategy for Intensifying Wind Energy Development[21]' the Group

[21] Renewable Energy Strategy Group (2000), Government of Ireland, Strategy for Intensifying Wind Energy Development, http://www.dcenr.gov.ie/NR/rdonlyres/ADD4AF22-E434-403B-A3A4-87716C9EE7C0/0/RenewableEnergyStrategyGroupReport.pdf

outlined a strategy of promoting large-scale wind energy projects to achieve efficient deployment of wind energy.

In the National Spatial Strategy 2002 – 2020, it is stated as follows:

"..in economic development the environment provides a resource base that supports a wide range of activities that include agriculture, forestry, fishing, aqua-culture, mineral use, energy use, industry, services and tourism. For these activities, the aim should be to ensure that the resources are used in sustainable ways that put as much emphasis as possible on their renewability."

5.3.2 National Development Plan 2007 - 2013

The National Development Plan 2007-2013[22] is the largest and most ambitious investment programme ever proposed for Ireland and it sets out the roadmap to Ireland's future.

The Plan outlines a number of High Level Objectives that will guide investment priorities and allocations. These include environmental sustainability, whose promotion, including tackling climate change, is a key objective of the investment strategy in the Plan. Climate Change and Renewable Energy are two of the six identified areas in which investment under the Plan will make a major contribution to the protection and enhancement of the environment.

This Plan sets out objectives to stimulate renewable energy production and notes as follows:

"Ireland has significant renewable energy resources available but their large-scale exploitation continues to require support and intervention by policy makers because of the investment costs and risks entailed. This intervention is required across the three principal energy sectors: electricity, heat and transport and in the industrial, public, commercial and domestic sectors".

"The proposed investments will considerably enhance environmental sustainability. Increased market penetration of renewable energy technologies in the electricity, heat and transport sectors will displace fossil fuels such as coal, oil, gas and peat. In the case of electricity, the 2010 target for renewable energy consumption has been increased to 15%".

The Sustainable Energy Sub-Programme states that renewable energy measures will focus on achieving Government targets for renewable energy production and meeting policy goals with regard to competitiveness, environment, security of supply, R&D and the development of a sustainable All-Island energy market.

[22] Transforming Ireland – A Better Quality of Life for All

In addition it notes as follows:

"Renewable energy measures will focus on achieving Government targets for renewable energy production and meeting policy goals with regard to competitiveness, environment, security of supply, R&D and the development of a sustainable All-Island energy market. The primary focus will be on the large-scale deployment of wind, the emerging potential and deployment of biomass and biofuels, preparatory action on ocean energy and deployment of other technologies such as solar and geothermal technologies. Deployment will be delivered through a range of supports including taxation, direct grant aid and other funding or support mechanisms;"

In the context of Regional Development the regional policy approach embraces the role of other smaller towns, villages and rural areas and states as follows:

Towns, villages and rural areas need to be supported in the development of new areas of economic activity such as: local value added enterprise activities; tourism; local enterprise; services; and renewable energy to both complement the surviving elements of a restructured agri-business/natural resource sector and provide new employment opportunities.

5.3.3 Renewable Energy Development - 2006

The Department for Communications, Energy and Natural Resources holds responsibility for renewable energy policy in Ireland. The Renewable Energy Development Group, established in May 2004 considered the future options to develop increased use of renewable energy in the electricity market to 2010 and beyond. Its Renewable Energy Development 2006 presented an overview of policy and strategy evolution, stating as follows:

"Renewable energy deployment fits with a range of policy imperatives across many areas. It has clear environmental benefits and helps meet our international environmental commitments. It reduces reliance on imported fuels, reducing dependence and bringing associated economic benefits."

A conclusion was as follows:

"A sustainable energy economy depends on both efficiency in the supply and consumption of energy and in the substantial deployment of renewable sources."

5.3.4 Energy White Paper – 2007

The Government launched its Energy White Paper in March 2007. The White Paper describes the actions and targets for the energy policy framework out to 2020, to support economic growth and meet the needs of all consumers. It is set firmly in the global and European context which has put energy security and climate change among the most urgent international challenges.

Sustainability is at the heart of Government's energy policy objectives. The Paper outlines that the challenge of creating a sustainable energy future for Ireland will be met through a range of strategies, targets and actions to deliver environmentally sustainable energy supply and use. The underpinning Strategic Goals include accelerating the growth of renewable energy sources.

The key targets as set out in Table 5.1 were set regarding renewable electricity.

Table 5.1: National Renewable Energy Targets

Year	Criterion	Target
2010	Gross electricity consumption from renewable sources	15 %
2020	Gross electricity consumption from renewable sources	40 %

The Government's 40% renewable penetration target for 2020 is estimated to be equivalent to about 4,000 MW of installed wind energy capacity in Ireland. According to the IWEA, installed capacity on the island of Ireland in April 2012 was approximately 2,055 MW, indicating that significant further development is required.

The Government is evidently committed to delivering a significant growth in renewable energy as a contribution to fuel diversity in power generation. Wind energy will provide the pivotal contribution to achieving this target.

5.3.4.1 Update on the Energy White paper of 2007 – the Green Paper 2014

In May 2014, the Department of Communications, Energy and Natural Resources published a new Green Paper on Energy Policy in Ireland. In the forward to the paper, the then Minister Pat Rabitte stated

"Ireland faces significant inter-related challenges in relation to climate change, energy security and competitiveness. These can be addressed by transforming Ireland's economy from one based on a predominantly imported fossil fuel to a more indigenous low carbon economy centred around energy efficiency, renewable energy and smart networks. This transformation lies at the heart of this Government's energy policy".

and

"Since the publication of the 2007 Energy Policy Framework, 'Delivering a Sustainable Energy Future for Ireland', the global, EU and Irish energy landscape has undergone profound change as new technologies unlock cleaner fuels, the world economy regains positive momentum, and addressing the threat of climate change becomes ever more critical. The significant changes in Ireland's economic position mean that key assumptions supporting policy, as outlined in that White Paper, are no longer valid.

As the EU looks towards 2030 and 2050, it is timely to reflect on what has been achieved and to reorient Irish energy policy priorities towards the 2030 horizon. We must now rethink some of the key components of our energy policy".

The Green Paper sets out the main developments in the Irish, European and global energy landscape since the Energy White Paper 2007, and identifies the major energy policy documents, strategies, plans and reports published since 2007. Recognising that energy is integrated into all sectors and areas of modern life and that many different themes and issues are relevant to the debate on Ireland's future energy path the Green Paper proposes six energy policy priorities for consideration as follows:

- Priority 1: Empowering Energy Citizens
- Priority 2: Markets and Regulation
- Priority 3: Planning and Implementing Essential Energy Infrastructure
- Priority 4: Ensuring a Balanced and Secure Energy Mix

- Priority 5: Putting the Energy System on a Sustainable Pathway
- Priority 6: Driving Economic Opportunity

Some 1,200 submissions have been received and a subsequent round of focussed stakeholder engagement was undertaken. The submissions and comments received will help shape the governments' energy policy going forward towards a road map to decarbonisation by 2050.

5.3.5 National Climate Change Strategy 2007 - 2012

The National Climate Change Strategy (NCCS) 2007 – 2012 of April 2007[23] follows on from the first national strategy, which was published in 2000 and reviewed in 2002. It details the measures by which Ireland will meet its Kyoto 2008 - 2012 commitment. It also outlines how the measures will position Ireland for the post-2012 period.

With regard to renewable electricity production the NCCS states:

"electricity generation from renewable sources provides the most effective way of reducing the contribution of power generation to Ireland's greenhouse gas emissions".

It is forecast that an annual emissions savings of 3.26 Mt of CO_2 will be achieved on foot of the Government's 33% target for 2020 and even larger savings will result from the revised renewables target of 40%. Oweninny wind farm, when fully operational, could lead to a reduction in CO_2 emissions of over a quarter of million tonnes through displacement of fossil fuel energy production, see Chapter 12, Section 12.2.

5.3.6 Strategy for Renewable Energy, 2012 – 2020

In May 2012 the Department of Communications, Energy and Natural Resources published the Government's Strategy for Renewable Energy, 2012 – 2020.

The Strategy notes as follows:

"The Government firmly believes that the development and deployment of Ireland's abundant indigenous renewable energy resources, both onshore and offshore, clearly stands on its own merits in terms of the contribution to the economy, to the growth and jobs agenda, to environmental sustainability and to diversity of energy supply. In addition, and in support of the Government's own energy policy objectives, Ireland is committed to delivering on its obligations under European Union Energy Policy which include the binding national target for renewable energy by 2020".

[23] National Climate Change Strategy 2007 – 2012 http://www.environ.ie/en/Publications/Environment/Atmosphere/FileDownLoad,1861,en.pdf

This document sets out five strategic goals, the first of which is as follows:

- "Strategic Goal 1: Progressively more renewable electricity from onshore and offshore wind power for the domestic and export markets".

The Strategy explains as follows:

"Further strategic deployment of onshore wind projects will develop a base of indigenous and foreign companies and create employment in the short-term in wind farm construction, possible turbine component manufacturing and servicing, the opportunity to capture international supply chain opportunities and the manufacture of niche onshore renewable energy generating equipment. In addition to exporting electricity from renewables to the UK and continental Europe, Ireland has the opportunity to become a recognised world leader in the testing of next generation offshore renewable energy equipment".

5.3.7 National Renewable Energy Action Plan

Ireland's National Renewable Energy Action Plan 24 ('NREAP, 2010') sets out the Government's strategic approach and concrete measures to deliver on Ireland's 16% target under Directive 2009/28/EC25 promoting the use of renewable energy. The NREAP was prepared in response to the submission required under the Directive and follows the format (data and questions) required in the template established by the EU. This Directive requires each Member State to adopt a national renewable energy action plan setting out the Member States national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy.

The Government's ambitions for renewable energy and the related national targets are fully commensurate with the European Union's energy policy objectives and the targets addressed to Ireland under the Renewable Energy Directive. Ireland's energy efficiency ambitions (20% by 2020) as set out in the National Energy Efficiency Action Plan are duly reflected in the NREAP. The Government has set a target of 40% electricity consumption from renewable sources by 2020 and indicated estimated trajectories towards achieving this, see Table 5.2.

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[24] National Renewable Energy Action Plan, IRELAND, Submitted under Article 4 of the EU Directive 2009/28/EC, http://www.dcenr.gov.ie/NR/rdonlyres/C71495BB-DB3C-4FE9-A725-0C094FE19BCA/0/2010NREAP.pdf

[25] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

In terms of renewable wind energy the plan estimated that 4,649MW would be required to achieve the stated target for the energy sector.

Table 5.2: National 2020 target and estimated trajectory of energy from renewable sources in heating and cooling, electricity and transport

Year	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
%	6.9	20.4	24.6	25.3	30.5	31.0	32.4	32.2	33.8	37.5	37.3	42.5

The NREAP also set out the policy, technical and financial measures which would be required to implement the plan and achieve the targets.

"It is acknowledged that development of renewable energy is central to overall energy policy in Ireland, reducing dependence on fossil fuels, improving security of supply, and reducing greenhouse gas emissions creating environmental benefits while delivering green jobs to the economy, thus contributing to national competitiveness."

The NREAP also identifies the need for the Irish grid to increasingly cope with the challenges posed by large amounts of intermittent power as the country moves towards meeting the 2020 targets. It states that:

"All key national entities, including the Energy Regulator, the distribution and transmission system operators and the renewable energy sector are working with the Government to deliver the 2020 target through grid connection and grid development strategies".

The plan stresses the need for a fully joined up and integrated approach, involving all appropriate public sector bodies at national, regional and local level as been critical for delivery over the next decade. The challenge posed by the potential introduction in new energy infrastructure is also identified

"..in setting out to achieve a significant transformation of the energy landscape, the Government does not underestimate the challenge (not unique to Ireland) of winning the hearts and minds of local communities, in support of the new infrastructure required to deliver change. This challenge will need to be progressively addressed in the context of implementation of the plan".

The commitment of the Irish Government in facilitating sustainable renewable energy development was also stated in the plan as follows:

"We are working to create the economic, infrastructural and planning conditions conducive to the sustainable development of all of Ireland's renewable energy resources, which offer the potential for Ireland to become a significant exporter of renewable energy over the coming decades. The Government will continue to work with the European Commission and other Member States to realise Europe's ambitions for renewable energy, both onshore and offshore".

5.3.8 NREAP First and Second Progress Report

Ireland submitted its first progress report on the NREAP to the EU Commission in January 201226 indicating the level of progress made and changes towards achieving the national targets. In relation to the energy sector the report indicated that the bulk of renewable energy would likely come from wind energy with a focus on on-shore wind. The estimated contribution from wind energy towards achieving the energy sector 2020 targets was also reduced from 4,649 MW set out in the original NREAP to 3,521 MW due to the downturn in the national economy. The report also indicated that an annual additional capacity of 200 MW of renewable wind energy would need to be added to achieve the national target by 2020 (based on EirGrid indication that 1,637 MW had been grid connected by March 2013)27.

Progress of the EU 28 members towards achieving their NREAP 2012 targets and likelihood of achieving their 2020 targets is tracked by the EU's Keep on Track Project (www.keepontrack.eu). The analysis of deviations and barriers to achievement published in 2014[28] indicates that there is doubt as to whether Ireland can achieve its 2020 targets.

The development of the proposed wind farm at Oweninny is fully in line with the Governments NREAP and will contribute significantly towards achieving the 2020 target set for renewable energy.

5.3.9 Climate Action and Low Carbon Development Bill 2015

The Department of Environment, Community and Local Government published the Climate Action and Low Carbon Development Bill 2015 in January 2015 having secured Government approval for the provisions of the Bill.

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[26] National Renewable Energy Action Plan (NREAP), IRELAND, First Progress Report, Submitted under Article 22 of Directive 2009/28/EC, January 2012 http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf

[27] http://www.eirgrid.com/media/All-Island_Wind_and_Fuel_Mix_Report_March_2013.pdf

[28] Spitzley J.B., Banasiak J., Filip Jirous, Najdawi C. (eclareon), Steinhilber S. (Fraunhofer ISI), Keep-on-Track! Project, Analysis of Deviations and Barriers 2013/2014, Published 30.06.2014, Contract N: IEE/11/842

The Bill sets out the national objective of transitioning to a low carbon, climate resilient and environmentally sustainable economy in the period up to and including the year 2050.

The Bill provides for the preparation, and approval by the Government, of five-yearly National Low Carbon Transition and Mitigation Plans (or “National Mitigation Plans”) which will set out how Ireland’s national greenhouse gas emissions are to be reduced, in line with both existing EU legislative requirements and wider international commitments under the United Nations Framework Convention on Climate Change (UNFCCC).

5.4 REGIONAL AND LOCAL PLANNING AND POLICY

5.4.1 Regional Planning Guidelines

The updated Regional Planning Guidelines 2010 – 2020[29] for the West Region were made by the West Regional Authority on the 24th June 2010 in accordance with the Planning and Development Acts 2000-2010 and the 2009 Regional Planning Guidelines Regulations.

The objective of the Guidelines is to provide a framework for long term strategic development of the West Region for the period 2010 – 2022 in the context of the National Spatial Strategy 2002 - 2020.

A key aspect of the West Regional Authority’s Regional Planning Guidelines is integrating sustainable economic development with the protection and enhancement of the environment. The Regional Planning Guidelines are influenced by a wide range of international, national and regional level plans, programmes and legislation. The Guidelines also establish a framework for other lower level plans and programmes. The Regional Planning Guidelines (RPGs) set out the vision for the West Region and also sets out priorities including those which fall under the Strategic Infrastructure Act, 2006. Local planning policy (namely county, city and town Development Plans) must be consistent with the new Regional Planning Guidelines to ensure that zoning corresponds with population targets as set out by the Department of the Environment, Heritage and Local Government and the West Regional Authority. These targets provide for a sufficient supply of sustainable development to meet the needs of the regional population over the lifetime of the Guidelines.

CO14: Support the identification of suitable wind energy development locations through Habitats Directive Assessment, including consideration of cumulative and in combination

[29] Regional Planning Guidelines for the West Region, 2010 – 2020, http://www.galway.ie/en/Business/WestRegionalAuthority/RegionalPlanningGuidelinesOtherPlans/

effects, landscape character assessments or landscape management strategy and habitat designations (Please refer to CO15 & IO54).

CO15: Initiate a Regional Energy Strategy for the West Region in order to identify suitable and unsuitable locations for new energy projects including networks. The strategy will be informed by Habitats Directive Assessment, landscape character assessments (or landscape management strategy) and other environmental assessment and will include consideration of potential cumulative and in combination environmental impacts (Please refer to CO14 & IO54).

With respect to planning and economic development the Guidelines sets out priority policies and objectives, with two considerations being deemed paramount:

- Productivity and Competitiveness
- Role of Cities/Urban Areas

Actions are listed (Section 3.5.2) to achieve competitiveness in the region. With respect to Section 3.5.2 (g) Renewable Energy the guidelines acknowledge the changing nature of energy supply as driven by resource depletion in hydrocarbons and the concerted global approaches being taken to address climate change. This is identified as providing opportunities and challenges for Irish enterprises over the coming years with forecast growth in the global energy goods and services. Potential activities range from the design, manufacture and installation of advanced equipment and infrastructures, project management and engineering services and solutions and operational management of energy assets and infrastructures.

The potential to harness opportunities in renewable energy in the West Region, due to its natural resources, include wind, wave and wood energy. The following policies and objectives are listed to support renewable energy development taking account of the need for appropriate assessment under the Habitats and Birds Directives as required (See Section 3.1.1 of the Regional Planning Guidelines).

Policies
EDP20: Support the region as a leader in research and development of sustainable renewable energy (Section 3.1.1 applies). (Please refer to CO14, CO15 & IO54). **EDP21:** Support the development of the electricity grid network to facilitate the roll out of renewable energy infrastructure (Section 3.1.1 applies). (Please refer to CO14, CO15 & IO54).

Objectives
EDO8: Subject to Habitats Directive Assessment and/or other relevant environmental assessment, support the deployment of renewable energy infrastructure in appropriate locations (Please refer to CO14, CO15 & IO54).

Section 5.5.4 of the Guidelines states that areas identified for wind farms must have regard to the level of the resource, the nature of the landscape, the status of surrounding lands and the Department of the Environment, Heritage and Local Government's 'Wind Energy Development Guidelines, 2006'. It also refers to the need for a Habitats Directive 'Appropriate Assessment' Screening along with other relevant environmental assessments where wind energy developments are proposed in or near a Natura 2000 site.

The development of the proposed Oweninny wind farm is supported by Policies EDP21 and EDP22 and Objective ED08. The Oweninny wind farm proposal has been developed with regard to the Department of the Environment, Heritage and Local Government's 'Wind Energy Development Guidelines, 2006'. A full ecological assessment of the potential for impact of the development on the ecology of the site has been undertaken (see Chapter 6 and Chapter 7). As the proposed development is located adjacent to special areas of conservation designated under the EU Habitats Directive screening for appropriate assessment has been undertaken also. This is provided as a separate document in the planning application.

The west Regional Authority reported that in the year following the adoption of the Regional Planning Guidelines for the West Region 2010-2022, implementation progressed well. Six of the eight development plans, including that of Mayo County Council had incorporated Core Strategies by the end of the 2011 in accordance with the Planning and Development Act 2000 (as amended)30.

5.4.2 Planning Policy - Mayo County Development Plan

Under Part II Chapter 1 of the Local Government Planning and Development Act, 2000, Planning Authorities are obliged to make Development Plans for their functional area every six years. The Mayo County Development Plan 2014 - 2020 came into effect in July 2015, following incorporation of Variation No. 1 into the plan, and is the framework document for guiding and controlling future developments in the county.

5.4.3 Mayo County Development Plan 2014 – 2020

The Mayo County Development Plan 2014 - 2020 is the current framework document for guiding and controlling future developments in the county. It presents the County Council's vision and strategy for the proper planning and sustainable development of the County. Variation No 1 of the Mayo County Development Plan 2014 – 2020, which was initiated in

[30] National Regional Planning Guidelines Implementation, Annual Report, 2011 http://www.galway.ie/en/Business/WestRegionalAuthority/RegionalPlanningGuidelinesOtherPlans/RPGs%20Implementation%20Annual%20Report%202011%202nd%20April%202012.pdf

July 2014 addresses the sections of the Plan (adopted on 22nd April 2014) deemed likely to result in significant effects on the environment including aspects of the Plan deemed likely to have a significant effect on one or more European sites and/or which were inconsistent with Ministerial Guidelines for Planning Authorities on Sustainable Rural Housing and Spatial Planning and National Roads."

The plan has undergone Strategic Environmental Assessment, Habitats Directive Assessment and Flood Risk Assessment and it was considered that no significant environmental effects are likely as a consequence of the plan or Variation No. 1. Additionally, it was determined, in view of best scientific knowledge, that Variation No. 1, individually or in combination with another plan or project would not be likely to have a significant effect on one or more European sites.

The purpose of Variation No. 1 was to, inter alia, address deficiencies in the adopted Plan from an SEA / Appropriate Assessment perspective and therefore to prevent significant effects on the environment and / or one or more European sites, Variation No. 1 was deemed likely to have positive effects on the environment and / or the integrity of one or more European sites.

5.4.3.1 Development Policies and Objectives

The Plan sets out objectives under Energy and Renewable Energy in Section 2 Economic Development Strategy as follows:

Energy Strategy EY-01 It is an objective of the Council to support and facilitate the provision of a reliable energy supply in the County, with emphasis on increasing energy supplies derived from renewable resources whilst seeking to protect and maintain bio-diversity, wildlife habitats, the landscape, nature conservation, and residential amenity.
EY-02 It is an objective of the Council to implement the Renewable Energy Strategy for Co. Mayo 2011-2020.
EY-05 It is an objective of the Council to support and facilitate the provision of a high quality electricity infrastructure in the County, whilst seeking to protect and maintain bio-diversity, wildlife habitats, scenic amenities, including protected views and nature conservation.
Renewable Energy Strategy RE-01 It is an objective of the Council to implement the Renewable Energy Strategy for Co. Mayo 2011-2020 or any amendment to same.
RE-02 It is an objective of the Council to identify at least one renewable energy hub in the County which will allow for the development of renewable energy devices and associated infrastructure/vessels/equipment and deployment of the same having regard to the needs of the industry while ensuring no adverse impact on the environment including Natura 2000 sites.
RE-03 It is an objective of the Council that proposals for wind farms shall demonstrate consistency with the Landscape Appraisal of County Mayo with reference to the four Principal Policy Areas shown on Map 3A Landscape Protection Policy Areas and the

Landscape Sensitivity Matrix (Figure 3), and the Wind Energy – Guidelines for Planning Authorities (2006).

The proposed Phase 1 and Phase 2 development for Oweninny wind farm is in line with the Energy Strategies EY-01 and EY-02 and the Renewable Energy Strategies RE-0, RE-02 and RE-03 in that it will increase energy derived from renewable energy in the county and is located in Priority Area for wind as set out in the renewable Energy Strategy for Mayo.

5.4.4 County Landscape Policy

Mayo County Council's Landscape Protection and Appraisal is discussed in detail in Chapter 11 – Landscape.

5.4.5 Mayo Renewable Energy Strategy

Mayo County Council adopted its Renewable Energy Strategy on 9th May 2011[31]. The Strategy sets out a path to allow County Mayo to contribute to meeting the national legally-binding renewable energy targets and clarifies the approach Mayo County Council takes to renewable energy. The Renewable Energy Strategy revises and replaces the Wind Energy Strategy for County Mayo. Its aim is to provide a plan-led approach to the location of renewable energy development in a more focused manner than that outlined in the Wind Energy strategy (2008). All major forms of renewable energy are considered in the Strategy, including wind energy.

With respect to wind Section 3.3.1 Renewable Energy from Wind states that wind power is currently one of the most developed and cost-effective renewable electricity technologies. Wind power is a renewable source of energy and produces no greenhouse gases during its operation.

Policy 3 deals with Strategic Infrastructure and states

"It is the policy of the Council to encourage and assist in the provision of strategic infrastructure at appropriate locations to facilitate the provision and exporting of renewable energy".

Section 6.4.1 relates to on-shore wind energy and Map 1 of the strategy classifies potential areas for on-shore wind energy development, (reproduced as Figure 5-2). Four classifications are identified:

[31] Forward Planning Section, Mayo County Council Renewable Energy Strategy for County Mayo, 2011-2020

Priority Areas are areas which have secured planning permission and where on shore wind farms can be developed immediately.

Tier 1 - Preferred (Large Wind Farms) are areas in which the potential for large wind farms is greatest.

Tier 1 - Preferred (Cluster of Turbines) are areas identified as being most suitable for smaller clusters of wind turbines (clusters of up to three to five turbines depending on site conditions and visual amenity).

Tier 2 - Open for Consideration identifies areas which may be considered for wind farms or small clusters of wind turbines but where the visual impact on sensitive or vulnerable landscapes, listed highly scenic routes, scenic routes, scenic viewing points and scenic routes will be the principal consideration. The Tier 2 classification will be reviewed by the Council following a determination by EirGrid of grid infrastructure for the County.

The Oweninny proposed wind farm site is located within the area classed as “Priority Areas”, which is an area where planning permission for wind energy development has been secured. Its development will contribute significantly to Mayo’s contribution to achieving national renewable energy targets.

5.4.5.1 Strategic Environmental Assessment – Draft Renewable Energy Strategy County Mayo

Strategic Environmental Assessment (SEA) is the process by which environmental considerations are required to be fully integrated into the preparation of Plans and Programmes and prior to their final adoption. The requirements for SEA in Ireland are set out in the following national Regulations;

S.I. No. 435 of 2004 (European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 and

S.I. No. 436 of 2004 (Planning and Development (Strategic Environmental Assessment) Regulations 2004 as amended by

S.I. No. 200 of 2011 (European Communities (Environmental Assessment of Certain Plans and Programmes) (Amendment) Regulations 2011) and

S.I. No. 201 of 2011 (Planning and Development (Strategic Environmental Assessment) (Amendment) Regulations 2011) respectively.

A Strategic Environmental Assessment of the Draft Renewable Energy Strategy for County Mayo was carried out in parallel to the Strategy by the SEA Team in Mayo County Council with an accompanying Environmental Report prepared by the Forward Planning Section of the Council.

Five Scenarios were considered as part of the alternatives assessed:

Scenario 1: Do Nothing Scenario - Retain Current Wind Energy Strategy and Mayo County Development Plan Renewable Energy Policies and Objectives

Scenario 2: Ad-hoc Planning for Renewable Energy Development

Scenario 3: Off-shore Renewable Energy Development only

Scenario 4: Strategically Planned off-shore and On-shore Renewable Energy Development

Scenario 5: Renewable Energy Development along the Mayo Coastline only

On the basis of the SEA analysis carried out, Scenario 4: Strategically planned Off-shore and On-shore Renewable Energy Development emerged as the most environmentally sustainable of the five scenarios considered.

The analysis also indicated that;

"Although Table 6.4 of the Environmental Report indicated that there is potential for conflict with the EPOs (Environmental Protection Objectives) under this Scenario in respect of Population and Human health; Freshwater, Material Assets including Drinking Water infrastructure, Piers and Harbours and IWAK, Cultural heritage and Landscape, such conflicts are likely to be mitigated by measures put in place to mitigate such conflicts. Scenario 4 also emerges as the alternative most likely to improve the status of the EPO's particularly those relating to Biodiversity, Flora and Fauna, Marine waters and Ecology, Soils and Geology, Material Assets such as Waste Management Infrastructure and Mayo Forest estate and the Architectural Heritage of the County

Having regard to planning considerations, Scenario 4 is also the option that emerges as the alternative that balances environmental protection with economic and social development. Therefore scenario 4 is the basis that forms the Draft RES"

The draft Renewable Energy Strategy was subsequently adopted on this basis and four classifications developed including "Priority Areas" within which the proposed Oweninny wind farm is located.

5.5 CONCLUSIONS

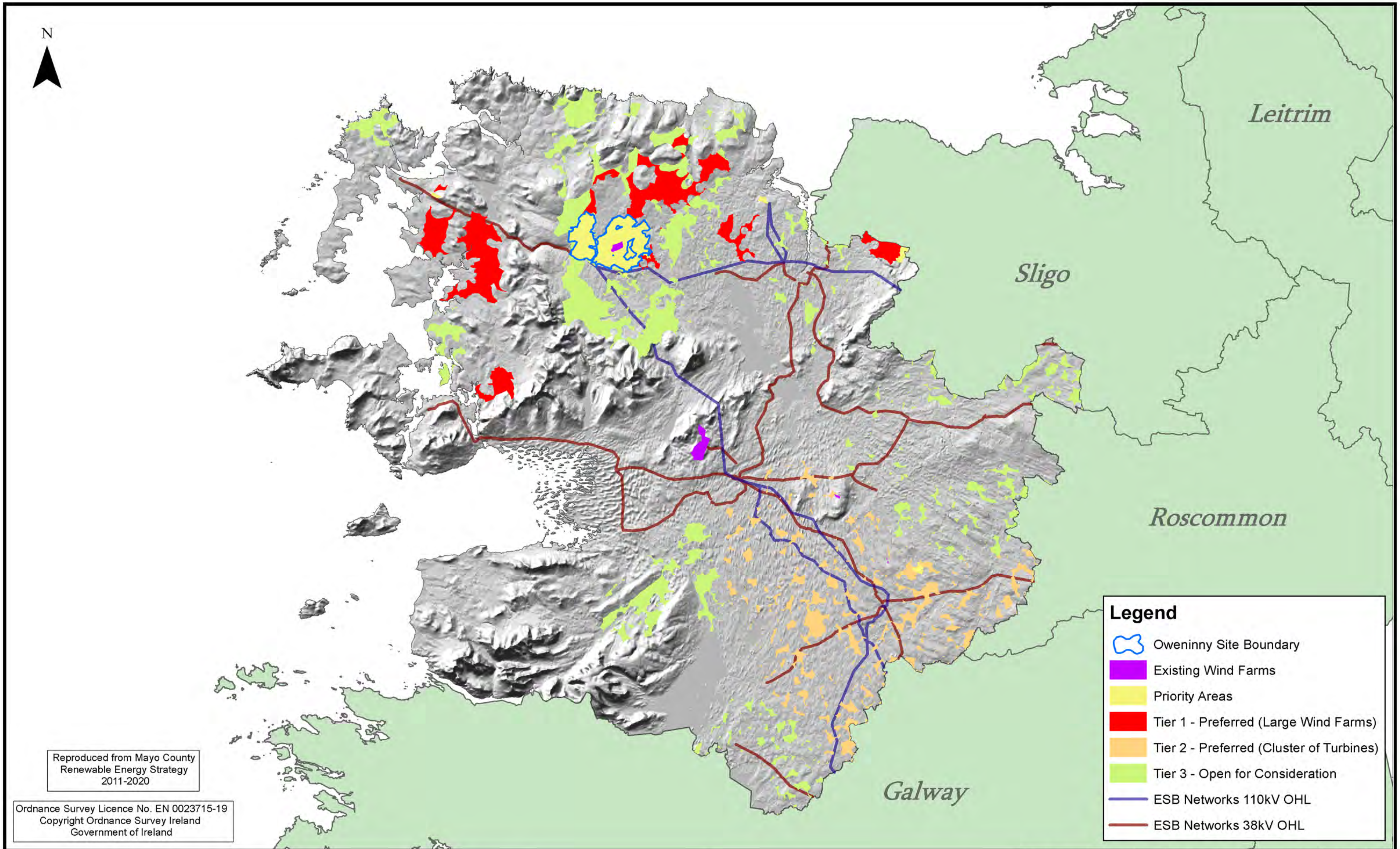
Ireland, like many modern economies, continues to face a wide range of challenges in energy policy due to a number of factors, including: rising prices of primary inputs (especially fossil fuels), energy and fuel price risk and volatility, energy supply security, greenhouse gas emissions, non-greenhouse gas emissions, rising demand, the requirement to invest/replace grid and infrastructure, and the creation of energy market competition and a single EU market. With these challenges to the fore, renewables policy is also an important issue for Ireland.

Within the portfolio of possible renewables, onshore wind power presents a potential means for Ireland to increase the amount of electricity that is produced by emission-free power generation capacity. Its potential contribution to achieving Irelands stated renewable energy target for 2020 is set out in Ireland's Renewable Energy Action Plan, with binding targets committed to under the promotion of the renewable energy directive. It can also contribute significantly to the EU's 2030 targets and towards decarbonising the Irish economy by 2050.

Ireland has an abundant wind energy resource and it is clear that there is strong support at multiple levels for the development of renewable sources of energy, such as will result from the proposed Phase 1 and Phase 2 of Oweninny Wind Farm.

Over the past decade, energy and environment policies have been adopted and realigned to reflect new concerns at national and international levels, to address the new realities in these areas and provide a focus for future actions. These are also reflected in the National Renewable Energy Strategy, the Regional Planning Guidelines and the policies and renewable energy strategy of Mayo County Council.

The development of Phase 1 and Phase 2 of the Oweninny wind farm, amounting to some 172 MW of installed wind energy, will contribute significantly to meeting the commitments of the Governments National Renewable Energy Plan (NREAP) obligation under the renewable energy Directive 2009/28/EC and towards meeting future EU targets. It is fully in line with the Regional Planning Guidelines and Mayo County Council's energy and renewable energy policies and objectives set out in the current County Development Plan 2014 – 2020 and is located within a Priority Area for wind development as designated by the Mayo Renewable Energy Strategy. The development will also contribute significantly to national greenhouse gas emission reduction and will contribute towards achieving Ireland's national target of renewable electricity generation.



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Mayo County Council Renewable Energy Wind Map
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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MAP REFERENCE

FIGURE 5.1

6 HUMAN BEINGS

6.1 INTRODUCTION

This chapter assesses the potential impact of the proposed project on human activity as related to the Phase 1 and Phase 2 development for Oweninny only. It covers the potential impact on the population of the area, on socio-economic activity and on the land use and amenity value of the area.

6.2 METHODOLOGY

The methodology for this chapter involved examination and compilation of relevant population and socio-economic data collected by the Central Statistics Office (CSO). Regard was also given to relevant planning and land use documents for the area.

An examination and compilation of the most recent Electromagnetic Field (EMF) research and studies was undertaken.

6.3 RECEIVING ENVIRONMENT

6.3.1 Population, Employment and Socio-economics

6.3.1.1 State population

The total population of the country enumerated on Census night 10 April 2011 was 4,588,252 persons, compared with 4,239,848 persons in April 2006, representing an increase of 8.2% in five years[32].

Despite continued growth rate population densities are still low from a European perspective and the overall population still remains below that of the island in the early-19th century. The population of the area comprising the Republic of Ireland was over 6.5 million as measured by the 1841 Census of Population.

Population structure and change in Ireland is strongly influenced by migration and emigration rates, rather than birth and death rates. Irish nationals continue to experience net outward migration, although at a lower level than in the previous year, falling from 29,200 to 23,200, while net inward migration among non-Irish nationals grew for the third

[32] Central Statistics Office, Statistical Year Book www.cso.ie

year in a row, from 7,900 to 11,600. Over the last 10 - 15 years, population trends in Ireland have changed dramatically. Historically, these trends were largely determined by labour market conditions in Ireland and in the countries to which Irish people migrated. Population growth peaked at 81,000 per annum during the 2002-2006 period. In April 2015 the population had risen to 4,635,400, an increase of almost 50,000 or just over 1% of the 2011 figure[33]. There were 67,000 births and 29,600 deaths in the period April 2014 to 2015, resulting in a natural increase in population of some 37,400.

While the natural increase of Ireland's population has in general been positive over the past 50 years, the large swings in net migration have had a strong effect on overall population growth. Net outward migration has varied considerably over the past 50 years. Outward migration during the 1950s led to a population low point of 2.8 million being recorded in the 1961 Census with net migration remaining negative throughout the 1960s.

Net inward migration was recorded briefly for the first time in the 1970s with an annual average of 14,000 between 1971 and 1979. This quickly reverted to net outward migration again throughout the 1980s with a record low point of 44,000 in 1989. The turnaround began in the 1991-1996 inter-censal period, with small positive inflows leading up to the peak net inward migration period of 2002-2006 when derived net inward migration measured 191,000 for the four year period (or 47,800 on annual average basis). Irish nationals continue to experience net outward migration in 2015, although at a lower level than in the previous year, falling from 29,200 to 23,200, while net inward migration among non-Irish nationals grew for the third year in a row, from 7,900 to 11,600

The combined effect of natural increase and negative net migration resulted in an overall increase in the population of 25,800 bringing the population estimate to 4.64 million in April 2015.

6.3.1.2 Mayo Population

The statistical year book, an annual publication by the Central Statistics Office, provides a comprehensive overview of the country in terms of population, labour market, education, agriculture, industry, the economy, housing and the environment. The statistical year book 2012 indicates that the population of Mayo stood at 130,638 persons in April 2011 an increase of 5.5% over the previous statistical year 2006. The population in County Mayo increased by 11.2% respectively during the periods 2002 to 2011, which is lower than the national average rate of increase for the same period. As

[33] CSO Statistical release, 26 August, 2015

would be expected, growth that was recorded was not uniform throughout the county. Substantial growth occurred in rural areas around the main towns, with decreasing numbers in other rural areas.

There has traditionally been a strong rural dimension to Co Mayo, which is still evident today, as the majority of the population live within rural areas. The principal towns are Castlebar, Ballina and Westport. Castlebar is the chief town in Co. Mayo.

Decreases in population in rural areas are generally attributed to the continuing decline in agricultural employment in rural areas.

Population decline is reflective of a number of processes at work, particularly in rural Ireland. These influences include the decrease in the number of farmers and the consequent increase in farm sizes, lack of locally based employment opportunities, lack of access to services and the movement of population, particularly the young, towards the larger urban centres.

The Mayo County Development Plan for 2014 – 2020 in its Core Strategy & Settlement Strategy sets population targets for 2020 for mayo in general and settlements around the Oweninny site as follows:

- Total Population target 148,414 (130,638 in 2011)
- Crossmolina - 1206 (1061 in 2011),
- Foxford – 1,507 (1,326 in 2011)
- Bangor Erris – 333 (293 in 2011)

The strategy targets and overall 13.6% increase in population in Mayo and these rural settlements.

6.3.1.3 Population in District Electoral Divisions at Oweninny site

The proposed development is located in a sparsely populated area of North Mayo. The proposed site boundary includes two electoral areas in County Mayo, namely Ballina and Bellmullet electoral areas. District Electoral Divisions (DEDs) intersecting the site include Kilfian South, Glenco/Sheskin, Derry, Kilfian West and Deel – see Figure 6-1. The most populous DED covering most of the site is Kilfian South. The populations of each DEDs from Census of Ireland data produced by the Central Statistics Office are shown in Table 6.1.

The population of the state and of County Mayo are included here also. With the exception of Kilfian South there has been a decline in the rural population in the district electoral divisions surrounding Bellacorick.

Table 6.1: Population Change 2002-2011

Area	Persons 2002	Persons 2006	Persons 2011	% Change 2002 - 2011
State	3,917,203	4,239,848	4,588,252	+17.1%
West Region	380,297	414,277	445,356	+17.1%
Mayo	117,446	123,839	130,638	+11.2%
Ballina Rural Area	15,041	15,545	16,416	+9.1%

Area	Persons 2002	Persons 2006	Persons 2011	% Change 2002 - 2011
Belmullet Rural Area	7,927	7,923	8,005	+1.0%
022 Kilfian South	250	246	259	+3.6%
058/065 Glenco/Sheskin	125	117	97	-22.4%
019 Derry	236	216	195	-17.4%
023 Kilfian West	151	133	134	-11.3%
018 Deel	551	511	532	-3.4%

6.3.2 Socio-economics

The occupation by industry for County Mayo is shown in Table 6.2. Similar to the national picture a significant drop in employment occurred in the construction and associated activities (quarrying and transportation) with a reduction in manufacturing industry also. The service industry, public administration and defence and education saw an overall increase during this period. The numbers unemployed more than doubled in the inter-censal period.

Table 6.2: Number of Persons in Employment by Industry - Co. Mayo

Occupation	2006	2011	% change
Agriculture, forestry and fishing	4,754	5,411	+13.8
Mining, quarrying and turf production	337	249	-26.1
Manufacturing industries	6,676	5,838	-12.6
Electricity, gas and water supply	309	373	+20.7
Construction	7,787	3,127	-59.8
Wholesale and retail trade	7,035	7,675	+9.1
Hotels and restaurants	3,410	3,481	+2.1
Transport, storage and communications	1,971	1,697	-13.9
Banking and financial services	1,040	1,018	-2.1
Real estate, renting and business activities	2,788	2,931	+5.1
Public administration and defence	2,531	3,203	+26.6
Education	3,465	4,190	+20.9
Health and social work	5,697	5,695	0.0
Other community, social and personal service activities	1,836	1,988	+8.3
Industry not stated	2,641	2,200	-16.7
Total at work	52,277	49,076	-6.1

Occupation	2006	2011	% change
Unemployed - looking for first regular job	774	893	+15.4
Unemployed - having lost or given up previous job	4,466	10,973	+145.7
Total in labour force	**57,517**	**60,942**	**+ 5.9**

However, while acknowledging this in the Economic Strategy of the Mayo County Development Plan 2014 many positive outcomes have also been identified in Mayo since 2008 which assist in the promotion of the County as a place to invest, work, visit and live in,. These include population growth, significant investment in infrastructure, increased rail service to the County, establishment of new indigenous businesses, investment in renewable energy developments, and general focus on quality of Mayo's socio economic aspects. Recovery in Mayo is underpinned by the Government commitment to achieving economic recovery and getting Ireland "back to work" supported by specific strategies, targets and actions including:

- Action Plan for Jobs 2012 & 2013
- Delivering Our Green Potential
- Harnessing Our Ocean Wealth
- Strategy for Renewable Energy
- Food Harvest 2020
- Supporting Economic Recovery and Jobs Locally

The Mayo County Development Plan's economic development strategy supports the Governments Commitments with the establishment in 2012 of an Enterprise and Investment Unit (EIU) The key sectors this Unit is currently focusing on are Tourism, Renewable Energy, ICT, Marine, Micro Enterprise and the Diaspora, with a view to expanding into other areas in due course following the completion of an Emerging Sectors report currently being prepared.

6.3.2.1 Summary

In terms of population dynamics Mayo has seen an overall increase in population of 11.2% between 2006 and 2011, the last inter-censal period, with a targeted increase to 2020 through its development plan core strategy. This is largely associated with urban and near urban area growth. By contrast, with the exception of Kilfian South DED, there has been a marked decline in population numbers in the rural DEDs around the proposed development site. Mayo has also seen a 6% increase in the total available labour force in the intercensal period, however some 11,866 people were stated as being unemployed (19.5% of the total labour force) at that time. Unemployment is largely associated with the construction industry and with the associated supply chain industries such as mining and quarrying and manufacturing.

The Oweninny Phase 1 and Phase 2 wind farm project will provide meaningful direct employment in the construction industry during the construction phases of the project which could see employment opportunities over a 5 year period with additional spin off employment in quarrying and materials supply. Additionally, employment opportunities will arise during the operational period.

6.3.3 Public Attitudes

The report 'Attitudes towards Wind Farms and Wind Energy in Ireland[34]', which provided the results from Ireland's first independent study of the Irish public's attitude towards the development of wind energy, highlighted the following:

- There is a high level of public support for developing more sources of renewable energy in Ireland.
- The overall attitude to wind farms is very positive. More than eight of ten people believe wind energy to be a good or fairly good thing.
- A large majority of the general public believes that wind farm developments do not impact on the scenic beauty of an area. This is the case irrespective of the type of landscape.

It was noted that a significant portion of those opposed to a local wind farm did not really have any reason they could articulate, other than that they simply didn't want it.

More recently Fáilte Ireland, in association with the Northern Ireland Tourist Board (NITB), commissioned a survey of both domestic and overseas holidaymakers to Ireland to determine their attitudes to wind farms[35]. Interviews indicated that most visitors are broadly positive towards the idea of building more wind farms on the island, although a sizeable minority (14%) exists who are negative towards wind farms in any context, see Chapter 16, Section 6.2.3).

At two public consultation meetings held in Crossmolina and Bangor in December 2012 the majority of the public were considered to be supportive of the proposed wind farm development mainly due to the employment opportunities that would arise during its construction and operation.

6.3.4 Health and Safety

The basic technology to be employed in the project is well understood and there have been significant technical advances in the recent past that have further improved it in terms of health and safety. The development of the technology is reflected in its growing application in many successful projects both nationally and internationally.

[34] Attitudes Towards the Development of Wind Farms in Ireland, Report by Sustainable Energy Ireland, 2003

[35] Fáilte Ireland, Visitor Attitudes on the Environment - Wind Farms, 2008/ No 3

6.3.5 Electromagnetic Fields

Electric and magnetic fields (electromagnetic fields (EMF)) around wind farms can originate from the grid connection lines, wind turbine generators, electrical transformers, and underground network cables. Both electric and magnetic fields also occur naturally. The Earth's magnetic field, which is due mainly to currents circulating in the outer layer of the Earth's core, varies between about 30µT (microtesla, 1000µT = 1mT, millitesla) at the Equator and about 60µT at the poles. This field may be distorted locally by ferrous minerals or by steelwork such as in buildings.

At the Earth's surface there is also a natural electric field, created by electric charges high up in the ionosphere, and varying between 100 and 150 Volts per metre (V/m) in fine weather. Below a storm cloud containing large quantities of electric charge for example, the field may reach intensities up to 20kV/m over flat surfaces, while above hillocks or other irregularities or near the tops of objects such as trees, the field strength can be considerably higher. In mountains, for instance, the presence of these fields produces electrical discharges and crackling noises on sharp ridges and on the ends of ice peaks.

6.3.6 Ice shedding

Similar to other structures there is some potential for ice to form on wind turbines under certain atmospheric conditions, typically with ambient temperatures near freezing (0°C) combined with high relative humidity, freezing rain, or sleet. Weather conditions, the force of gravity and turbine blade rotation may cause this ice to be shed, giving rise to safety concerns. Under certain conditions changing temperatures and climatic conditions may cause ice fragments to loosen and fall. Rotating turbine blades may also propel ice fragments up to several hundred metres from the turbine depending on conditions. The immediate risk area will be directly beneath the turbine blades and within several hundred metres from the wind turbine itself.

Two types of ice can form on the blades of wind turbines. Smooth glaze ice, which is transparent and highly adhesive, forming when moisture contacts surfaces colder than 0°C, (e.g., ice storms at low elevation). It normally falls straight down shortly after formation. Granular and opaque rime ice (formed from super-cooled droplets which trap air giving the ice a white appearance) can form at colder temperatures and is less adhesive. It is sometimes thrown from moving turbines, but often breaks into smaller pieces. Falling ice may cause damage to structures and vehicles, and injury to site personnel and the general public, unless adequate measures are put in place for protection. Ice shedding from stationary turbines could place service personnel within the wind farm at risk.

6.3.7 Shadow Flicker

Wind turbines, as with trees or any other tall structure, can cast long shadows when the sun is shining and is low in the sky. A phenomenon, known as shadow flicker, which could be considered a nuisance even though the effect would be very short-lived, could occur under certain conditions. This is where the blades of a wind turbine cast a shadow over a window in a nearby house. The rotation of the blades might cause a shadow to be cast about once per second or two in the room whose window is affected. The potential for shadow flicker at distances greater than 10 rotor diameters (a maximum of 1,200m in the case of Oweninny) is very low. Where unacceptable impacts in terms of level of shadow flicker are predicted the relevant contributing turbines can be curtailed in operation for the brief critical periods. An assessment of the potential for shadow flicker from wind turbines within the Oweninny wind farm on houses within 10 rotor diameters to occur is provided in Chapter 8 of this EIS.

6.3.8 Noise

Noise may have various effects on human beings exposed to it ranging from discomfort and annoyance to various psychological and pathological conditions. The susceptibility of people to noise, and the level of annoyance they experience, varies widely; indeed the degree of annoyance is dependent on the quality of the sound and the recipient's attitude towards it. Measurable psychological and pathological effects have been shown to be attributable to noise. They include effects on health, sleep, communications, working efficiently, industrial accidents and mental stress. An increase in background noise will occur during the construction and operational phases of the development. Construction noise will be typical of that associated with any large construction site and will be temporary in nature. An increase in background noise will occur when the wind farm is operational and generating electricity. The levels of noise attributable to the proposed development are such that significant health effects outside the site boundary (such as occupational deafness, etc.) can be ruled out. Impacts such as annoyance must however be examined as part of this study. A full assessment of the construction and operational noise is provided in Section 7 below.

6.4 POTENTIAL IMPACTS OF THE DEVELOPMENT CONSTRUCTION PHASE

6.4.1 Population, Employment and Socio-economics

6.4.1.1 Local Level

The proposed development of Phase 1 and Phase 2 contains no residential component and will have no significant direct impact on the composition of the population in the immediate area. There is no evidence from Ireland or elsewhere that the presence of a wind energy development in an area has an effect on population numbers.

During construction there may be some limited impacts on the residential amenity of the population living in the locality of the development. These would be short-term impacts relating primarily to construction noise and traffic. These impacts are quantified and described in detail elsewhere herein.

As in many capital intensive industries, renewable energy development tends to be characterised by substantial short-term employment creation during the construction phase and relatively modest long-term employment thereafter. As the Oweninny project will be developed over a number of phases its short term construction employment opportunities will extend over a more prolonged period than normal for a wind farm development. In the case of Oweninny short term employment opportunities during the construction phase will extend over a prolonged period as the wind farm is constructed in phases. At peak employment, it is estimated that more than 100 construction jobs will be created with an estimated 6 full time jobs associated with wind farm maintenance during the operational phase and a further 5 -10 jobs in the proposed Visitor Centre. For example at Bord na Moná's Mount Lucas wind farm development up to 150 people have been employed in construction at peak periods.

Employment in the wind energy sector is closely related to the rated capacity planned, constructed and installed and, as such, jobs supported by the wind industry are located largely where generating capacity is installed. Therefore, for the industry as a whole the jobs created will be widely dispersed around the island of Ireland, including Co. Mayo. The installed capacity proposed for the site means that maintenance personnel are likely to be based there and essentially dedicated to the operation and maintenance of the wind farm.

During the construction phase, which will occur over two separate phases, with phase 1 and phase two lasting about 24 months each, there will be significant expenditure on the provision of fill and aggregate materials and on site facilities including the construction of the civil and electrical infrastructure. These can benefit local companies, contractors and their employees. There will also be indirect employment in the manufacture of building materials and equipment used in construction.

A requirement for some temporary or medium-term accommodation may arise during project construction.

The wind farm will impact significantly on other employment in the area particularly local quarries that may be awarded contracts for the supply of fill material aggregates and concrete. The project will generate annual Local Authority Rates for Mayo County Council that will provide indirect long-term benefit for the broader community.

The anticipated total capital cost of the project is of the order of up to €326M. In addition to impacts on the national economy, this expenditure will result in economic benefit to the local economy. Up to approximately 25% of expenditure will be on the supply of construction material, non-turbine equipment and services.

There will be a significant benefit to Mayo County Council in terms of rate payments. Local Authorities receive annual rates from wind developers with an average of €6866 per MW. In 2013 local authorities will benefit to the tune of €11.9 million[36] demonstrating the wind industry's benefit to county councils.

[36] The Irish wind Energy association, Economic Benefits of Wind Energy, 2013

6.4.1.2 National Level

Based on the estimates of the capacity to be installed to reach national targets for renewable energy generation, a report in 2009 by Deloitte [37] indicated that the construction and development of wind energy projects across Ireland to 2020 will involve c. €14.75 billion of investment, c €5.1 billion of which will be retained in the local Irish economy to 2020.

Studies have shown that in 2007 with an installed capacity of just over 56,500 MW, the EU wind energy sector employed more than 150,000 people directly and indirectly in the sector.

The Deloitte report suggested that the wind energy sector to 2020 in Ireland is capable of supporting more than 10,760 jobs through direct and indirect involvement in the sector. Regarding potential employment in the renewables sector, construction jobs include civil engineering, electrical engineering, labouring, project management, health and safety, turbine transport and crane operation, and further environmental analysis required to satisfy planning conditions. Figure 6-2 shows the breakdown in Irish Wind jobs by category.

The above is a substantial contribution, particularly given the decline in traditional industries including agriculture and across a number of areas of manufacturing. In addition many of the jobs created in the renewables sector would be private sector employment, thereby contributing to the necessary balance between the enterprise and public sectors. The estimates take no account of turbine installation, as international suppliers tend to predominantly deploy in-house teams rather than sub-contracting all activities. Projected employment in the wind industry is shown in Figure 6-3.

The report also identifies other sectors where activity is expected to increase to facilitate wind energy development generating additional employment opportunities;

"Other opportunities in the Wind Energy Sector are becoming apparent, such as grid development upgrade works, pump storage, energy exports and electric transport and many others, and these initiatives will all contribute positively to the growing employment numbers in the wind energy sector and the investment in the sector. At this stage, the research is still ongoing in relation to these initiatives and as such employment numbers cannot be quantified accurately".

The outcome of the analysis undertaken regarding employment is comparable with the results found in studies elsewhere.

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[37] *Deloitte, IWEA* Jobs and Investment in Irish Wind Energy Powering Ireland's Economy,2009

6.4.1.3 Avoidance of imported fossil fuels

The Sustainable Energy Authority of Ireland (SEAI) released the results of a comprehensive study of Ireland's electricity system throughout the whole of 2012[38]. The study shows that renewable electricity resulted in greatly reduced use of gas, coal and peat, saving Ireland €245 million in fossil fuels and reducing CO_2 emissions by 1.9 million tonnes.

The bottom line' savings:

- Renewable electricity generation in the Republic of Ireland is estimated to have saved 778 ktoe of fossil fuel, with an associated CO2 emissions reduction of 1.94 million tonnes. Wind generation is the largest contributor, with savings estimated at 586 ktoe of fossil-fuel and a CO2 emissions reduction of 1.51 million tonnes.
- The value of the fossil fuels not consumed in the Republic of Ireland in 2012 as a result of renewable electricity generation is estimated at €245 million, with the value of avoided CO2 emissions being a further €15 million. Savings from wind generation are estimated at €177 million in fossil fuel and €11 million in CO2 emissions. Apart from a small quantity of peat, all of the savings are due to the displacement of imported fossil fuels.
- The total fossil-fuel generation displaced by renewable electricity generation in the Republic of Ireland in 2012 is equivalent to the electricity demand of 780,000 Irish households.

Thus wind energy contributes very significantly to savings for Ireland's economy and can increasingly do so going forward.

6.4.1.4 Cumulative Impacts Population, Employment and socio economics

Wind farms

Should the construction of Corvoderry, Tawnanasool and Dooleeg wind farms occur at the same time as Phases 1 and 2 of Oweninny then there would be increased employment opportunity in the general north Mayo area. This would be associated with the construction of the wind farm itself and also through indirect employment related to the provision of materials for construction and in their transportation.

[38] SEAI, Quantifying Ireland's Fuel and CO2 Emissions Savings from Renewable Electricity in 2012

During the operational phase there would be limited potential for additional long term employment opportunities associated with operational and maintenance activities due to the smaller scale of these wind farm developments.

Potential future development of Oweninny Phase 3

The potential future development of Oweninny Phase 3 would almost double the time frame for construction of Oweninny Phase 1 and 2 leading to prolonged employment in its development. Peak numbers employed, would not however increase but the period of employment would be extended. Indirect employment associated with materials production for wind farm construction would also be extended as would the socio-economic benefit to the region in general.

During the operational phase additional personnel would be employed on a long term basis for operation and maintenance.

The cumulative impacts of Phases 1, 2 and 3 are as described in the original EIS document which accompanied the planning application to An Bord Pleanála in 2013.

Overhead line uprates.

Construction related to the uprating of the Bellacorick to Castlebar, Bellacorick to Moy 110kV overhead lines and of the Bellacorick to Bangor Erris 38kV line would involve relatively low numbers of people but would still add to the overall employment opportunities. Operational and maintenance activities associated with these existing lines are routinely carried out by ESB Networks or their sub-contractors and no additional employment would occur.

Power plant

Should the proposed power plants proceed to development, this would offer additional employment opportunities in the general area during the construction and operational phase.

Substation upgrade.

The proposed upgrade of the Bellacorick substation requires minimal works and no significant employment or socioeconomic benefit will accrue cumulatively from this.

6.4.2 Public Attitude to Wind Farms

Surveys of public attitudes both across Europe and in specific countries show consistent, strong support for renewable energy in general and for wind power in particular.

6.4.2.1 Ireland

The results from Ireland's first independent study of the Irish public's attitude towards the development of wind energy were reported by the Sustainable Energy Authority of Ireland34.

Because wind turbines and wind farms are a relatively new feature on the landscape and have been largely confined to remote areas, the direct experience by the public of wind farms is limited. Thus, while the supportive attitude of the general public towards wind farm development is of obvious interest, the views of those living in close proximity to existing wind farms are of particular interest. For this reason the study collected views of people living in the vicinity of a wind farm.

The report noted that people in the immediate vicinity of an existing wind farm are positively disposed to the development, see Figure 6-4.

- *The study highlighted that wind farms are seen in a positive light compared to other utility-type structures that could be built on the landscape:*
- *The study indicates that the overall attitude to wind farms is almost entirely positive. More than eight out of ten believe wind energy to be a very or fairly good thing.*
- *The study highlights that wind farms are seen in a positive light compared to other utility-type structures that could be built on the landscape.*

Encouragingly, the study highlights that two-thirds of Irish adults are either very or fairly favourable to having a wind farm built in their locality, with little evidence of a 'Not In My Back Yard' effect."

Of those who are positively disposed to a local wind farm, the overwhelmingly cited reason was that it produces clean energy. Where negative attitudes were voiced towards wind farms the visual impact of turbines on the landscape was the strongest influence. However, impact on the landscape was not a major concern for those living near an existing wind farm.

In a more recent Ipsos MRBI poll carried out on behalf of the IWEA in March 2013, 80% of those polled were in favour of wind energy with 53% sharply in favour and only 8% firmly opposed.

6.4.2.2 Britain & Northern Ireland

Various wind farm developers have carried out surveys to explore public attitudes to wind farm development. In all surveys, a majority of respondents have indicated a high level of satisfaction with wind farms. The surveys also show that local approval rises once a wind farm becomes operational. The British Wind Energy Association has noted that over 50 surveys have determined that wind farms have a high level of public support, with an average of 70 - 80% of respondents, including those residents living near wind farms, believing that wind energy is, in principle, a good thing. In 2003 a Scottish Executive poll of nearly 2,000 people living within 20 km of Scotland's ten largest wind farm found more than 80% are in favour of increasing the amount of electricity generated by the turbines. Only 2% said that it should be reduced. Around 20% thought that wind farms have a positive effect on their area, compared to 7% who disagreed. Almost 90% said the landscape had remained unspoiled by the development of wind-powered turbines.

These surveys are echoed in Northern Ireland by the study Attitudes and Knowledge of Renewable Energy39, prepared on behalf of the Department of Enterprise, Trade and Employment (DETI) and others. It showed that 98% of the general public of Northern Ireland believes that renewable energy is a "very good idea" or "a fairly good idea." Of the respondents in this survey 87% stated that they would be happy to have a renewable energy development in their area. Of all types of renewable energy, on-shore wind ranked with solar-power as the most widely accepted technologies. Of the respondents 90% believed that wind development is a good idea and 70% approved of such a development locally.

Market Research Northern Ireland carried out a survey of residents around Elliot's Hill Wind Farm in 2003, interviewing 400 householders within 4 km of the development. The results showed that 70% of residents expressed approval for the wind farm and 86% were of the opinion that the wind farm fits in with the surrounding countryside and landscape. Those residents close to and within sight of the wind farm were more likely to have a favourable opinion.

These results are further echoed by a Millward Brown Ulster40 survey conducted in Northern Ireland in April 2005. This study determined that 87% of people in Northern Ireland believe that wind farms are necessary to meet current and future energy needs; that 66% of people in Northern Ireland and 73% of those in the western portion of the province would be happy to have a wind farm in their local area. This survey showed increases in positive attitudes towards wind farms by those in the southern and western regions of Northern Ireland.

6.4.3 Community Benefit

Community benefit schemes, which are over and above the local direct project investment, are a well-established component of wind energy developments in Ireland. The Irish Wind Energy Association (IWEA) recognises and stresses that increasing community acceptance of wind energy is central to the efficient deployment and expansion of wind energy in Ireland with the consequent positive economic development resulting in greater security of our energy supply, job creation, lower energy prices and a reduction of greenhouse gas emissions. IWEA have reinforced their commitment to local

[39] Attitudes and Knowledge of Renewable Energy amongst the General Public, Report of Findings August 2003

[40] NI Omnibus Action Renewable 2005 Milltown Brown Ulster

communities through publication of its community engagement and commitment guidelines41, the principles of which will be followed by Oweninny Power Limited. The wind sector already delivers long lasting community benefits to communities across Ireland

Often seen as a goodwill contribution, community benefit schemes are a commitment by developers to ensure that a proportion of the benefits delivered by wind energy projects are realised within the communities that live near them. Community benefit is also recognition of local communities' accommodation of wind farms in their area.

Contributions made by the developer are used to support the local community, through funding of projects and services over and above those required to be provided by the local authority. These can include:

- the provision or improvement of amenity facilities
- the provision or improvement of recreational facilities
- the provision or improvement of educational facilities
- the provision or improvement of cultural or heritage facilities
- the protection or enhancement of the environment

The IWEA published protocol for community benefit sets out the key principles are as follows:

- *"These Best Practice principles apply to onshore wind energy projects of 5MW and above in the Republic of Ireland reaching commercial operation 6 months after publication of the principles*
- *Any method of community funding will be determined by the relevant developer with the project specific communities. The communities will be identified through a process of engagement involving all relevant stakeholders. The community to benefit from developer contributions could be determined by taking a number of factors into consideration such as population and population density. Local consultation and knowledge should be central to defining the local community.*
- *the protocol to be agreed by all participating onshore IWEA members and apply to all projects of 5MW and above in Ireland reaching commercial operation 6 months after adoption of the protocol.*
- *Support equivalent to a value of at least €1000/MW of installed capacity per annum, index-linked for the lifetime of the project to be provided.*

[41] Irish Wind Energy Association , Good Neighbour, IWEA Best Practice Principles in Community Engagement and Community Commitment, 2013

- *Payments and/or benefits in kind under a community benefit scheme to commence not later than twelve months from the date of completion of commissioning of the windfarm (unless otherwise agreed by the developer/operator and any proposed recipient to be paid at a later date).*
- *Payments and/or benefits in kind shall be provided for the duration of the commercial operation of the wind farm. Annual payments may be wholly or partially aggregated over the permitted operational life, as agreed through consultation between the project developer/operator and the community.*
- *All parties to this Best Practice will continue to commit to full, open and transparent dialogue with local communities around proposed windfarm projects."*

Oweninny Power Limited believes in the importance of community benefit and both Bord na Móna and ESB take a balanced and sensitive approach to local communities where its wind farms are located. In line with the IWEA protocol and the ESB Community Engagement Policy, Oweninny Power Limited will:

- *Seek to be fair and equitable in its dealings with the local community*
- *Consult and engage with the local community where possible*
- *Try to remedy genuine concerns the local community may have about the project*
- *Put in place local community funding arrangements for the Oweninny wind farm community area. A support fund will be put in place for Oweninny wind farm with the funding directed towards areas such as the Visitor Centre development and operation, education and sustainable development and assisting vulnerable groups in the community.*
- *A regulated independent grant making body will be retained to administer and distribute the community support funds. This body will work within an agreed framework and will manage approval committees, prepare and evaluate applications for funding, distribute funds to selected projects. A detailed control framework will be put in place and the grant making body will*
    - *Promote and publicise the fund and the application process through local partnerships, community associations and local media*
    - *Provide application forms and Web application for funding projects*
    - *Assess all applications to the community support funds within a specified time frame*
    - *Notify successful and unsuccessful applicants*
    - *Provide Oweninny Power Limited with a project appraisal document outlining the projects for funding*
    - *Recommend the Area of Benefit for the fund in conjunction with the local community*
    - *Promote and assist Oweninny Power Limited in public relations events in the local community*
    - *Support Oweninny Power Limited in setting up a local Community Liaison Committee if required*
    - *Provide evidence of project completion and success and provide Oweninny Power Limited with a follow up report.*

- *Evaluate the impact of the support fund on the local community*
- *Provide Oweninny Power Limited with annual accounts for audit*

6.4.4 Health & Safety

The Department of Environment, Heritage and Local Government (DoEHLG) Wind Farm Planning Guidelines note as follows regarding safety aspects:

"There are no specific safety considerations in relation to the operation of wind turbines".

As with any structure, fires in wind turbines are not totally unknown. A wind turbine caught fire in hurricane-force winds at Ardrossan, North Ayrshire, Scotland, during severe weather in 2011. A wind turbine collapsed in the Maas area of Ardara in Donegal in 2013. A wind turbine also collapsed in January 2014 on the Screggagh wind farm near Fintona in Co Tyrone. While such events are dramatic visually, they are nevertheless extremely rare in context of 165,000 working, productive wind turbines worldwide.

6.4.4.1 Electromagnetic Radiation

All electrical equipment produces both electric and magnetic fields, collectively termed electromagnetic fields or EMF. In common with electrical equipment, the turbines and other equipment associated with a wind farm emit electromagnetic radiation. Such emissions for the type of machine under consideration would be very low in the immediate vicinity of the machine and almost non-existent at any distance from it. There is no evidence that such emissions, which are common at higher levels in all built-up areas, are injurious to human health.

Domestic electrical appliances and tools for example can generate much higher magnetic and electric fields in their close proximity than transmission lines at a nominal 50m distance away. A comparison of typical magnetic and electric fields from 220kV transmission lines and the fields generated by domestic appliances is shown in Plate 6-1.

Power systems generally use alternating voltages and currents and hence the fields they produce are also alternating. Power lines in Ireland operate at 50 cycles per second (hertz or Hz); so voltage, current and fields each alternate at this frequency.

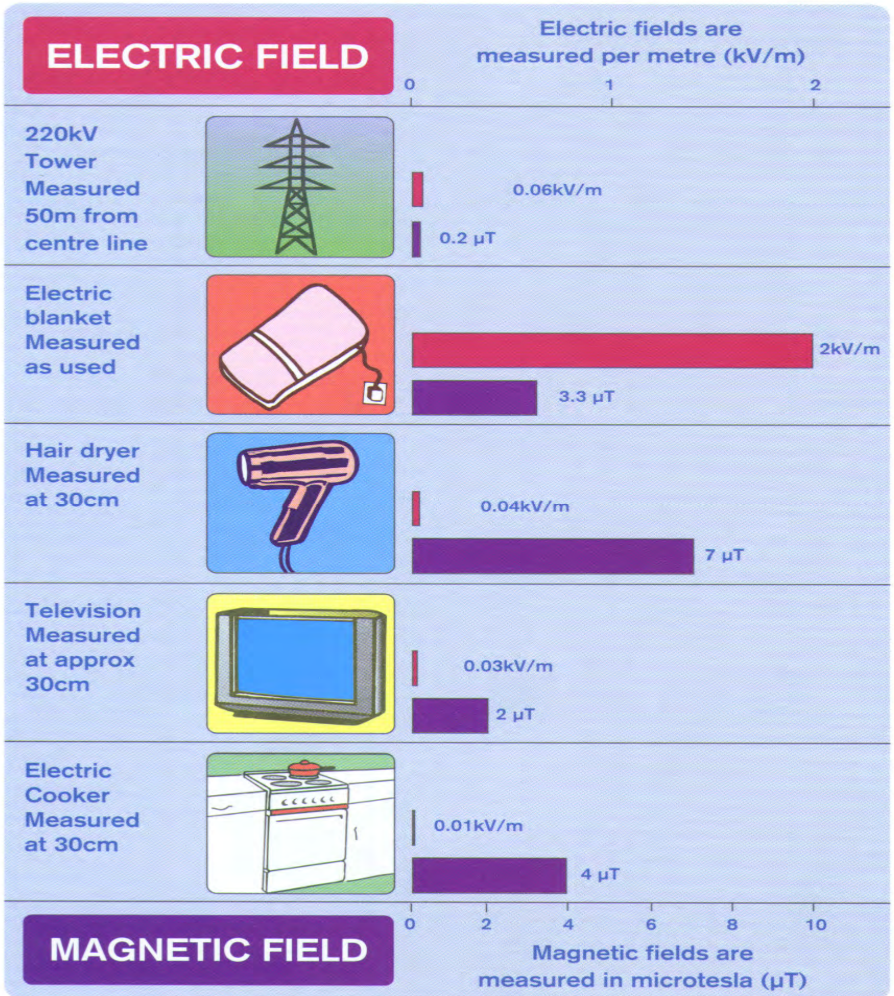


Plate 6-1: Electric and Magnetic Field comparisons

Additionally EirGrid, the National Grid Operator, have published a booklet "EMF & YOU" which provides information on electric and magnetic fields and the transmission system in Ireland.[42] This booklet includes an assessment of the most recent research findings into the health and safety effects of electric and magnetic fields from both direct current

[42] EirGrid, EMF & YOU, Information about Electric & Magnetic Fields and the electricity transmission system in Ireland, Revised July 2014

and alternating current transmission systems. This identifies that no adverse health effects have been established below the limits suggested by international guidelines and to date scientific research has not confirmed any adverse effect to human health.

It is accepted internationally that wind turbine generators and underground electricity cables do not give rise to potential EMF impacts with human beings. Turbine generators are located inside the turbine's central housing, which will be situated up to 120 m above ground, and will result in little or no EMF at ground level. In addition all wind turbines are at least one kilometre from the nearest dwelling house. The underground cables that connect the turbines effectively generate no EMF at the surface because of the close placement of phase conductors, that is placing the cables with small separation distances, to minimise the EMF field generation and screening of the cables. Transformers located in substations are the main EMF generation focal points within the wind farm itself and there are also localised fields associated with the 110 kV overhead electricity lines. However, in the case of Oweninny the nearest dwellings are in excess of 400m from the nearest proposed overhead line or substation and as such there will be no impact from EMF associated with these, see Table 6.3.

Table 6.3: Distance of neighbouring houses to OHL and substation locations

House Code	Distance to nearest OHL (km)	Distance to nearest substation (km)	House Code	Distance to nearest OHL (km)	Distance to nearest substation (km)
H1	2.6	2.5	H24	5.8	4.8
H2	2.5	2.4	H25	6.6	4.9
H3	2.5	2.4	H26	6.7	5.0
H4	2.5	2.6	H27	5.1	5.1
H5	2.5	2.8	H28	5.1	5.1
H6	2.4	2.7	H29	5.1	5.1
H7	1.6	2.7	H30	5.2	5.1
H8	1.1	2.6	H31	5.3	5.3
H9	1.2	2.9	H32	5.4	5.3
H10	1.3	3.0	H33	5.4	5.4
H11	1.3	3.0	H34	5.6	5.5
H12	6.1	2.3	H35	5.7	5.5
H13	0.4	1.8	H36	5.3	5.1
H14	0.4	1.5	H37	5.3	5.3
H15	1.2	1.2	H38	5.5	5.4

House Code	Distance to nearest OHL (km)	Distance to nearest substation (km)	House Code	Distance to nearest OHL (km)	Distance to nearest substation (km)
H16	1.4	1.3	H39	5.6	5.5
H17	4.6	3.6	H40	5.8	5.6
H18	4.8	3.5	H41	5.8	5.7
H19	4.8	3.5	H42	6.6	6.5
H20	4.9	3.5	H43	6.7	6.5
H21	4.9	4.6	H44	6.8	6.7
H22	5.3	4.8	H45	6.9	6.7
H23	5.7	4.8	H46	8.1	8.0

6.4.4.2 Structural Integrity of Turbines:

In the past, some poorly designed wind turbines have experienced blade failures during storms. This has applied particularly to two-bladed machines. In documented cases of wind turbine blade failure, the maximum reported throw distance is 150 m for an entire blade, and 500 m for a blade fragment.

The type of wind turbine proposed will be a three-bladed machine with High IEC Class Two Certification for Structural Integrity issued by Germanischer Lloyd. The machines will be designed to withstand gusts of up to 70 m/s (157 miles/hour), which is well above the wind speed applicable to the design of conventional structures in this part of Ireland. The maximum gust recorded at Belmullet between 1981 and 2010 was 94 knots (109 miles/hour).[43] The extreme conditions represented by the design wind speed are very rare and, if they did occur, would cause widespread destruction to dwellings and infrastructure. Because of the distance to the nearest dwellings, greater than 1000m, it is extremely unlikely that even under these conditions the wind turbines would cause additional damage or risk to persons.

[43] http/www.met.ie/climate-ireland/1981-2010/Belmullet.html

The DoEHLG Planning Guidelines refer to the possibility of injury to people or animals from a damaged blade as being very remote. The Guidelines explain why this is the case, as follows:

"Most blades are composite structures with no bolts or separate components and the danger is minimised as a result."

6.4.4.3 Hazard from Falling Ice

In cold climates or at high altitude ice can potentially build up on the blades or other parts of a wind turbine. Ice falling off could potentially injure persons below. This does not arise when a turbine is in operation but rather where it has been stopped, following a grid failure for example, and the ambient temperature is very low, allowing ice to build up. Any ice formation during operation would be likely to cause a dynamic imbalance on the rotating blades that would automatically result in a shut-down of the wind turbine.

Falling ice could cause damage to structures and vehicles, and injury to site personnel and the general public, unless adequate measures are put in place for protection.

The DoEHLG Wind Farm Planning Guidelines refer to the possibility of injury to people or animals from flying fragments of ice. The Guidelines explain why this is the case, as follows:

"The build up of ice on turbine blades is unlikely to present problems. Most wind turbines are fitted with anti-vibration sensors, which will detect any imbalance caused by the icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation."

Wind turbines installed in such environments may incorporate an automatic ice warning system and some components in the wind turbine require a certain time for preheating prior to turbine restart. This does not arise in Irish conditions and there is no single known recorded incidence of flying fragments of ice occurring at a wind farm in Ireland in almost 20 years of commercial operation.

6.4.4.4 Summary:

Ireland has had operational wind farms for a considerable period at this stage and to date there has been very few turbine failures with one incident at Maas near Ardara in County Donegal and a more recent failure at Screggagh wind farm, Co Tyrone. There were no impacts on human beings associated with these turbine failures.

The minimum distance between wind turbines at Oweninny and occupied dwellings is over 1,000m, sufficient to provide protection of residential amenities and to meet safety requirements. Extensive operational experience has shown that the health and safety record of wind turbines is exceptionally high, being better in most instances than other forms of electricity production.

Some health or safety related topics are covered by separate and more specific legislation and so do not form part of this environmental assessment; examples include worker health and safety, and construction safety.

6.4.1.4 Public Safety

Wind farms

Increased potential for public safety issues to arise from the construction and operation of Corvoderry, Tawnanasool and Dooleeg wind farms development and Phases 1 and 2 of Oweninny could arise. However, Corvoderry wind farm is located within the Oweninny site and is remote from main traffic arteries and dwellings and cumulative impacts are unlikely to occur. Tawnanasool is also remote from Oweninny Phase 1 and 2 and no cumulative impact is possible.

Potential future development of Oweninny Phase 3

The potential future development of Oweninny Phase 3 would have similar potential health and safety impacts as described for the Phase 1 and 2 development.

The cumulative impacts of health and safety arising from the development of all three Phases are as described in the original EIS document which accompanied the planning application to An Bord Pleanála in 2013.

Overhead line uprates.

No additional cumulative impacts associated with the overhead line projects are

Power plant

Potential health and safety issues could arise during the proposed power plant construction and operation cumulatively with Oweninny Phase 1 and 2. However, these have been assessed environmentally and no significant health and safety effects were identified and hence any cumulative effect will be insignificant.

Substation upgrade.

No additional cumulative impacts on Health and Safety will occur from the planned upgrade of the Bellacorick Substation as this structure is already in existing and works will occur within the substation site.

6.4.5 Other Issues

Other significant concerns for human beings are generally audibility, shadow flicker and visibility. These issues are dealt with in Chapters 7, 8 and 10, which deal with Noise, Shadow Flicker and Landscape respectively.

6.5 MITIGATION

6.5.1 General

Mitigation of impacts on human beings has been considered in the context of mitigation of other aspects of this development in the relevant Sections of the EIS.

6.5.2 Health & Safety

Safety is a core value in both ESB and Bord na Móna and in their subsidiary companies. Its management and continual improvement are an integral part of each company’s activities. This emphasis on safety will be applied to all aspects of the construction and operation of the Oweninny Wind Farm.

Access to electrical equipment will be restricted to authorised persons who will operate under specific safety rules.

Health and safety provisions will be in accordance with recognised best practice in the wind energy industry. General health and safety procedures will include but will not be limited to the following:

- Site access will be restricted to authorised construction personnel only.
- Clear signage will be provided indicating site restricted area
- All appropriate safety regulation signage will be displayed at the site entrance and elsewhere as appropriate.
- All construction works will be to codes of practice and certified standards set by the various construction trades, such as electricians, excavators, transportation, etc.

It is the developers' intention that the project will be built, operated and maintained to the highest standards of safety. All relevant legislation will be fully adhered to during all stages of development. Any risks that might be associated with this project will be minimised by the use of recognised best practice and technology.

Modern wind turbines incorporate sophisticated control systems that continually monitor the operational status and safe working of key components of each wind turbine and allow an operator to remotely manage the turbines. Under fault conditions, affected turbines shut down automatically and transmit an alarm to the control centre. For safety-critical faults, turbines do not restart until a maintenance engineer has diagnosed and rectified the problem.

Specific actions in relation to safety will include the following:

- The wind turbines will be equipped with lightning protection to effectively and safely discharge a lightning strike to earth.
- The 110 kV overhead lines will be equipped with lightning protection to effectively and safely discharge a lightning strike to earth.
- All electrical systems will comply with the relevant national and international standards.
- Access to electrical equipment will be restricted to authorised persons who will operate under specific safety rules.

6.5.3 Electromagnetic Radiation

The 110 kV overhead line routes and substations are located more than 400m from any dwelling and EMF effects on local residents will not arise from the development.

With respect to site staff Oweninny Power Limited regards the protection of the health, safety and welfare of its staff and the general public as a core company value. Its policy is to

- Fully comply with all legal requirements relating to EMF,
- Design and operate the wind farm infrastructure in compliance with legislation and with due regard to the most up to date recommendations and guidelines of the leading expert and independent international bodies.
- Closely monitor and support engineering and scientific research in the area.

- Provide advice and information to its workers and the general public on the issue.
- Comply fully with the 1998 ICNIRP Guidelines and the EU Council Recommendation adopted in June 1999. The exposure limits in the EU Recommendation are identical to those in the ICNIRP Guidelines.

6.5.4 Structural Integrity of Turbines:

Wind turbine structural failures are extremely rare but in the case of Oweninny a setback distances of at least 1000m has been provided. It should be noted that the Department of Environment, Heritage and Local Government Wind Energy Guidelines recommend a setback distance of 500m and this is exceeded in case of Oweninny. The setback distance provides an adequate safe distance from occupied dwellings should a total or partial structural failure of the wind farm occur.

In addition to ensuring safe distances from occupied buildings additional mitigation to protect site personnel and the public the following mitigation will also be implemented in the event of damage to a turbine and subsequent likely turbine failure

- Physical and Visual Warnings such as fences and warning signs will be erected as appropriate for the protection of site personnel and the public.
- The facility for remote turbine deactivation will be provided
- Access to turbines for site personnel will be restricted in storm events. Where access by site personnel is required safety precautions may include remotely shutting down the turbine, yawing to place the rotor on the opposite side of the tower door and parking vehicles at a distance of at least 100m from the tower. All personnel will be fitted with appropriate PPE.

6.5.5 Hazards from Falling Ice

To minimise the potential risk from falling ice the design of the wind farm has ensured that turbines are located a safe distance from occupied structure, road, or public use area. Wind Energy Production in Cold Climate[44] , recommended by Germanischer Lloyd as well as the Deutsches Windenergie- Institut (DEWI) for example, provides the following formula for calculating a safe distance:

1.5 * (hub height + rotor diameter)

[44] Tammelin, Cavaliere, Holttinen, Hannele, Morgan, Seifert, and Säntti, *Wind Energy Production in Cold Climate,* 1997.

In the case of Oweninny with a maximum hub height of 120m and a maximum rotor diameter of 120m this would equate to a safe distance of 360m. The Oweninny wind turbines are located a minimum distance of 1000m from any occupied dwelling and also the nearest turbine to the N59 is more than 400m distance well outside the calculated safe distance.

In addition to ensuring safe distances from occupied buildings additional mitigation to protect site personnel and the public the following mitigation will also be implemented in the event of ice formation on turbine blades

- Physical and Visual Warnings such as fences and warning signs will be erected as appropriate for the protection of site personnel and the public.
- The facility for remote turbine deactivation will be provided
- Access to turbines for site personnel will be restricted while ice remains on the turbine structure. Where turbine access by site personnel is required safety precautions may include remotely shutting down the turbine, yawing to place the rotor on the opposite side of the tower door, parking vehicles at a distance of at least 100 m from the tower, and restarting the turbine remotely when work is complete.
- All personnel will be fitted with appropriate PPE.

6.6 CONCLUSION

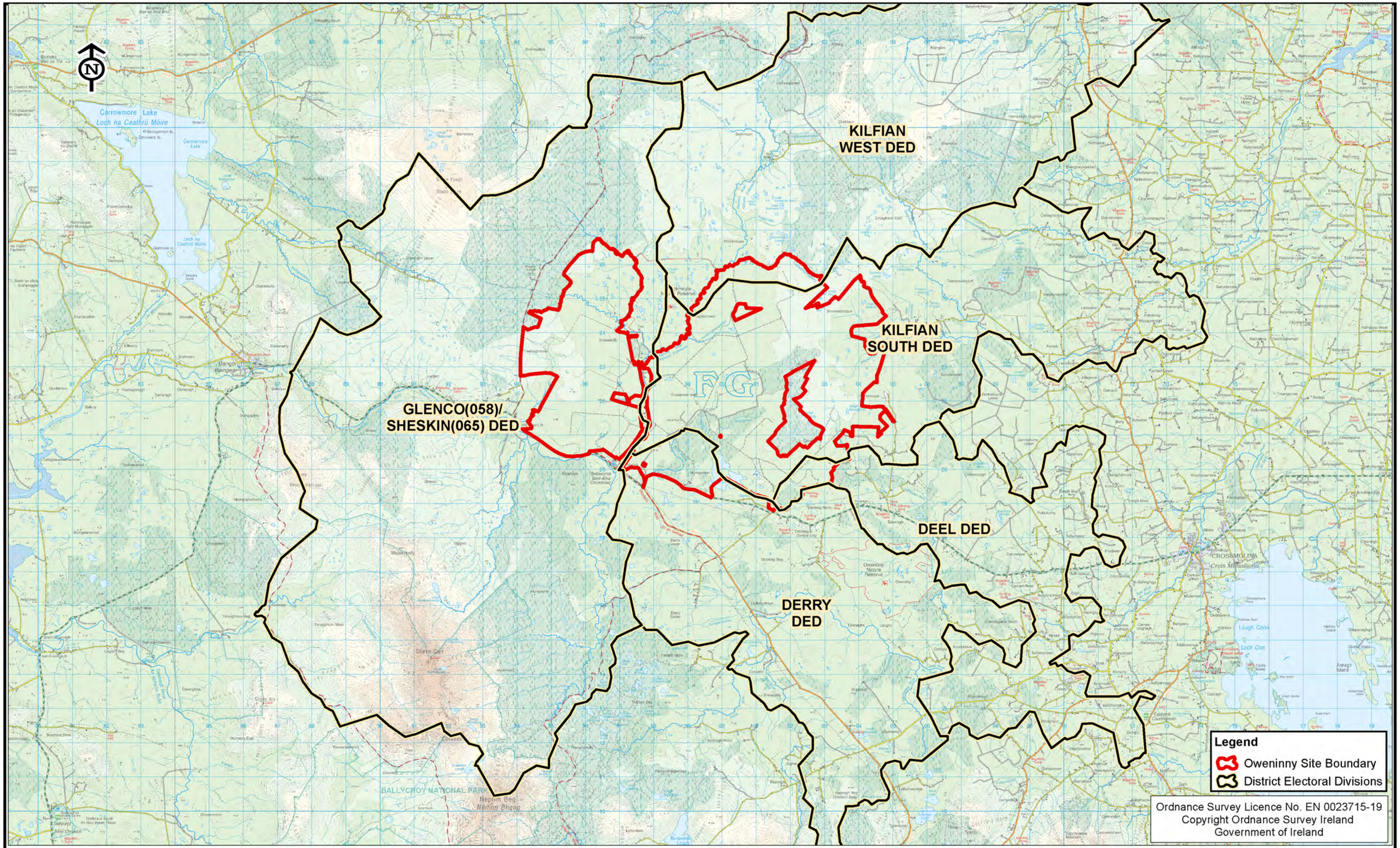
Phase 1 and Phase 2 of the Oweninny project is located in a sparsely populated area of County Mayo and as it has no residential component it will not impact on population of the area although through employment opportunities it may help sustain the existing population level. The project will contribute significantly to the national, regional and local economy during the construction phases both through direct and indirect employment opportunities created locally. It is estimated that at peak construction up to 100 jobs will be created with up to a further 6 full time positions associated with the wind farm operation and a further 5 - 10 employment opportunities in the proposed Visitor Centre. During its operational phase the project will contribute significant economic benefit to Mayo County Council through rates paid on the development. A significant community Benefit contribution will also be generated during the lifetime of the wind farm.

It is anticipated that the proposed development will not result in any significant adverse long-term impacts on human beings. Set back distances of project components will ensure no significant impact from EMF, potential turbine failure or possible ice throw during winter weather conditions. Construction activities may cause some nuisance impacts in the form of dust, noise, air emissions and increased traffic. However, these impacts will be minor and of a temporary nature and will cease once construction has been completed.

During the construction phase, which will occur over two separate phases, with phase 1 and phase two lasting about 24 months each, there will be significant expenditure on the provision of fill and aggregate materials and on site facilities including the construction of the civil and electrical infrastructure. These can benefit local companies, contractors and their employees. There will also be indirect employment in the manufacture of building materials and equipment used in construction.

Nationally, the project will contribute to the displacement of imported fossil fuel leading to significant avoided fuel import cost and savings in CO_2 emissions.

Overall the benefits to human beings in the area will be positive, increasing economic activity and providing employment opportunities in an area traditionally deprived of such opportunities.



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	District Electoral Divisions
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:100,000

MAP REFERENCE

FIGURE 6.1

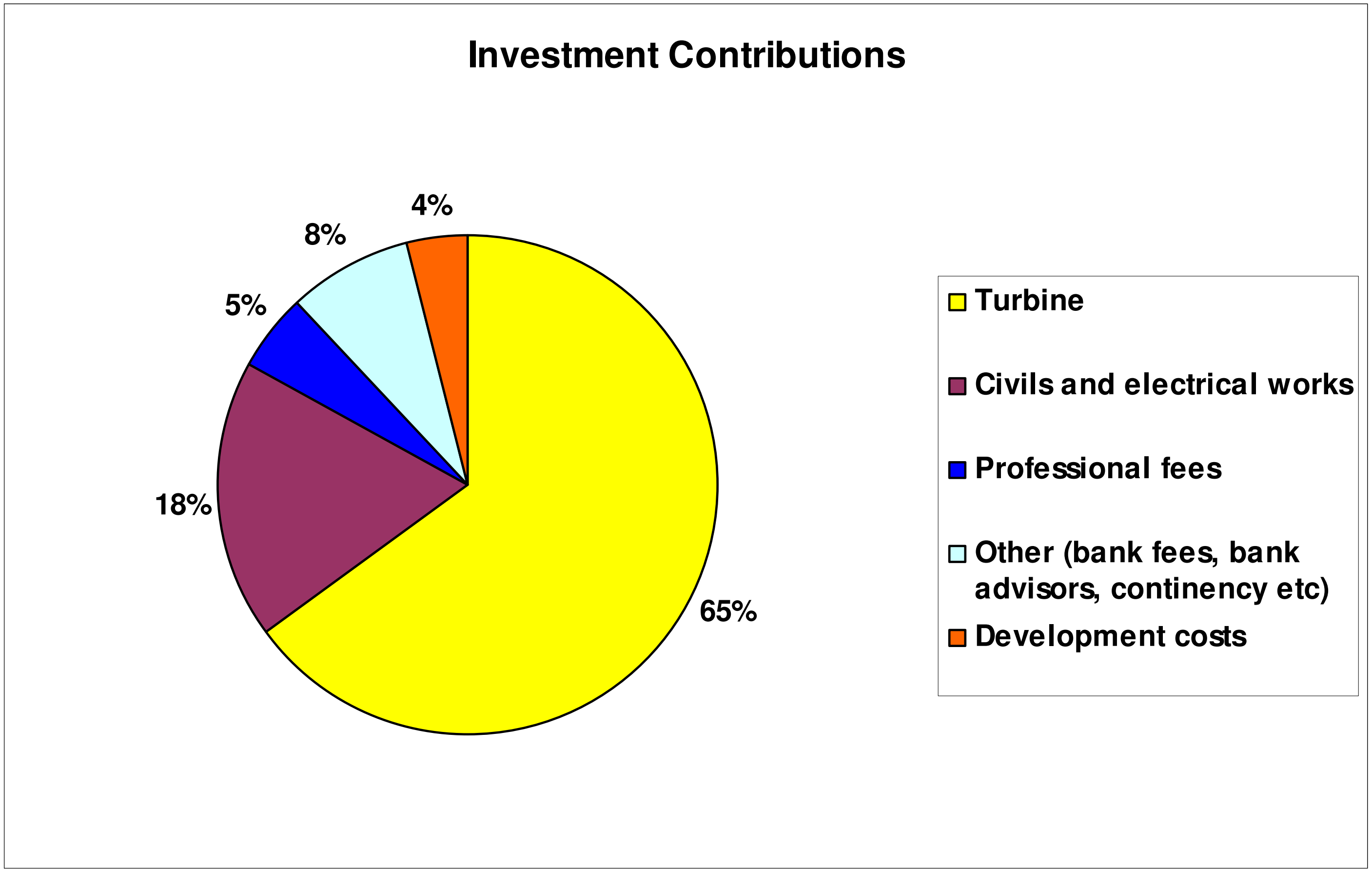


Figure 6-2: Investment Contributions

(Source: Deloitte, IWEA, Jobs and Investment in Irish Wind Energy, Powering Ireland's Economy, 2009)

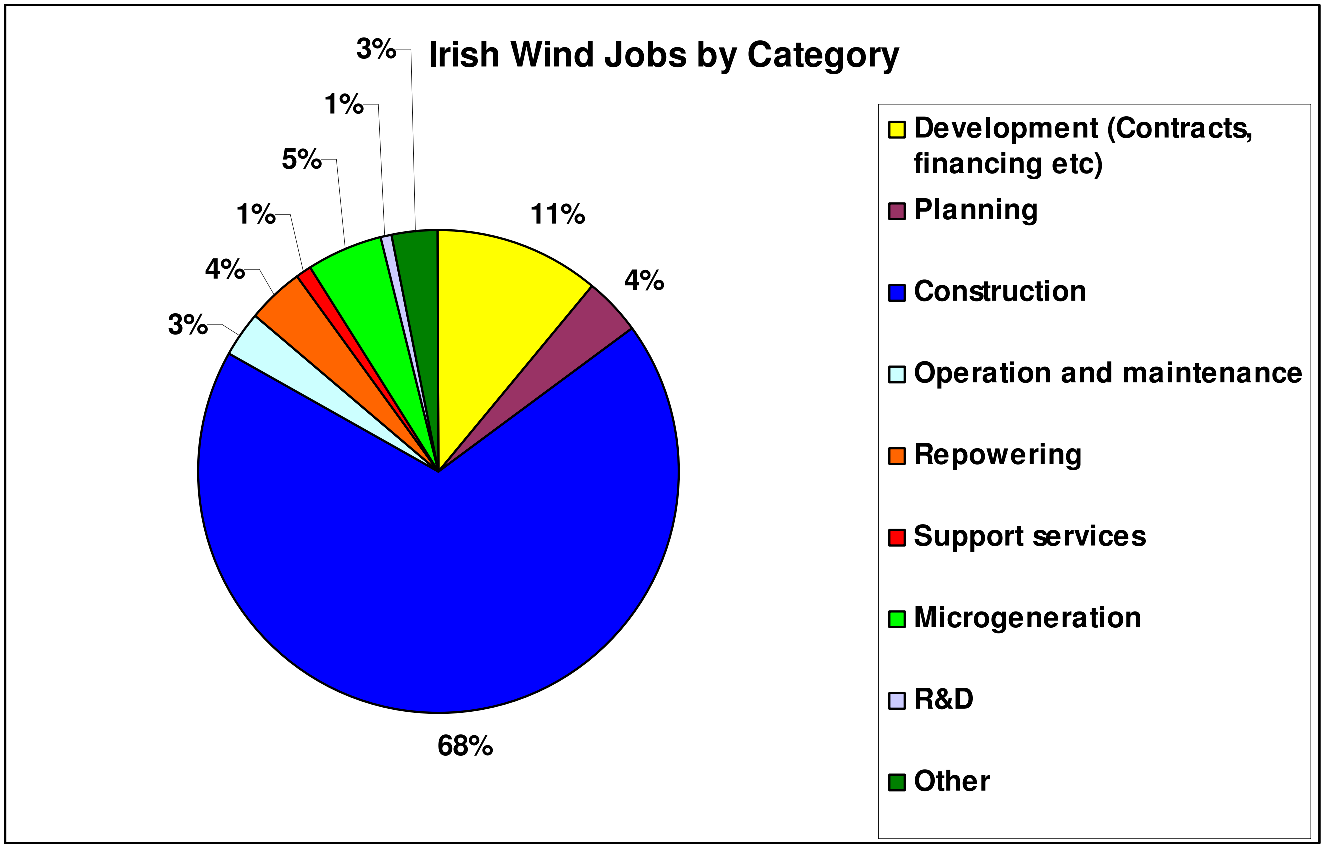


Figure 6-3: Irish Wind Jobs by Category

(Source: Deloitte, IWEA, Jobs and Investment in Irish Wind Energy, Powering Ireland's Economy, 2009)

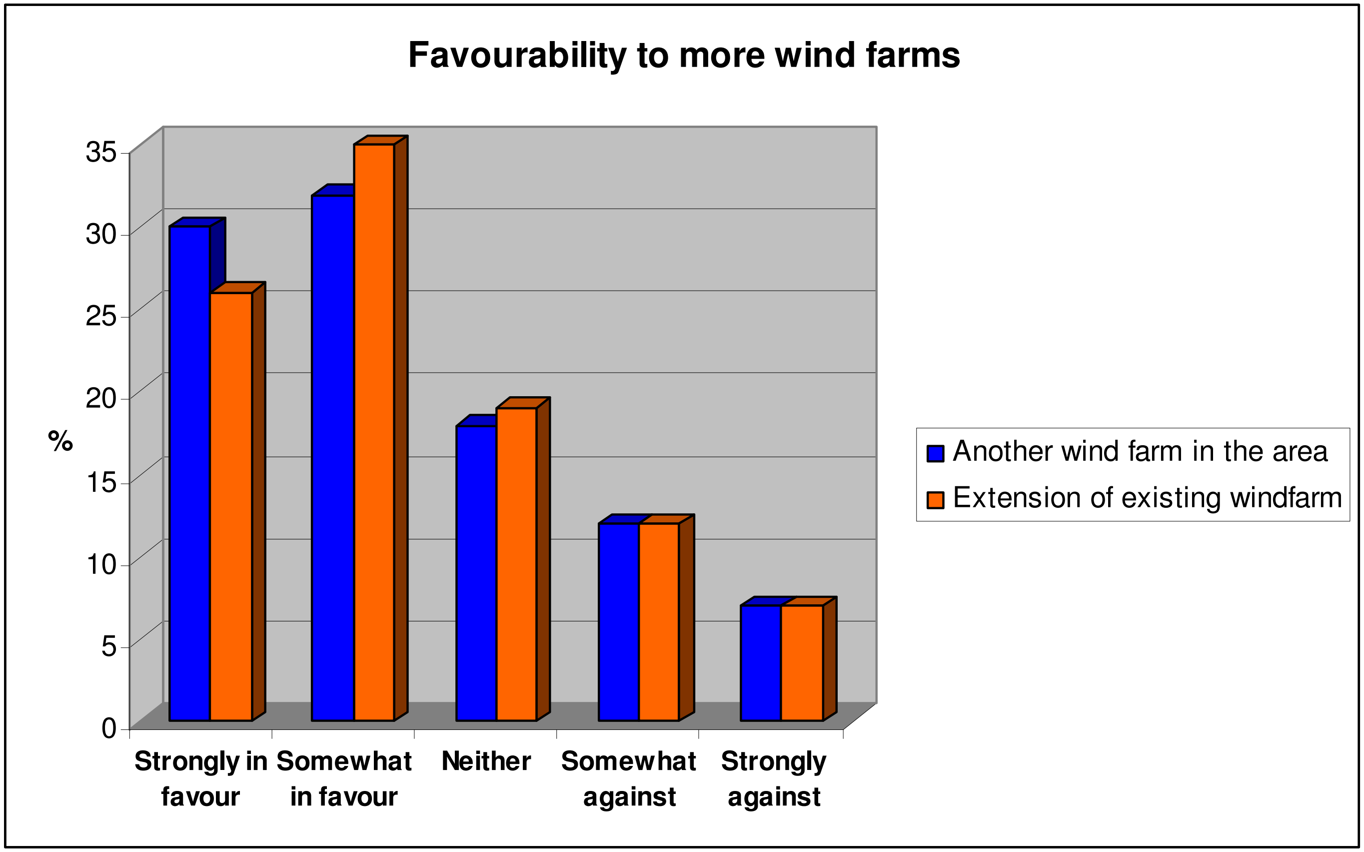


Figure 6-4: Favourability to More Wind Farms

(*Source: Attitudes and Knowledge of Renewable Energy amongst the General Public, Report of Findings August 2003*)

7 NOISE

7.1 INTRODUCTION

This chapter has been prepared by ESBI in conjunction with Biospheric Engineering Limited and revised by RPS Consulting Engineers Ltd. Noise prediction modelling has been undertaken by The Hayes McKenzie Partnership based on the proposed 112 wind turbine layout for all three phases of the wind farm. Revised modelling has been carried out for phase 1 and phase 2 without phase 3. This report details the methodology and findings of the revised prediction modelling, and potential noise and vibration impact of the proposed wind farm configurations for phase 1 and phase 2.

Common statistical metrics used to describe noise levels are as follows:

- Leq is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.
- L10 is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.
- L90 is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

A glossary of terms is provided at the end of this report.

7.2 APPROACH AND METHODOLOGY

An assessment has been made of:

- The potential impact of phase 1 and phase 2 of the proposed Oweninny wind farm acting alone and in combination with the proposed Corvoderry wind farm.

ESB International has identified 46 properties surrounding the site, which could potentially be impacted by the proposed development (see Figure 7-1). Background noise monitoring at representative noise sensitive locations around the site (drawn from these 46 properties) have been undertaken to establish baseline noise conditions. Noise levels have been modelled to produce predicted noise levels at locations around the site and compared with the baseline noise levels established through monitoring.

The Corvoderry wind farm development is described as follows:

- Corvoderry: On a site within the Oweninny site planning permission has been granted by Mayo County Council for a 10 turbine wind farm,

The noise impact assessment of the proposed Oweninny wind farm included:

- A baseline noise study to examine the existing noise climate in conditions equivalent to the operational wind speeds for the proposed wind turbines, undertaken in between March/April/May 2012 with some additional measurements carried out in November/December 2012 (see Appendix 7A).
- The modelled prediction of noise levels from a selection of wind turbines which are representative of potential candidate turbines for the site together with quality noise data for these turbines, guaranteed by the manufacturer (see Appendix 7.B).
- Wind farm operational noise has been assessed in accordance with the Wind Energy Development Guidelines (2006) published by the Department of Environment heritage and Local Government (DEHLG Guidelines) which is the current guideline for wind farm noise assessment in Ireland.

7.2.1 Background Noise and Wind Speed Monitoring

Continuous noise monitoring with simultaneous wind speed measurements was undertaken to establish the existing noise environment in the environs of the site, in terms of the correlation between wind speed and background noise. Measurements were undertaken at the noise sensitive locations shown in Figure 7-2.

Noise sensitive locations (NSLs) are deemed to be any location in which the inhabitants can be disturbed by noise from the site (including turbine noise). There are clusters of houses at Ballymonnelly Bridge, Bellacorick, Dooleeg More, Shanvolahan and Doobehy, with individual houses located on the network of local roads surrounding the site. In total, forty six (46) dwellings were identified as potential noise sensitive locations for inclusion in this assessment (see Figure 7-1). Eight locations (see Table 7-1) surrounding the Oweninny site were selected for monitoring. One location, H46 to the northeast of the site, was monitored by Coillte (see Table 7-2). The locations are described in Table 7-3 and were chosen as representing the clusters of noise sensitive locations outlined in Table 7-4.

Table 7-1: Representative Noise Sensitive Locations monitored for background

Location	Coordinates (ITM)		Nearest Turbine	Distance to Nearest Turbine (m)
	Easting	Northing		
H6	493863.00	822000.00	T51	1,165
H13	496430.84	820401.08	T87	1,120
H16	497356.07	820704.65	T111	1,057
H17	497643.45	821350.42	T111	1,119
H19	497478.03	823177.58	T45	1,043
H23	501855.21	818442.19	T109	1,179
H38	503929.02	819889.25	T101	1,394
H43	505448.23	824278.28	T16	1,744

Table 7-2: Coillte Cluddaun Noise Sensitive Locations monitored for background

Location	Coordinates (ITM)		Nearest Turbine	Distance to Nearest Turbine (m)
	Easting	Northing		
H46	505504.56	827435.45	T16	2,770

Table 7-3: Description of monitored locations around Oweninny site

Location	Description
H6	This property is located to the west of the proposed wind farm. Noise sources in the area comprise local traffic; distant traffic on the N59 and in the past would have included a contribution from both the Bord na Móna and the ESB operations. Background noise levels at 8m/s wind speed are 36 dBA L_{A90}.
H13	This location is much closer to the N59 and to some extent has a baseline determined by the existing sub-station. Background noise in the area would have been higher in the past due to the operation of the ESB Power Station. Background noise levels at 8m/s wind speed were 43 dBA L_{A90}
H16	This location is south of H19 and H17 on the same local road. It is close to the Oweninny River and closer to the N59. Hence traffic noise, agricultural activity and river noise all contribute to a low wind speed background noise level of 32 dBA LA_{90}. The existing wind turbines are just audible here under light north-easterly breezes. Background noise levels at 8m/s wind speed are 41 dBA L_{A90}.
H17	This location is south of H18 on the same road. It is closer to the existing wind turbines which are audible in light easterly winds. Noise sources in the area are farming activities and local traffic. Background noise levels at 8m/s wind speed were measured at 38 dBA L_{A90}.
H19	This location is at the northern end of a local road which will bisect the proposed wind farm. The existing wind farm is just audible at this location in light easterly winds. Noise sources in this area are local traffic and farming activities. Background noise levels at 8m/s wind speed were measured at 35 dBA L_{A90}
H23	This location overlooks the proposed wind farm site. It is located to the south of the N59 and the dominant noise source at this location is traffic on the N59. Background noise levels at 8m/s wind speed were measured at 43 dBA L_{A90}.
H38	This location is to the southeast of the proposed wind farm and located some 1 km north of the N59. The area is notably quieter than other noise sensitive locations due to the separation from any significant noise sources. Background noise levels at 8m/s wind speed were measured at 31 dBA L_{A90}
H42	This location is remote and generally unoccupied at present. Should the house become occupied, noise levels would increase slightly. Noise sources in the area are limited to agricultural activities and local traffic. Background noise levels at 8m/s wind speed were measured at 38 dBA L_{A90} possibly due to the elevation of the site.
H46	This location is situated to the northeast of the site and is extremely remote. Background noise levels at 8m/s wind speed are in the region of 31 dBA L_{A90} based on background noise monitoring undertaken by Coillte for their Cluddaun wind farm project

Table 7-4: Background noise monitoring location and cluster represented

Monitoring Location	Cluster Represented
H6	H1, H2, H3, H4, H5, H6, H7, H8, H9 and H10
H13	H11, H12, H13, H14 and H15
H16	-
H17	H18
H19	H20
H23	H21, H22, H23, H24, H25, H26, H27, H28, H29, H30, H31, H32, H33, H34, and H35
H38	H36, H37, H38, H39, H40 and H41
H42	H42, H43, H44 and H45
H46	-

Noise measurements were taken over a minimum of a two week period at the Oweninny monitoring locations. Monitoring at one location, designated H19, was carried out in parallel with the Oweninny locations, so that the data recorded at H19 is for a total of 52 days in a variety of wind conditions. Background noise measurement timing was synchronised with the wind speed measurements recorded at the on-site wind monitoring masts. As recommended by the DoEHLG Planning Guidelines 2006, the background noise level was determined using the LA_{90} criterion. The “A” suffix denotes the fact that the sound levels have been “A-weighted” in order to account for the non-linear nature of human hearing. The data gathered from each site was analysed together with wind speed data collected within the proposed site. Wind speed was taken as the average wind speed over each 10 minute measurement period. Background noise level was determined using the L90 criteria as recommended in ETSU-R-97. Wind speed at the site was measured using three existing wind masts, which record wind speeds on a continuous basis at 10 minute intervals. Each mast has anemometers at different heights and all three have instruments at 10m, which is the recommended height for ETSU type curves. The ETSU curves were prepared using the wind mast nearest the noise measuring point (see Table 7-5).

Table 7-5: Wind Masts and association with noise measuring locations

Mast No	Coordinates (ITM)		Ground Level (m) AOD	Association with monitoring location
	Easting	Northing		
0001	501362	824459	101.00	Mast 1 for H46
0002	495803	822607	100.20	Mast 2 for H19, H17, H16, H13 and H6
0003	503456	801832	104.75	Mast 3 for H23, H38 and H42.

Long term wind roses are illustrated on Figure 7-3 to Figure 7-5 and are predominantly south-westerly in direction.

7.2.2 Turbine Noise Prediction Modelling

Noise prediction models predicting the noise level that would occur for phases 1 and 2 of the Oweninny wind farm, as well as in combination with the Corvoderry wind farm, were prepared by The Hayes McKenzie Partnership (see Appendix 7.B).

The preliminary predictions are used to identify potentially affected residential properties in the vicinity of the wind farm as per the wind energy guidelines. These are termed noise sensitive properties.

The final turbine selection for the project will be made during the detailed design and procurement phase. It is therefore necessary for this assessment to consider the emissions of viable candidate turbine models which may be considered for the site. To this end, the application is based on seeking approval for an envelope range of turbines, with varying hub heights, rotor diameters, generating capacity and noise emission levels.

For the purpose of modelling ESB International has selected three (3) different makes of turbine which are representative of the range which could be considered for the site and which would represent the worst case scenario in terms of noise generation. All of the candidate turbines comprise three upwind rotor blades with variable blade pitch to control rotational speed), power generation and noise emissions. The representative turbine specifications are provided in Table 7-6.

Table 7-6: Representative turbine specification

Description	Candidate Turbines		
	Vestas V112-3	Siemens SWT-3-101	Vestas V90-3
Rotor Diameter (m)	112	101	90
Hub Height (m)	120	120	90
Rotor speed range (rpm)	6.2 – 17.7	6 - 16	8.6 – 18.4
Cut-in Wind Speed (m/s)	3	3	3.5
Cut-out Wind Speed (m/s)	25	25	25
Maximum Sound Power L_{WA} (Hz)	106.5	108	107

In order to consider the worst case scenario noise prediction, the following factors are built into the worst case model:

- The turbine with the highest noise emissions (SWT 3 101) was assumed for all wind farms
- Noise levels were modelled for all wind directions in 15 degree intervals and the worst case figure for each location was used in the assessment. As can be seen from Figure 7-3 to Figure 7-5 the wind direction is predominantly from the southwest.

- The wind speed used in the modelling is 8 m/s (at 10m height). The maximum sound power output for the worst case turbine is reached at 8m/s and no increase occurs at higher wind speeds.
- All turbines on both wind farms, proposed Oweninny and planning-approved Corvoderry, acting simultaneously.
- Ground absorption factors have been taken account in accordance with ISO 9613-2.
- Noise levels modelled at a receiver height of 4m, reducing the mitigating effect of barriers and ground attenuation, whereas most properties are bungalows. A height of 1.5m would be more appropriate and representative of these.

International best practice for wind turbine noise modelling is that all wind speeds are normalised at 10m height, to avoid difficulties relating to wind shear at hub height for modelling and ground level for background noise monitoring. In this case, background noise measurements were plotted against wind speeds at 10m and the noise model was calculated at the same baseline wind height.

The sound power levels presented in Table 7-6 have been derived from manufacturer test data which is based on the methodology of IEC-61400-11:2006 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques (IEC61400-11:2006). Detailed sound power level data, including frequency characteristics, are provided in Appendix 7.B.

7.2.3 Corrections for Existing Wind Farm Noise

Background noise in the area is influenced by noise from an existing wind farm on the Oweninny site. The existing Bellacorick Wind Farm has twenty 300kW turbines and one 450kW turbine. This wind farm noise was modelled by Biospheric Engineering Ltd. using the same methodology and parameters used in the Hayes McKenzie model for the proposed wind farm. Modelling was carried out for wind speeds in the range 4m/s to 8m/s for the nine background noise monitoring locations and compared against background levels at those locations at the same wind speeds. A correction factor for the total noise level was calculated on the basis of logarithmic addition of noise levels. The correction factors are provided in Table 7-7.

Table 7-7: Correction factors for background noise due to existing wind farm noise

	Correction factor dB Location				
	4m/s	5m/s	6m/s	7m/s	8m/s
H6	0	0	0	0	0
H13	0	0	0	0	0
H16	0	0	0	0	0
H17	-0.5	-1.0	-1.0	-1.0	-0.5
H19	-1.0	-1.0	-1.0	-1.0	-1.0
H23	0	0	0	0	0
H38	0	0	-0.5	-0.5	0
H42	0	0	0	0	0

H46	0	0	0	0	0

7.3 RECEIVING ENVIRONMENT

As recommended by the DoEHLG Planning Guidelines, the noise survey results were analysed in terms of LA_{90}, which is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise. The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. The sampling frequency period was 10 minutes.

Background noise level data was analysed to provide separate results for daytime periods (07:00 - 23:00hrs) and for night-time periods (23:00 - 07:00hrs) at different wind speeds. The data was averaged for each 0.5m/s interval in wind speed and a trend-line plotted along with correlation factors. The mean of all the values for each increment was calculated and a scatter plot of the mean L90 values for each 0.5 m/s wind speed increase was plotted against wind speed. The data is presented in Appendix 7A.

Table 7-8 provides the daytime background noise levels at the Oweninny measured locations for a range of wind speeds, corrected for existing wind farm noise.

Table 7-9 provides the night-time background noise levels at the Oweninny measured locations again for a range of wind speeds, corrected for existing wind farm noise.

Table 7-8: Daytime background noise levels: corrected for existing wind farm noise

Wind Speed	H6	H13	H16	H17	H19	H23	H38	H42 m/s
1	30.1	37.3	37.5	30.1	23.3	29.1	23.7	21.5
2	30.6	37.4	37.2	31.2	24.5	31.0	24.6	23.8
3	31.2	37.7	37.1	32.3	25.7	32.9	25.6	26.0
4	31.9	38.3	37.4	33.4	27.2	34.8	26.6	28.3
5	32.8	39.1	37.9	34.0	28.7	36.8	27.7	30.7
6	33.8	40.1	38.7	35.2	30.4	38.7	28.3	33.0
7	34.9	41.4	39.8	36.4	32.2	40.6	29.5	35.4
8	36.2	43.0	41.2	38.0	34.1	42.5	31.3	37.7
9	37.7	44.8	42.8	39.2	36.1	44.5	32.6	40.1
10	39.3	46.8	44.8	40.4	38.3	46.4	34.0	42.5
11	41.0	49.1	47.0	41.6	40.6	48.3	35.4	45.0
12	42.8	51.6	49.6	42.8	43.0	50.3	36.9	47.4
13	44.8	54.3	52.4	44.1	45.6	52.2	38.4	49.9
14	47.0	57.3	55.5	45.3	48.3	54.1	40.0	52.4
15	49.2	60.5	58.8	46.6	51.1	56.0	41.6	54.9

Table 7-9: Night-time background noise levels: corrected for existing wind farm

Wind Speed	H6	H13	H16	H17	H19	H23	H38	H42
1	29.6	33.9	33.9	26.1	19.5	20.3	18.1	19.3
2	29.8	34.5	34.0	27.2	20.9	22.9	19.1	20.1
3	30.1	35.2	34.3	28.4	22.3	25.6	20.2	21.1
4	30.5	35.9	35.0	29.6	23.8	28.2	21.3	22.3
5	31.1	36.6	36.0	30.4	25.3	30.9	22.5	23.7
6	31.8	37.3	37.3	31.7	27.0	33.5	23.2	25.3
7	32.6	38.0	38.9	33.1	28.7	36.2	24.5	27.2
8	33.5	38.8	40.9	35.0	30.6	38.9	26.4	29.2
9	34.6	39.6	43.2	36.5	32.5	41.6	27.8	31.5
10	35.7	40.4	45.9	38.0	34.5	44.3	29.3	34.0
11	37.0	41.3	48.8	39.5	36.5	47.0	30.8	36.6
12	37.0	42.1	52.1	41.2	38.7	49.7	32.4	39.5
13	40.0	43.0	55.8	42.8	41.0	52.5	34.1	42.6
14	41.7	44.0	59.7	44.5	43.3	55.2	35.8	45.9
15	43.5	44.9	64.0	46.3	45.7	58.0	37.5	49.4

Table 7-10 provides the daytime and night-time background noise levels at monitoring location H46 for a range of wind speeds, corrected for existing wind farm noise. Background noise data was provided by Coillte for this monitoring location.

Table 7-10: Daytime and night-time background noise for H46: corrected for existing wind farm

Wind Speed H46 m/s	Daytime	Night-time
1	19.2	18.2
2	19.9	20.0
3	21.0	21.8
4	22.4	23.7
5	24.1	25.5
6	26.2	27.3
7	28.6	29.1

Wind Speed H46 m/s	Daytime	Night-time
8	31.3	31.0
9	34.4	32.8
10	37.8	34.6
11	41.6	36.5
12	45.6	38.3
13	50.1	40.1
14	54.8	42.0
15	59.9	43.8

7.3.1 Summary background noise

For the area in general the noise climate is typical of a rural environment, and in some areas is influenced by: traffic movements on the N59 and local roads; the existing substation at Bellacorick; and farming activities in the area. Natural sounds such as the Oweninny and Owenmore rivers, birdsong and animal calls are also evident.

7.4 IMPACT OF THE DEVELOPMENT

7.4.1 Sources of 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), whereby the ‘A weighted’ filter in the measuring device elicits a response which provides a good correlation with the human ear. The A-weighting scale is the recommended scale to use according to the Department of Environment, Community and Local Government Guidelines on Environmental Noise. There are suggestions in other jurisdictions that other scales may be more appropriate for low frequency noise but none of these have been adopted in Ireland. The criteria for environmental noise control from wind farms are related to annoyance or nuisance rather than health impact.

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 (now the Department of Environment, Community and Local Government).

In terms of noise impact assessment the proposed development has been examined under the following phases:

- Construction Phase

- Operation Phase
- Decommissioning phase

The different phases give rise to different noise control measures.

Construction noise

The construction phases of Oweninny are of relatively short duration and will result in some significant localised noise generating activities, for short periods. Each construction phase will be carried out mainly by day so there is a balance between limiting noise and extending/shortening the duration of the construction phase. The noise control measures to be adopted must also be tailored to the activity.

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.

Operational noise

The operational phase is an on-going phase with wind turbine noise being the dominant source. Other sources during the operational phase include sub-stations and site traffic, which are relatively minor in comparison to turbine noise. The operating phase will be a 24/7 operation, requiring noise control both day and night to limit impacts on amenities and wildlife.

An examination of the potential impact of phases 1 & 2 and the cumulative impact of Oweninny and Corvoderry wind farms is included below.

The two most relevant types of noise emission for modern wind turbines are broadband and tonal noise emissions. Both of these are types of audible noise, the frequency range of which is generally taken to be the range of 20 - 20,000 Hz, with the greatest sensitivity to sound typically in the central 500 - 4,000 Hz region.

Aerodynamic noise is 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 without corresponding noise increases. Aerodynamic noise is broadband in nature and therefore closely simulates noise generated from the interaction of wind on trees/vegetation. Developments in turbine technology utilised in larger wind turbines do not mean pro rata increases in noise emissions. A typical 1980s turbine generating 100 kW and a 1990s turbine generating 500 kW both emit approx. 100 dB. This is only slightly less than a typical modern turbine generating 2 to 3 MW.

The sound spectrum of most modern wind turbines has the same characteristics as broadband noise but there have been concerns raised in relation to tonal noise. Tonal noise due to mechanical sources is typically associated with the rotation of mechanical equipment and pure tones tend to be related to the rotational frequencies of shafts and generators and the meshing frequencies of gears. Turbine manufacturers have focused considerable research and design towards reducing and eradicating tonal noise including: attention to gear teeth; adding baffles and acoustic insulation to the nacelle; using vibration isolators and vibration mounts for major components; and designing the turbine to limit noises from being transmitted into the overall structure. These steps are part of the normal design of most modern wind turbines. Low rotational speeds reduce the probability of any audible tonal or impulsive components.

There have also been other factors lessening the importance of noise of mechanical origin from wind turbines, notably their increasing size. Sizes have increased greatly over the past decade but mechanical noise does not increase with the dimensions of turbine as rapidly as aerodynamic noise.

Standing next to the turbine, it is usually possible to hear a swishing sound as the blades rotate; the cooling fan in the equipment room, whirr of the gearbox and generator may also be audible.

The noise a wind turbine creates is expressed in terms of its *sound power* level. Although this is measured in dB(A) re 10^{-12} watts, it is not a measurement of the noise level that is heard but of the noise power emitted by the machine. Under constant operational conditions the *sound power* level will be constant, but the sound pressure at some distance will depend on the distance involved, atmospheric conditions and topography.

In general, noise from wind turbines increases with wind speed and rotational speed. Most modern wind turbines are pitch regulated variable speed turbines which have a characteristic noise profile of steeply increasing noise with wind speed, up to a maximum level above which there is usually no increase in noise. In the case of the Siemen's SWT 101 – 3.0 MW wind turbine, for example, the maximum sound power level is 108 dB, which level is reached at a wind speed of 8 m/s and thereafter no increase occurs.

Some debate has now arisen in literature as to the potential impacts of low frequency noise. Low frequency noise is defined as noise in the frequency range 16 Hz to 125 Hz (or 20 Hz to 200 Hz depending on definitions).

Noise at frequencies below 20 Hz is generally referred to as Infrasound and regarded as inaudible.

There is growing concern among some members of the public that new large wind turbines might have a larger impact on the environment, associated with significantly more low frequency noise, 20 to 125 Hz for example, than that experienced from earlier generation smaller wind turbines. This concern is largely fuelled by publications on the internet and has led to several studies by government agencies to review the scientific evidence for such concerns.

A recent major study for the Danish Energy Authority prepared by DELTA Acoustics and Electronics[1] on low frequency noise from wind turbines compared sound power outputs from small (2.0 MW or under) and large (greater than 2.0 MW) wind turbines. The study concluded the following:

- *"The emitted A-weighted sound power level from wind turbines increases with the nominal power of the turbines. As the size of turbines increases the sound power increases. Doubling the power out from 2MW to 4 MW would give a 2.9 dB increase in the sound power level of the turbine indicating that certain amount of* *electrical power can be produced by larger turbines with slightly less noise emissions than smaller ones.*

- *Emitted low frequency sound power levels also increases with wind turbine size. Increasing the power output from 2MW to 4 MW would result in a 3.9 dB increase in sound power level meaning generally that the total low frequency noise emission increases slightly more with wind turbine size than the A weighted total sound power level."*

[1] DELTA, EFP-06 Project, Low Frequency Noise from Large Wind Turbines, Final Report, Performed for Danish Energy Authority, November 2010

Noise which is inaudible has not been shown to have any health impact in any peer reviewed health effects study.

There is an increase in turbine noise level as wind speed increases. However, Background noise - the noise from wind in nearby trees and hedgerows, around buildings and over local topography - also increases with wind speed, as indicated by the noise monitoring undertaken at the site, but at a faster rate.

Wind turbines do not operate below the wind speed referred to as the cut-in speed (usually around 3 - 5m/s at hub height). Background noise is low in calm conditions and turbine noise could be more discernible. However, they are not in operation in these conditions.

Wind turbine technology has been greatly refined and modern turbines, such as those proposed, produce relatively low noise.

Decommissioning noise

The decommissioning phase will be similar to the construction phase i.e. a campaign of relatively short duration with localised elevated noise levels.

7.4.2 Construction Noise

The main activity associated with construction will involve materials delivery via the N59, access track construction, foundation excavation, turbine foundation piling, concrete pouring at turbine bases, visitor centre, electrical substations, O&M building, and the placing of turbines in-situ. These activities, and the noise emission associated with them, will be dispersed throughout the site and a number of them will occur simultaneously once the internal access track way develops. Construction noise levels tend to be loud for short periods coinciding with peak construction activity, see Chapter 2 and 3 of the EIS. Turbine locations will either be excavated to foundation depth or piled where ground conditions require this or where the area is very sensitive environmentally, at the Bellacorick Iron Flush for example. Piling will take approximately three days per turbine base.

The noisiest construction activities are those associated with piling, the excavation and pouring of the turbine bases, and the extraction and crushing of stone from borrow pits. Unlike operational noise, construction activities are both short lived and typically occur only during daytime. Excavation of a turbine base can typically be completed in 1-2 days and the main concrete pours are usually conducted in one continuous pour which is completed within a day although this can extend into the evening time.

Material deliveries and workforce movements will be via the N59 road network and via the internal access tracks to the site. The daily increase in traffic flow along the local road network will be within 10% of the roads carrying capacity. 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. Generally, all construction activity will take place during daytime hours only. Some large deliveries may take place outside these hours if required by the relevant authorities, but otherwise there will be no night- time traffic noise associated with the development.

Construction activity will comprise standard construction techniques using standard equipment. Table 7-11 indicates the source noise level and typical numbers of equipment on site during construction. The actual noise levels will depend on equipment duty cycles and site activity at any stage during construction.

A certain amount of noise is inherent in all types of building and it can never be completely eliminated. Construction activity will comprise standard construction techniques using standard equipment. The problems of site noise control can often be complex and there are a number of practical implications including the pace of the works if unduly restrictive noise conditions are imposed. Practical noise reduction measures such as those outlined in British Standard 5228 Code of practice for Noise Control on Construction and Open Sites, can be implemented. The hours of work for noisy activities can be limited to avoid interference with residential amenity. It is not usual to impose a numerical noise limit on construction activity as equipment may need to operate near the site boundary for short periods and thus not be able to comply with a fixed numerical noise limit.

Table 7-11: Construction and decommissioning noise sources

Description	Purpose	Notes	Lw (dB)
Earth moving Dozer	Site clearance	Diesel Engine Powered	108
Tracked Excavator	Site works	Diesel Engine Powered	105
Rig for Bored Piles	Foundations	Diesel Engine Powered	115
Rock-breaker	Break up top layers and fractured rock	Diesel Engine Powered	115
Mobile Crane	Lifting plant, materials and equipment into position. Two may be required for some heavy plant	Heavy Plant. Tracked/Wheeled Diesel engine powered	105

Description	Purpose	Notes	Lw (dB)
Dumper Truck	Transport of material on site	Typically wheeled (6 wheel drive) Diesel engine powered.	117
Concrete Truck	Mixing, transport of concrete to site and placement.	Diesel engine powered	109
Compressors & pumps	General construction purposes,	Mobile, diesel engine powered enclosed and silenced	95
Generator	Provide electricity for equipment, hand tools and site lighting during construction.	Diesel engine powered enclosed and silenced	97
Concrete mixer	Mixing of concrete on site	Diesel engine powered	105
Trucks, vans, 4x4 vehicles	Transport of materials & personnel	Generally diesel powered	101
Hand tools	Cutting, fixing, welding and general construction	Generally 110V powered by Generator	102

Note *Reversing beacons and audible warning devices are required for safety reasons on most of the above; noise from such devices will be temporary and localised.*

Lw is the sound power in watts.

Typical noise levels for various distances from the sound power data for typical construction plant types are shown in Table 7-12 and are expressed as dB(A) L_{eq} (12 hour) equivalent continuous noise levels, the standard units for construction noise.

Table 7-12: Typical Noise Impact of Construction Activities

Distance	500 m	1,000 m	1,500 m	2,000 m
Earth Moving	45.2 dB(A)	37.7 dB(A)	33.3 dB(A)	30.2 dB(A)
Concreting	42.3 dB(A)	34.8 dB(A)	30.4 dB(A)	27.3 dB(A)

While no formal limits exist for construction noise, standards that have been applied to large civil engineering projects tend to fall in the range of 70 - 75 dB(A) L_{eq} (12 hour) for daytime construction activities. Construction noise will evidently not create significant impacts, particularly given the distances of the proposed turbine locations from any local residences. There is no published Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. While acknowledging that planning authorities, where appropriate, should control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion, the National Roads Authority (NRA) considers that the noise levels in Table 7-13 are typically deemed acceptable. Predicted construction noise levels at Oweninny are evidently well below relevant limit values and significant impacts will not arise.

Ground-borne vibration due to construction is very rapidly attenuated over distance. BS 5228-2: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration, discusses vibration attenuation at distances up to some tens of metres from the source. Vibration from construction activities, hundreds of metres from the receptors, and vibration from vehicle movements, with relatively low source levels, is considered to be not significant.

The only published construction noise limits, by a government agency in Ireland, are those adopted by the National Roads Authority (NRA) for the construction of road schemes, Table 7-13. These guidelines set maximum noise levels for different times of day and for different days.

Table 7-13: National Roads Authority (NRA) Construction Noise Limits

Day & Time		**LAeq (1 hr) dB re 20 µPa**	**LpA (max) slow dB re 20 µPa**
Monday to Friday	07:00 to 19:00 hrs	70	80
Monday to Friday	19:00 to 22:00 hrs	60	65
Saturday	08:00 to 16:30 hrs	65	75
Sundays and Bank Holidays	08:00 to 16:30 hrs	60	65

The construction noise controls set out above represent best international practice and will form the core of the noise measures to be adopted for both the construction and decommissioning phases of this project. As all of the noise sensitive locations are located at least one thousand meters from a turbine, the impact on any individual location is likely to be minimal and for short duration periods.

7.4.3 Operational Noise Impact

7.4.3.1 Method of Assessment and Noise Limits

The DoEHLG Planning Guidelines suggest that noise impact should be assessed by reference to the nature and character of noise sensitive locations. The latter includes any occupied dwelling house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational amenity importance. It recommends that noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed.

Wind turbine noise is directly related to wind speed. Therefore, the DoEHLG Planning Guidelines are based on the principle that turbine noise should be controlled with reference to fixed limits when background noise is low, or relative to background noise itself as it increases with wind speed, whichever is the greater. The common interpretation of these limits is that turbine-attributable noise should be limited to:

- 43 dB LA_{90} for night-time hours

- 45 dB LA_{90} or 5 dB above background noise, whichever is the greater, at the NSL for daytime hours
- 35 to 40 dB LA_{90} or 5 dB above background noise, whichever is the greater, at the NSL where background noise is less than 30 dB LA_{90}

Recent An Bord Pleanála decisions with respect to wind farm planning consents have reflected the Planning Guidelines with lower fixed limits of 45 dBA (L_{eq}) or 43 dBA (LA_{90}) for operational noise (see Table 7-14).

Table 7-14: Recent An Bord Pleanála decisions with respect to Planning

Planning Reference	Location	Planning Noise Limit
221656	Cashel, Co. Tipperary	43 dB LA_{90}
236212	Killala, Mayo	45 dB LA_{eq}
238762	Cloosh, Galway	43 dB LA_{90}

Planning Reference	Location	Planning Noise Limit
239743	Sliabh Bawn, Roscommon	Higher of 43 dB LA_{90} or 5 dB above Background
239118	Deradda, Co. Galway	43 dB LA_{90}
239133	Carrickeeney, Leitrim	43 dB LA_{90}
239594	Cappawhite, Tipperary	Higher of 43dB LA_{90} or 5 dB above Background
239473	Saorgus Project, Kerry	Higher of 43dB LA_{90} or 5 dB above Background

The noise limits proposed at Oweninny are shown in Table 7-15 and are based on the Planning Guidelines and the recent An Bord Pleanála decisions.

Table 7-15: Wind Speed and Daytime Limit Values dB(A) at Oweninny

NSL	Cluster	Noise Condition	Wind Speed 4	5	6	7	8	9	10
H6	H1 – H10	Background	32	33	34	35	36	38	
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	
H13	H11, H12, H14 and H15	Background	38	39	40	41	43	45	
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	
H16	-	Background	37	38	39	40	41	43	
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	

NSL	Cluster	Noise Condition	Wind Speed 4	5	6	7	8	9	10
H17	H18	Background	33	34	35	36	38	39	
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	
H19	H20	Background	27	29	30	32	34	36	
		Limit	*37.5*	*37.5*	*43*	*43*	*43*	*43*	
H23	H21, H22, H23, H24, H25, H26, H27, H28, H29, H30, H31, H33, H34 and H35	Background	35	37	39	41	43	44	
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	
H38	H36, H37, H38, H39, H40 and H41	Background	27	28	28	30	31	33	
		Limit	*37.5*	*37.5*	*37.5*	*43*	*43*	*43*	
H42	H43, H44 and H45	Background	28	31	33	35	38	40	
		Limit	*37.5*	*43*	*43*	*43*	*43*	*43*	
H46*	-	Background	22	24	26	29	31	34	
		Limit	*37.5*	*37.5*	*37.5*	*37.5*	*43*	*43*	

*** Based on background noise monitoring data provided by Coillte**

7.4.3.2 Predicted Noise

Modelling data for Oweninny Phases 1 & 2 alone and in conjunction with Corvoderry wind farm is provided in Appendix 7A and summarized in the tables below. The worst case noise prediction model for Oweninny, prepared by The Hayes McKenzie Partnership, is provided in Table 7-16. They are also shown on contour plots in Figure 7-6 and Figure 7-7. The worst case scenario is taken as the Siemens SWT-3-101 which has sound power levels which increase from 95.7 dBA re 1 pW at 4m/s to 108dBA re 1 pW at 8m/s wind speed. The sound power level (and consequently noise emissions) does not increase at wind speeds higher than 8 m/s. By calculating noise levels at this wind speed worst case conditions are modelled.

The wind turbines for Corvoderry have been assumed as Siemens SWT-3-101 with hub heights of 55m, based on information supplied by developers.

The highest sound power level has been used in each case, with octave band data also taken from manufacturers' data for a wind speed of 8 m/s and normalised to the overall level used.

All predictions are based on a worst case scenario of a two-storey house with a receptor height of 4 metres. The majority of the noise sensitive locations are bungalows and, due to localised screening, will be subject to additional noise attenuation.

7.4.3.3 Predicted Operational Noise

The output from the noise predictive model for the case where Oweninny acts alone and using the Siemens SWT-3.0-101 turbine are shown in tabular form on Table 7-16 in the EIS. This provides the modelled noise for a representative 17 properties which reflect individual and clusters of houses around the wind farm site together with the predicted noise level for the worst case wind.

The predicted impact of the Oweninny, wind farm alone using Siemens SWT-3-101 Turbines complies with the daytime noise limit of 43 dB LA $_{90}$ (free field) at a wind speed of 8 m/s.

Table 7-16: Noise Predictions for Oweninny (Phase 1&2 – SWT-3-101) Acting Alone (dB L_{A90})

Sector Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	41.5	39.6	38.5	38.4	40.3	41.2	41.9	41.2	41.0	28.0	27.8	27.5	27.5	27.6	29.6	29.4	40.4
15	41.5	39.6	38.5	38.4	40.0	40.6	41.5	41.3	40.7	27.7	27.5	27.2	27.1	27.3	29.1	27.9	41.0
30	41.5	39.4	38.4	38.3	39.4	40.1	40.9	41.1	40.9	27.4	27.1	26.8	26.8	26.9	28.1	25.9	41.2
45	41.5	39.0	37.9	37.8	38.5	39.3	40.4	40.8	40.6	26.5	26.1	25.8	25.8	25.5	26.3	21.3	41.5
60	41.3	38.4	37.0	36.9	37.4	38.6	39.8	40.8	40.3	24.9	24.5	24.2	24.1	24.1	24.1	18.0	41.5
75	41.1	36.9	35.6	35.5	36.2	38.0	39.4	40.4	40.4	23.5	22.9	22.7	22.6	21.9	19.6	15.8	41.5
90	40.4	35.7	34.2	34.0	35.0	37.6	39.2	40.3	40.3	20.3	19.2	18.9	18.7	17.9	16.7	14.7	41.5
105	39.6	33.7	32.0	31.9	34.0	37.0	39.0	40.5	40.4	16.6	16.0	15.7	15.6	15.2	15.1	14.7	41.3
120	38.2	31.8	30.0	29.9	33.0	36.6	38.4	40.8	40.7	14.6	14.2	14.0	13.9	13.7	14.5	15.6	41.0
135	36.6	30.7	29.0	28.9	32.0	35.8	38.2	41.2	41.0	13.8	13.6	13.4	13.3	13.4	15.1	17.6	40.5
150	35.2	29.0	26.4	26.2	30.6	34.9	37.4	41.4	41.3	14.2	14.1	13.9	13.9	14.1	16.8	20.7	39.9
165	33.3	27.6	24.7	24.5	30.3	35.3	37.5	41.8	41.7	15.8	15.7	15.5	15.5	15.9	19.8	24.6	38.8
180	32.2	27.9	25.1	24.8	31.9	35.9	37.9	41.9	41.6	18.7	18.9	18.5	18.5	19.0	22.7	27.4	37.9
195	31.8	29.4	26.8	26.7	34.7	37.6	38.4	41.9	41.9	21.8	21.7	21.5	21.4	21.7	25.7	29.1	36.2
210	32.2	32.5	30.6	30.5	36.0	38.3	39.4	41.9	42.0	23.4	23.4	23.1	23.2	23.4	27.6	30.0	34.7
225	33.3	34.9	33.9	33.7	37.5	39.3	39.8	41.9	41.9	25.4	25.5	25.2	25.2	25.8	29.0	30.6	32.1
240	35.3	36.7	35.7	35.6	38.7	39.6	40.2	42.0	41.8	26.8	26.7	26.5	26.5	26.6	29.5	30.6	30.6
255	37.2	38.0	37.0	36.9	39.2	39.9	40.4	42.0	41.7	27.4	27.3	27.0	27.0	27.3	29.9	30.6	30.4
270	38.4	38.5	37.7	37.6	39.4	40.1	40.6	41.9	41.6	28.0	27.8	27.6	27.5	27.7	29.9	30.6	32.1
285	39.5	39.2	38.1	38.0	39.7	40.5	41.0	41.8	41.5	28.1	27.9	27.6	27.6	27.7	29.9	30.6	34.3
300	40.5	39.4	38.3	38.2	39.9	40.8	41.3	41.8	41.4	28.1	27.9	27.6	27.6	27.7	29.9	30.6	35.9
315	41.0	39.4	38.3	38.2	40.1	41.2	41.6	41.6	41.3	28.1	27.9	27.6	27.6	27.7	29.9	30.6	37.5
330	41.3	39.5	38.5	38.4	40.2	41.4	42.0	41.5	41.2	28.1	27.9	27.6	27.6	27.7	29.9	30.6	38.7
345	41.5	39.6	38.5	38.4	40.3	41.3	42.0	41.5	41.1	28.1	27.9	27.6	27.6	27.7	29.9	30.2	39.7
Max	**41.5**	**39.6**	**38.5**	**38.4**	**40.3**	**41.4**	**42.0**	**42.0**	**42.0**	**28.1**	**27.9**	**27.6**	**27.6**	**27.7**	**29.9**	**30.6**	**41.5**

7.4.3.4 Predicted Cumulative Impacts

Location H46, monitored by Coillte is predicted to have a noise level of 41.8 dB LA_{90} at 8m/s wind speed based on the Hayes McKenzie contour model. The cumulative impact of the Oweninny and Corvoderry wind farms using Siemens SWT-3-101 Turbines is provided in Table 7-17.

Table 7-17 provides the modelled noise at representative house locations predicted for the cumulative impact case where Corvoderry wind farm is operating at the same time as Oweninny. The turbine type modelled at all three locations is the Siemens SWT-3-101 turbine at 120 metres hub height in Oweninny, 99.5m hub height in Cluddaun and 55m in Corvoderry. The maximum modelled background noise for this scenario is 42.8 dB LA_{90}. This would occur at house location H18 located on the local road in the centre of the site although house locations H16, H17, H19, H20 and H36 would have similar predicted noise levels. Location H46, monitored by Coillte is predicted to have a noise level of 41.8 dB LA_{90} at 8m/s wind speed based on the Hayes McKenzie contour model. The cumulative impact of the Oweninny and Corvoderry wind farms using Siemens SWT-3-101 Turbines complies with the noise limit of 43 dB LA 90 (free field) at a wind speed of 8 m/s.

Table 7-17: Noise Predictions for Oweninny (Phase 1&2 – SWT-3-101) and Corvoderry (dB L_{A90})

Sector Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	41.5	39.7	38.6	38.5	40.3	41.3	42.0	41.2	41.0	34.1	33.4	33.0	32.9	32.4	31.5	29.8	40.4
15	41.5	39.7	38.6	38.5	40.1	40.7	41.6	41.3	40.8	33.7	32.9	32.5	32.4	31.6	30.5	28.3	41.0
30	41.5	39.5	38.5	38.4	39.5	40.2	41.0	41.2	40.9	33.5	32.1	31.7	31.5	31.0	29.3	26.4	41.2
45	41.5	39.1	38.0	37.9	38.7	39.4	40.5	40.9	40.7	31.8	30.9	30.5	30.4	29.0	27.3	22.3	41.5
60	41.4	38.5	37.1	37.0	37.6	38.8	39.9	40.8	40.4	30.8	28.4	28.4	27.9	27.1	25.4	19.9	41.5
75	41.2	37.1	35.8	35.7	36.4	38.2	39.6	40.5	40.4	27.5	26.4	26.2	25.9	24.9	22.1	18.8	41.5
90	40.4	35.9	34.4	34.3	35.3	37.8	39.4	40.4	40.4	24.8	23.6	23.4	23.1	22.3	20.8	18.8	41.5
105	39.6	33.9	32.4	32.3	34.4	37.2	39.2	40.6	40.5	22.7	21.8	21.6	21.4	20.9	20.7	19.8	41.3
120	38.2	32.2	30.7	30.6	33.5	36.8	38.5	40.9	40.8	21.6	21.0	20.7	20.6	20.4	21.5	21.6	41.0
135	36.6	31.2	29.8	29.8	32.6	36.1	38.3	41.3	41.1	21.3	20.9	20.5	20.5	20.6	23.3	23.6	40.5
150	35.3	29.7	27.6	27.5	31.3	35.3	37.7	41.5	41.4	21.7	21.5	21.1	21.1	21.6	26.2	25.4	39.9
165	33.4	28.3	26.0	25.9	31.0	35.6	37.7	41.9	41.7	22.9	22.9	22.4	22.5	23.3	27.5	27.6	38.8
180	32.3	28.5	26.1	25.9	32.3	36.1	38.1	42.0	41.7	25.0	25.3	24.6	24.9	26.5	29.5	29.5	38.0
195	31.9	29.6	27.2	27.1	34.8	37.7	38.5	41.9	41.9	28.4	28.4	27.9	27.9	29.2	30.7	30.7	36.2
210	32.3	32.6	30.8	30.6	36.0	38.4	39.4	41.9	42.0	30.0	30.6	30.0	30.0	30.4	31.6	31.3	34.8
225	33.4	35.0	33.9	33.8	37.6	39.3	39.8	41.9	41.9	32.4	31.9	31.4	31.3	31.9	32.3	31.7	32.1
240	35.3	36.7	35.7	35.6	38.7	39.6	40.2	42.0	41.8	32.9	33.0	32.5	32.4	32.3	32.6	31.7	30.7
255	37.2	38.0	37.0	36.9	39.2	39.9	40.4	42.0	41.7	33.9	33.3	32.8	32.7	32.6	32.8	31.7	30.4
270	38.4	38.5	37.7	37.6	39.4	40.1	40.6	41.9	41.6	34.1	33.4	33.0	32.9	32.7	32.8	31.7	32.1
285	39.5	39.2	38.1	38.0	39.7	40.5	41.0	41.8	41.5	34.1	33.5	33.0	32.9	32.7	32.8	31.7	34.3
300	40.5	39.4	38.3	38.2	39.9	40.8	41.3	41.8	41.4	34.1	33.5	33.0	32.9	32.7	32.8	31.7	35.9
315	41.0	39.5	38.4	38.3	40.1	41.2	41.7	41.6	41.3	34.1	33.5	33.0	32.9	32.7	32.8	31.5	37.5
330	41.3	39.6	38.6	38.5	40.3	41.4	42.0	41.5	41.2	34.1	33.5	33.0	32.9	32.7	32.4	31.3	38.7
345	41.5	39.6	38.6	38.5	40.3	41.3	42.0	41.6	41.1	34.1	33.5	33.0	32.9	32.7	32.2	30.8	39.7
Max	**41.5**	**39.7**	**38.6**	**38.5**	**40.3**	**41.4**	**42.0**	**42.0**	**42.0**	**34.1**	**33.5**	**33.0**	**32.9**	**32.7**	**32.8**	**31.7**	**41.5**

7.4.3.5 Summary of noise impacts

A summary of predicted daytime noise for both Oweninny acting alone and Oweninny acting in conjunction with Corvoderry wind farm is provided in Table 7-18. Under worst case conditions the impact of both the Oweninny wind farm and the cumulative impact of the Oweninny Corvoderry wind farm combined, are within the proposed noise limit of 43 dB at 8m/s wind speed.

Table 7-18: Daytime predicted and background noise levels at 8m/s

Location	Cluster	Predicted L_{90} dB re 20 µPa (Hayes McKenzie) 8m/s Oweninny acting alone	Predicted L_{90} dB re 20 µPa (Hayes McKenzie) 8m/s Oweninny Phases 1 & 2 and Corvoderry	Background Daytime Background L_{90} dB re 20 µPa (Measured) 8m/s
H6	H1 – H10	41.8	41.5	36
H13	H11, H12, H14 and H15	40.3	39.7	43
H16	-	42.4	40.3	41
H17	H18	42.8	41.4	38
H19	H20	42.4	42.0	34
H23	H21, H22, H24, H25, H26, H27, H28, H29, H30, H31, H33, H34 and H35	42.1	33.0	43
H38	H36, H37, H38, H39, H40 and H41	39.4	33.0	31
H42	H43, H44, H45	41.6	31.7	38
H46*	-	32	30	31

*based on data from Figure 3 and Figure 4 of The Hayes McKenzie report (2015) attached in Appendix 7A

7.5 CUMULATIVE IMPACTS

7.5.1 Cumulative Impact of Oweninny and Corvoderry

The main cumulative noise impacts will arise as a result of the proposed Corvoderry wind farm construction and operation and those of the Oweninny wind farm development.

The Corvoderry site is also located within the Oweninny site and construction of its access track, crane stands, turbine foundations and substation will give rise to construction noise similar to that described above. As the Corvoderry development comprises only 10 turbines the cumulative noise impact will be of a short duration.

In the noise assessment of the operational phase of Oweninny (Section 7.4.3.4 above) the predicted noise levels at the noise sensitive locations based on cumulative noise from Oweninny Phases 1 & 2 in conjunction with Corvoderry represent the worst case scenario.

The cumulative assessment indicates that the limit value of 43 $dBLA_{90}$ will be complied with at all locations.

7.5.2 Cumulative Impact with other projects

The potential cumulative impact of the Oweninny wind farm Phases 1 & 2 and Corvoderry Wind Farm with other projects in the area is described below. The additional projects considered are:

- Cluddaun Wind Farm (application refused)
- Tawnanasool Wind Farm (proposed)
- Dooleeg Wind Turbine
- Bellacorick Moy 110kV
- Bellacorick-Castlebar 110kV
- Bellacorick – Bangor Erris 38kV
- Sheskin Meteorological Mast

Cluddaun Wind Farm

This proposed development comprised 48 turbines and was located to the north of Oweninny wind farm. An Bord Pleanála made a decision to refuse permission for this development on 1st May 2015. For the purposes of this report the Cluddaun wind farm and noise emissions emanating from it are not considered further.

Tawnanasool Wind Farm

This proposed development comprises 6 (six) wind turbines on a site over 10km west of the proposed Oweninny site. Based on the Hayes McKenzie noise models for the Oweninny wind farm a separation distance of 10km from wind turbines at one wind farm will result in a noise level of less than 20 dB at the second wind farm.

During the construction phase any activity being carried out with a 10km separation distance will not have any significant environmental impact.

The addition of a 20 dB noise level to anything greater than 40 dB level (close to an adjoining wind turbine) will result in a cumulative level of 40 dB due to the logarithmic addition of decibels.

Dooleeg Wind Turbine

This 2 MW wind turbine is permitted (following a decision by An Bord Pleanála, ref. PL 16.236402 in 2010) but not yet developed on a site 200m south of the N59. The grid connection for the site has lapsed.

The Dooleeg wind turbine site is approximately 500m from H23 and the cluster of houses in the Dooleeg area, which is half the distance from the proposed turbines at Oweninny.

Decision PL 16.236402 does not include a condition relating to noise but it is clear from the EIS submitted with the development and the Inspectors Report that a noise level of 45 dBA as set out in the 2006 Planning Guidelines was envisaged. The EIS submitted with the application predicted a noise level at H23 (Location A in the Dooleeg Wind Turbine EIS) of 40.3 dBA at full output.

The Hayes McKenzie noise model for Oweninny and Corvoderry wind farms combined predicts a worst case (wind blowing from Turbine T109) towards H23 of 31 dBA at full output. The difference in noise levels is 9.3 dBA, which would give a cumulative noise impact of 40.8 dBA.

This cumulative noise impact is below the proposed limit of 43 dBA proposed for Oweninny wind farm. It is important to note that the cumulative noise level is not likely to increase as it is not possible to have both turbines operating upwind of H23 simultaneously. A more likely scenario would be a smaller cumulative impact, which in acoustic terms is negligible.

Potential future development of Oweninny Phase 3

Should Phase 3 of Oweninny be developed in accordance with the layout indicated in the original EIS then there would be a cumulative increase in the timescale during which potential noise construction impacts could occur associated with the construction period of Phase 3.

During the operational stage of Phase 3, in combination with Phase 1 and 2 the predicted noise impact on noise sensitive locations would increase particularly to the east and southeast of the site. The predicted noise impact for all three phases of the Oweninny development operating together would be as described in the original EIS Chapter 7, submitted to An Bord Pleanála in 2013. Cumulative impacts with other wind farms in the area would also increase. The cumulative impacts would not lead to noise levels in excess of the existing Department of the Environment Guidelines of 2006.

Bellacorick - Moy 110kV

The Bellacorick - Moy 110kV line is an existing line that connects the Bellacorick substation with the Moy substation and runs approximately parallel to the N59, through the Oweninny Wind Farm study area. The proposed upgrading to the existing overhead transmission line will involve changes to the conductors and replacement of some structures, along with ancillary works.

As the works required in the upgrade of the existing Bellacorick – Moy 110kV Line are proposed to be carried out by small-scale construction machinery (ranging from tracked quads, to four-wheel drives, to Mobile Elevated Working Platforms (‘MEWP’s), to tracked excavators), noise emissions are not expected to be any greater than those used in the construction of domestic and agricultural buildings. Any noise emissions arising will be short term and localised to the section of the line being worked on.

There will be no noticeable changes in the operational noise of the Line, as a result of the uprate.

The cumulative impact of this proposed development when taking place in parallel with the Oweninny wind farm project will not have any significant environmental impact on the study area.

Bellacorick – Castlebar 110kV

The Bellacorick-Castlebar 110kV line is an existing line that connects the Bellacorick Sub-station with the Castlebar Sub-station area distance of approximately 19.5 km. The line route is from Bellacorick Sub-station parallel to the N59 to the junction of the R312 where it heads off in a south-easterly direction towards Castlebar. The proposed upgrading to the existing overhead transmission line will involve changes to the conductors and replacement of some structures along with ancillary works.

As the works required in the upgrade of the existing Bellacorick – Castlebar 110kV Line are proposed to be carried out by small scale construction machinery (ranging from tracked quads, to four-wheel drives, to Mobile Elevated Working Platforms ('MEWP's), to tracked excavators), noise emissions are not expected to be any greater than those used in the construction of domestic and agricultural buildings. Any noise emissions arising will be short term and localised to the section of the line being worked on.

There will be no noticeable changes in the operational noise of the Line, as a result of the uprate.

The cumulative impact of this proposed development when taking place in parallel with the Oweninny wind farm project will not have any significant environmental impact on the study area.

Bellacorick – Bangor Erris 38kV

The Bellacorick-Bangor Erris 38kV line is an existing line that connects the Bellacorick 110Kv Sub-station with the Bangor Erris 38kV Sub-station and runs approximately 12.3km parallel to the N59 westerly to the townland of Bangor Erris. The proposed upgrading to the existing overhead transmission line (PL15/611) will involve reinforcement of foundations of steel towers, changes to the conductors, replacement of intermediary/angle wooden pole sets and rerouting of existing line at two locations along with ancillary works.

As the works required in the upgrade of the existing Bellacorick – Bangor Erris 38kV Line are proposed to be carried out largely by small scale construction machinery (ranging from tracked quads, to four-wheel drives, to Mobile Elevated Working Platforms ('MEWP's), to tracked excavators), noise emissions are not expected to be any greater than those used in the construction of domestic and agricultural buildings. Deliveries of materials to locations within the SAC areas will be made by helicopter. Although this will result in localised noise increase the activities will be of very short duration and localised to the section of the line being worked on.

There will be no noticeable changes in the operational noise of the Line, as a result of the uprate.

The cumulative impact of this proposed development when taking place in parallel with the Oweninny wind farm project will not have any significant environmental impact on the study area.

7.5.3 Decommissioning Phase

During decommissioning there would be a cumulative noise impact similar to the construction phase.

7.6 MITIGATION

7.6.1 Construction phase

The site activity associated with the construction of the wind farm (placement of turbines) will be limited to a maximum hourly L_{eq} value, as set out in Table 7-13 above, at any nearby residence during normal working hours; while for most of the construction period the L_{eq} values will be considerably less than 55 dB (A).

Some construction activities will be required to take place on a round-the-clock basis, such as pumping water, treating fresh concrete surfaces and provision of security lighting. Such activities are very limited in scope and do not require the use of heavy machinery. Activities at this level of intensity will not cause any noise related impact outside the site boundary and are necessary for the efficient execution of works.

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 (typically a decrease of 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 normally be short term.

The scale of the Oweninny development is such that construction will take place over an extended period in different locations within the site but will by its nature be intermittent. Other than in exceptional circumstances, all construction works will be carried out during the day-time period.

7.6.2 Operational phase

The wind farm will operate in such a manner to limit turbine noise at any noise sensitive residence in the area to the limits specified in Table 7-15 above.

Older wind turbines were generally fixed speed machines, which operated at one or possibly two speeds regardless of the wind speed. The wind turbines proposed are pitch-controlled, variable-speed machines, meaning that by design these turbines operate at a range of different rotor speeds and can vary their rotor speed on demand. As blade noise is related to blade tip speed and the turbines are capable of being operated at varying rotor speed and pitch settings, the turbines can be tuned either aggressively for maximum energy recovery or, in noise sensitive areas, for lower energy recovery and lower noise - on a turbine by turbine basis.

A documented noise complaint procedure will be put in place for recording, reporting and handling noise complaints, should they arise.

Monitoring

It has become relatively common practice on all but the most remote wind farm sites to identify suitable noise sensitive receptors for pre- and post-construction noise monitoring if required.

A programme of noise monitoring will be undertaken, if required, using the noise monitoring locations which have been identified at Oweninny in connection with establishing background conditions. The developer would engage a suitably qualified independent professional acoustics consultant who holds adequate professional indemnity insurance to carry out the measurements, subject to agreement of the relevant property owners. The survey would be implemented by monitoring which would entail deploying attended and / or unattended sound level meters.

Monitoring at each location would consist of a series of measurements taken in a variety of wind conditions. These would include the selected turbine cut-in wind speed and wind speeds within the range 4 m/s to 9 m/s at hub height.

Measurement periods will be such that the noise from non-wind farm sources can be discounted so that a measurement period of 10 minutes relating to wind farm noise only shall be achieved.

In the case of measurements indicating noise levels exceeding limit values, consideration of mitigation measures will include the de-rating of turbine output, to achieve the specified limits.

A typical noise monitoring station would comprise a noise level meter and a weather station (wind and rain events) with data storage facilities and capable of logging data every 10 minutes.

It is proposed that noise levels be monitored as required post commissioning to demonstrate compliance with the relevant guidance.

7.6.3 Decommissioning

Mitigation measures will be similar to those employed at the construction stage.

7.7 CONCLUSIONS

The noise emission from wind farms tends to be steady broadband noise with some energy in the low frequency spectrum. Noise emissions close to wind farms tend to equate to natural (non-man made) sounds. It is normally characterised as wind generated noise and noise emanating from the wind effects on trees, shrubs and other vegetation. When the wind is blowing away from residences towards the turbines, the noise emission should be indiscernible.

In most rural areas the Background noise environment is controlled in the main by the wind speed influences / interaction of wind on foliage / vegetation – the higher the wind speed the higher the noise levels generated. In elevated wind speeds, above 8m/s, the noise emissions from the wind farm will begin to 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.

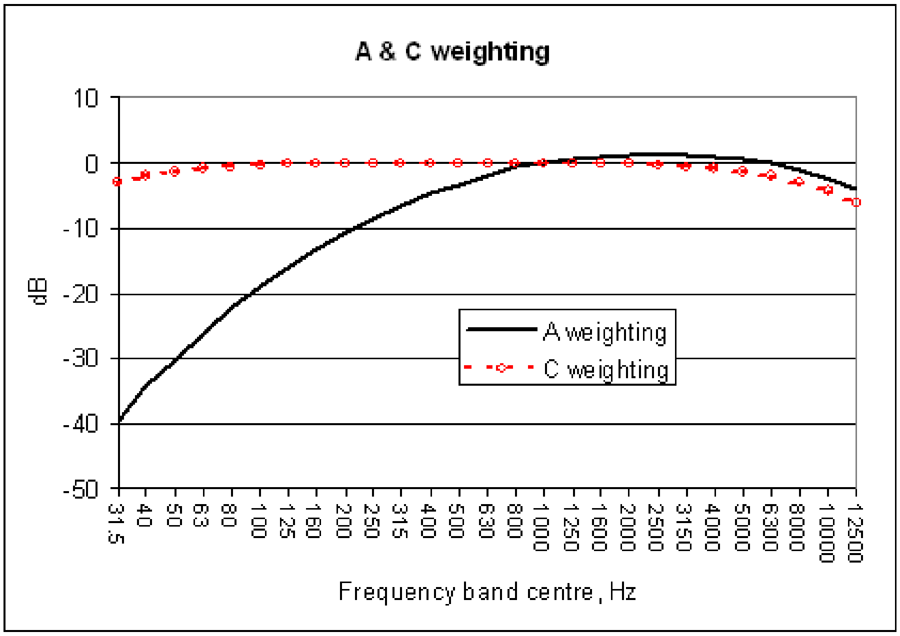
The predicted operational noise levels are in many cases higher than the existing background levels. While within planning guideline limits, turbine noise will be audible in some locations under certain weather conditions. However, the limits proposed of 43 dB LA_{90} where the daytime Background noise is 30dB LA_{90} or greater, and 37.5 dB LA_{90} where the daytime background noise is less than 30 dB LA_{90}, as set out in Table 7-15 are appropriate noise level compliance targets. The Planning Guidelines for Wind Farm development published by the Department of the Environment reflect Government policy which seeks to strike a balance between offering a 'reasonable degree of protection', while also would not 'unduly restrict wind energy'.

The predicted noise at the noise sensitive locations, both when the wind turbines at Oweninny are operational alone and also when Oweninny operates in conjunction with wind turbines at Corvoderry, will not exceed 43 $dBLA_{90}$ at 8m/s wind speed and will not give rise to significant impact.

In summary the noise from the wind farm, when operating alone and when operating in conjunction with Corvoderry, will not exceed 43 dB LA_{90} (free field) at any noise sensitive location.

7.8 GLOSSARY AND DEFINED TERMS

ABP	An Bord Pleanála
Broadband	Refers to a signal or oscillatory quantity whose spectrum covers a wide range of frequencies
dBA	A-weighted Sound Pressure level in decibels with a reference level of 20 μPa
D0EHLG	Department of Environment, Heritage and Local Government
DECLG	Department of Environment, Community and Local Government (formerly DEHLG)
EPA	Environmental Protection Agency
Free field	An environment free of scattering or reflecting boundaries, so that outgoing waves never return towards the source region
Hertz	Unit of frequency defined as the number of cycles per second of a periodic phenomenon
Infrasound	According to the International Electrotechnical Commission's *60050-801:1994 International Electrotechnical Vocabulary - Chapter 801: Acoustics and electroacoustics*, infrasound is defined as: Acoustic oscillations whose frequency is below the low frequency limit of audible sound (about 16 Hz). However this definition is incomplete as infrasound at high enough levels is audible at frequencies below 16 Hz. For the purpose of this report an upper limit of 20 Hz is taken.
km	kilometre
Low-frequency sound	Sound in the frequency range that overlaps the higher infrasound frequencies and the lower audible frequencies, and is typically considered as 10 Hz to 200 Hz, but is not closely defined.
L_p	Sound pressure level in decibels: The sound pressure level is given by the formula $L_p = 10 \text{ Log } (p/p_o)^2$ where, P is the root mean square sound pressure in Pascals, p_o is the reference sound pressure (20 μPa)
L_{pA}	A-weighted sound pressure, in decibels: The root mean square sound pressure determined by use of frequency network "A" (see IEC 61672:2003)
L_{pC}	C-weighted sound pressure, in decibels: The root mean square sound pressure determined by use of frequency network "C" (see IEC 61672:2003).



L_w Sound power level in decibels: The sound power level is given by the formula

L_w = 10 Log $(w/w_o)^2$ where, w is the sound power in Watts and w_o is the reference sound power (10^{-12} Watts)

MW Megawatt, unit of energy equal to one million Watts

Noise Sensitive Location (NSL)

NSL – any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels

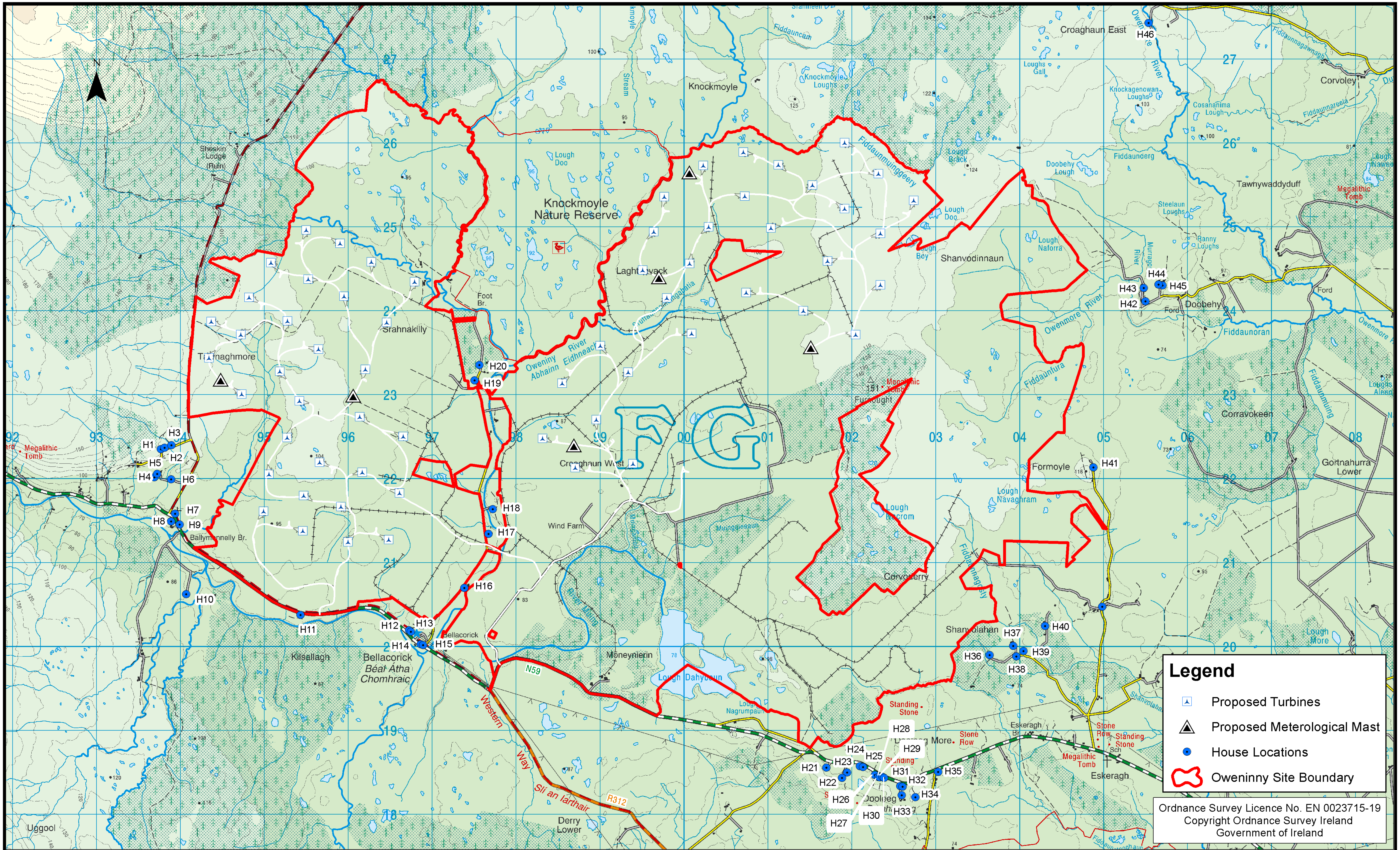
Sound Power The rate of acoustic energy flow across a specified surface or emitted by a specified sound source, in Watts

Tone A single frequency sound, in the audio frequency range, sometimes called a pure tone

µPa micro Pascals

Watt Defined as one joule per second, measures the rate of energy conversion or transfer

24/7 Operating 24 hours per day on a 7 day week basis



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Oweninny Power Ltd.

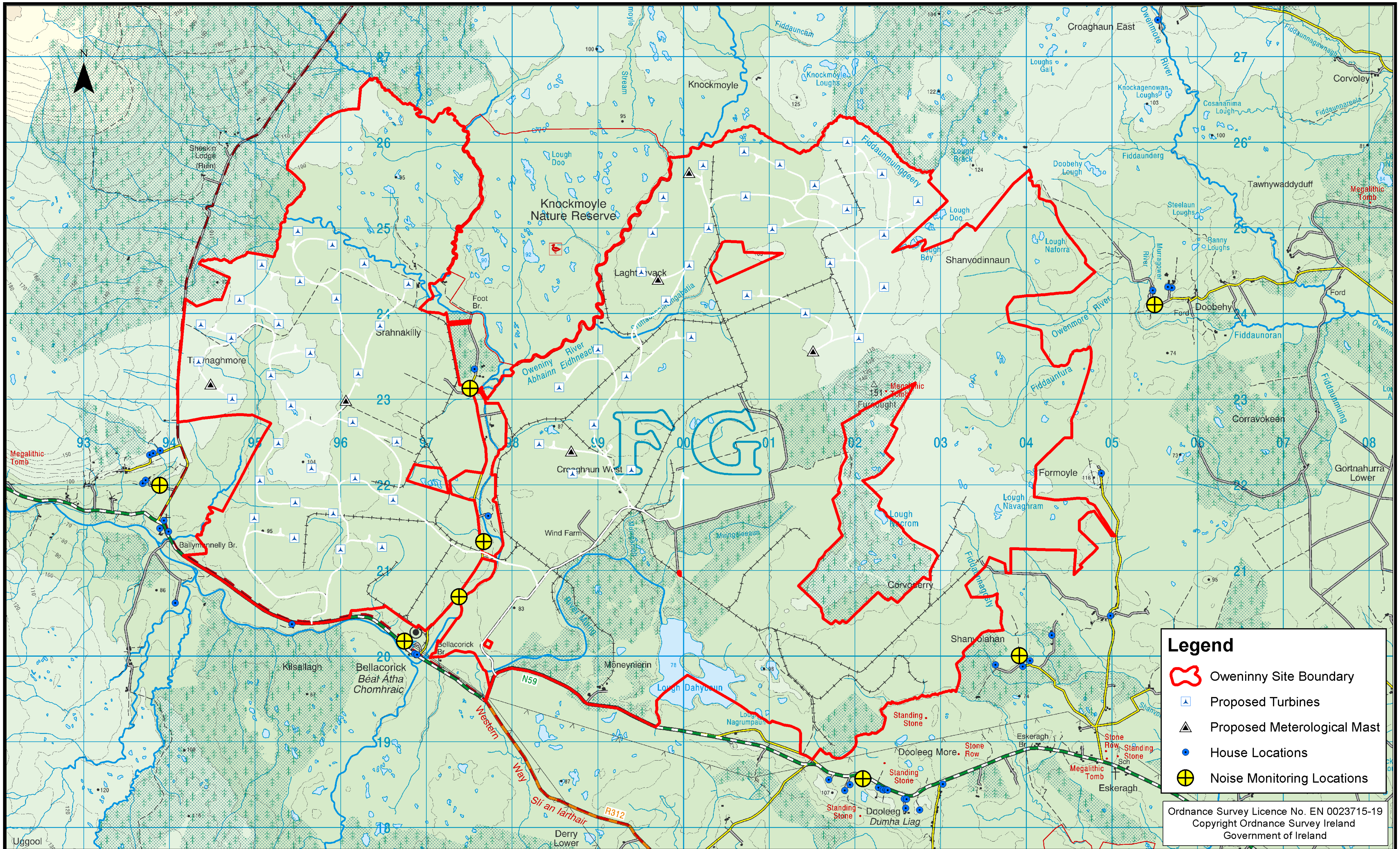
Client	Oweninny Power Ltd.
Project	Wind Farm at Oweninny, Co. Mayo
Title	Wind Farm Layout with Noise Sensitive Locations - Phasing 1 & 2
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
EO'S	C.F	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
	00-00	A3	1:40,000

MAP REFERENCE

FIGURE 7.1



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Representative Noise Monitoring Locations - Phasing 1 & 2
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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EO'S	C.F	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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MAP REFERENCE

FIGURE 7.2

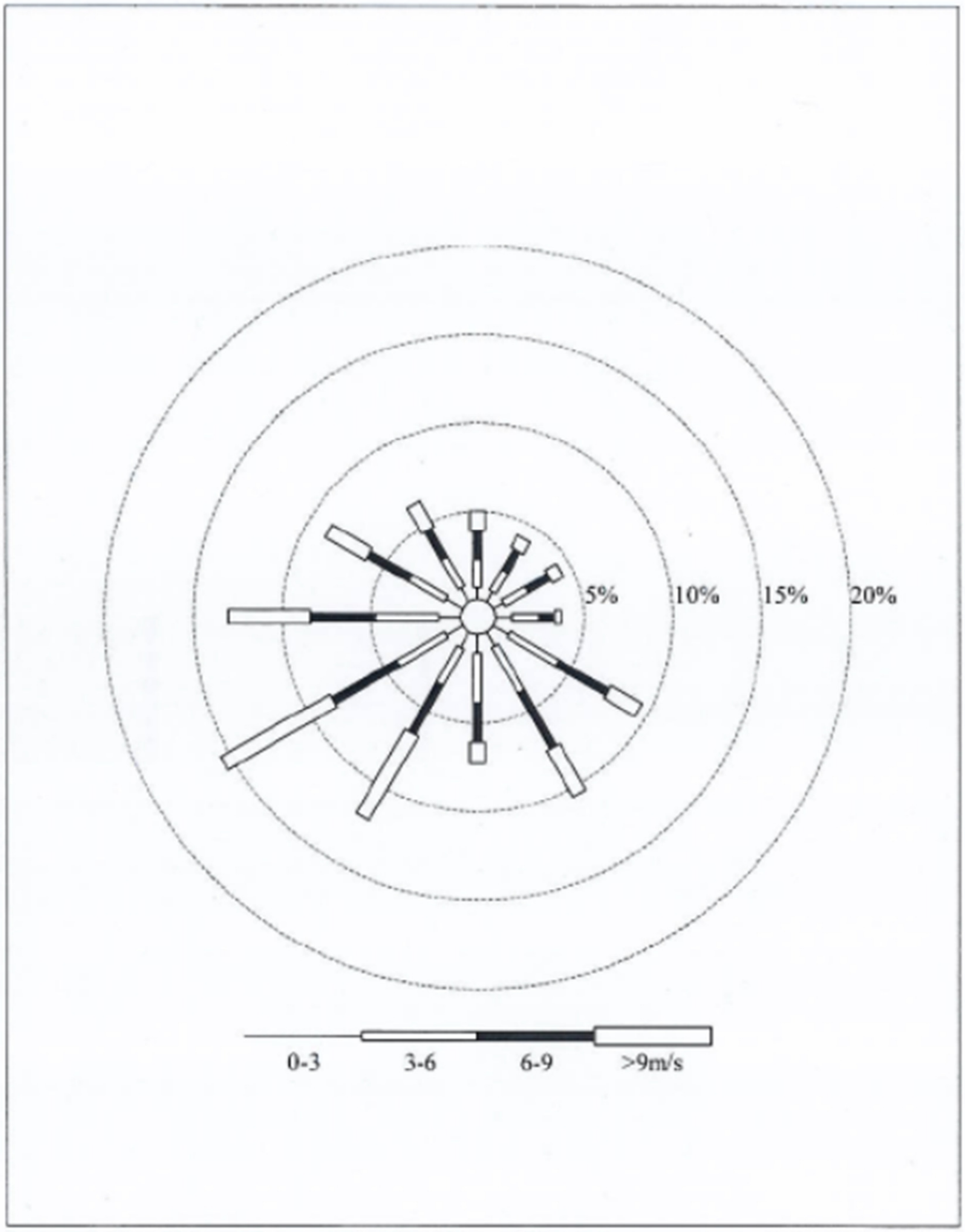


Figure 7-3: Predicted long term wind speed and direction at Mast 1 @ 50m

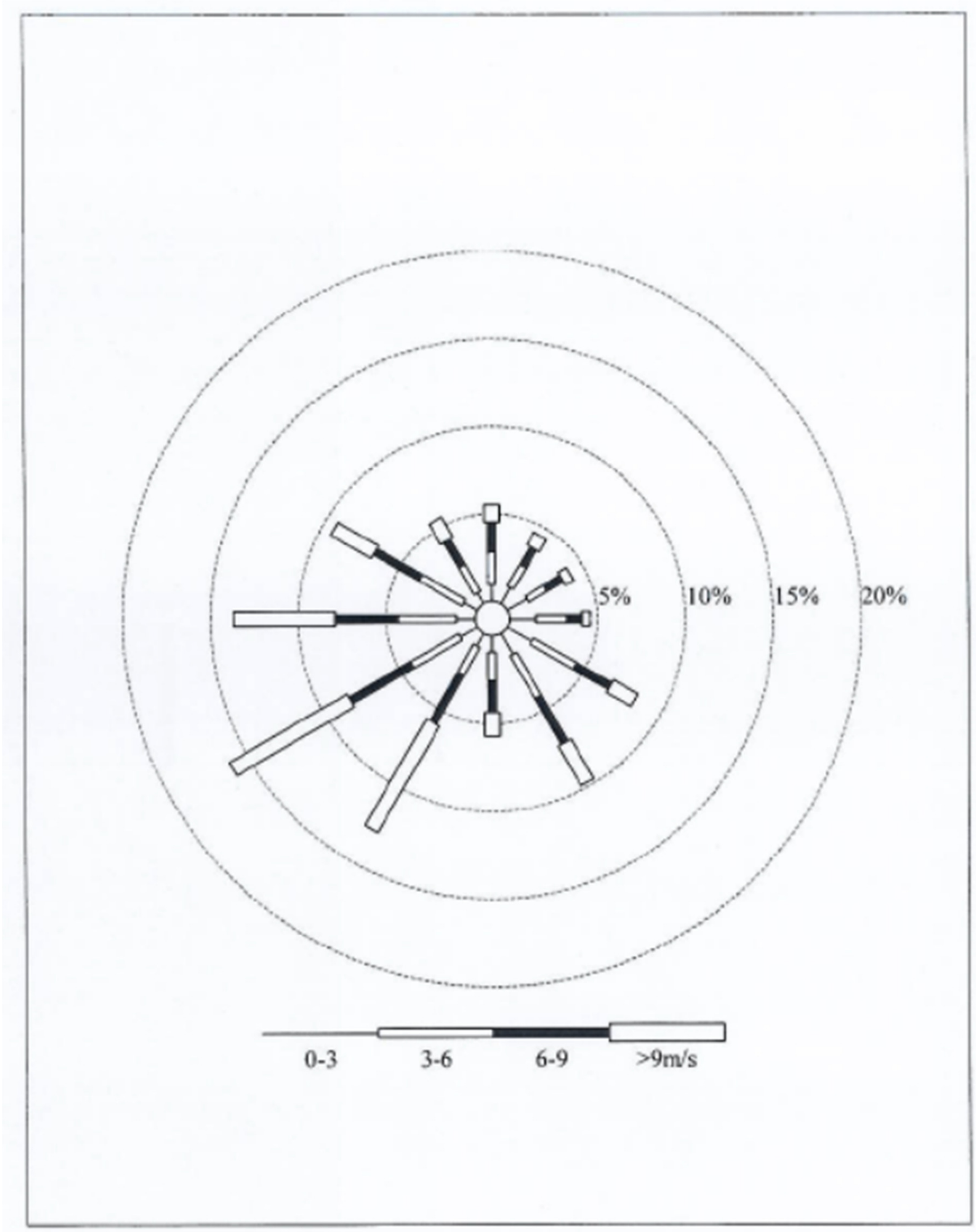


Figure 7-4: Predicted long term wind speed and direction at Mast 2 @ 50m

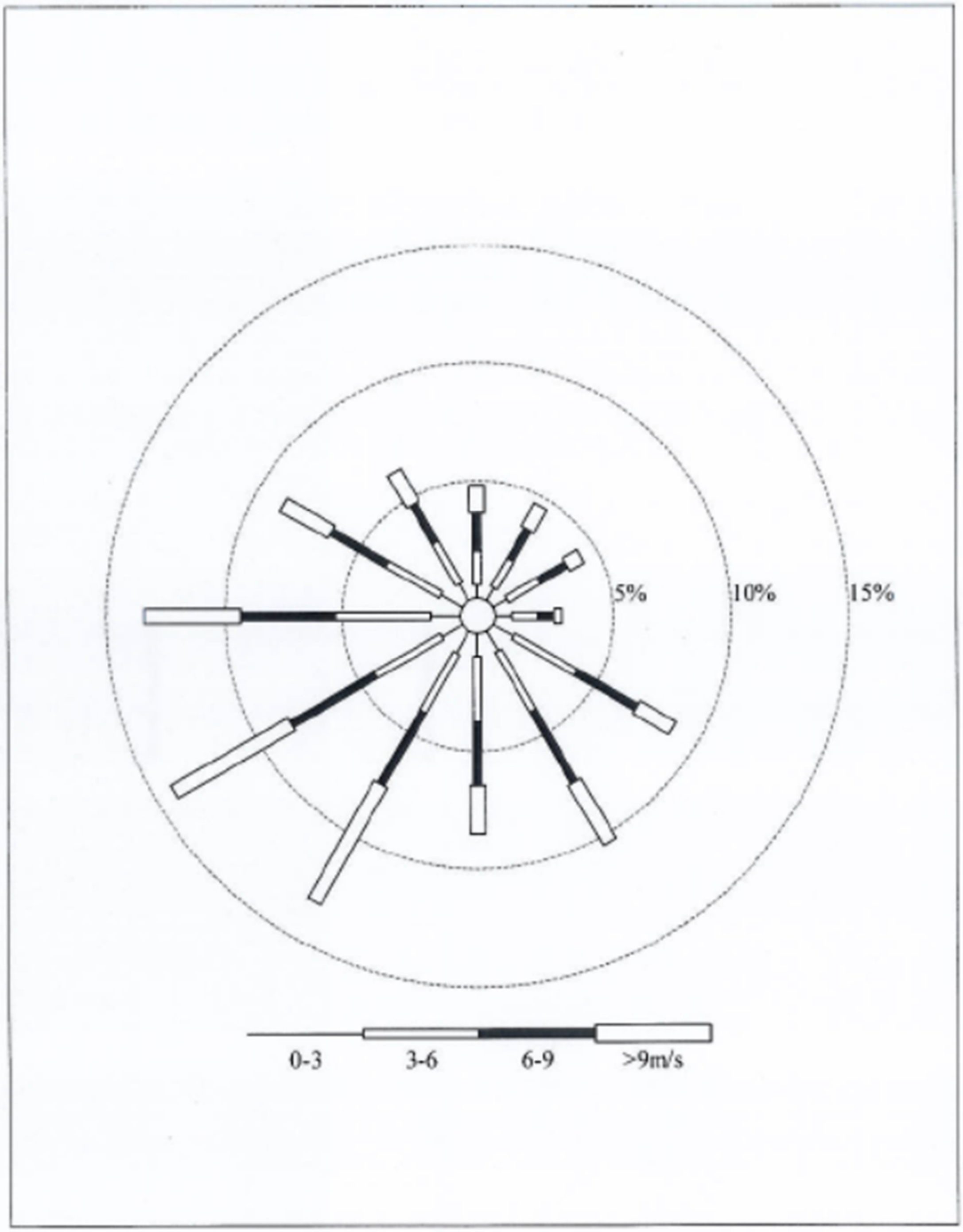
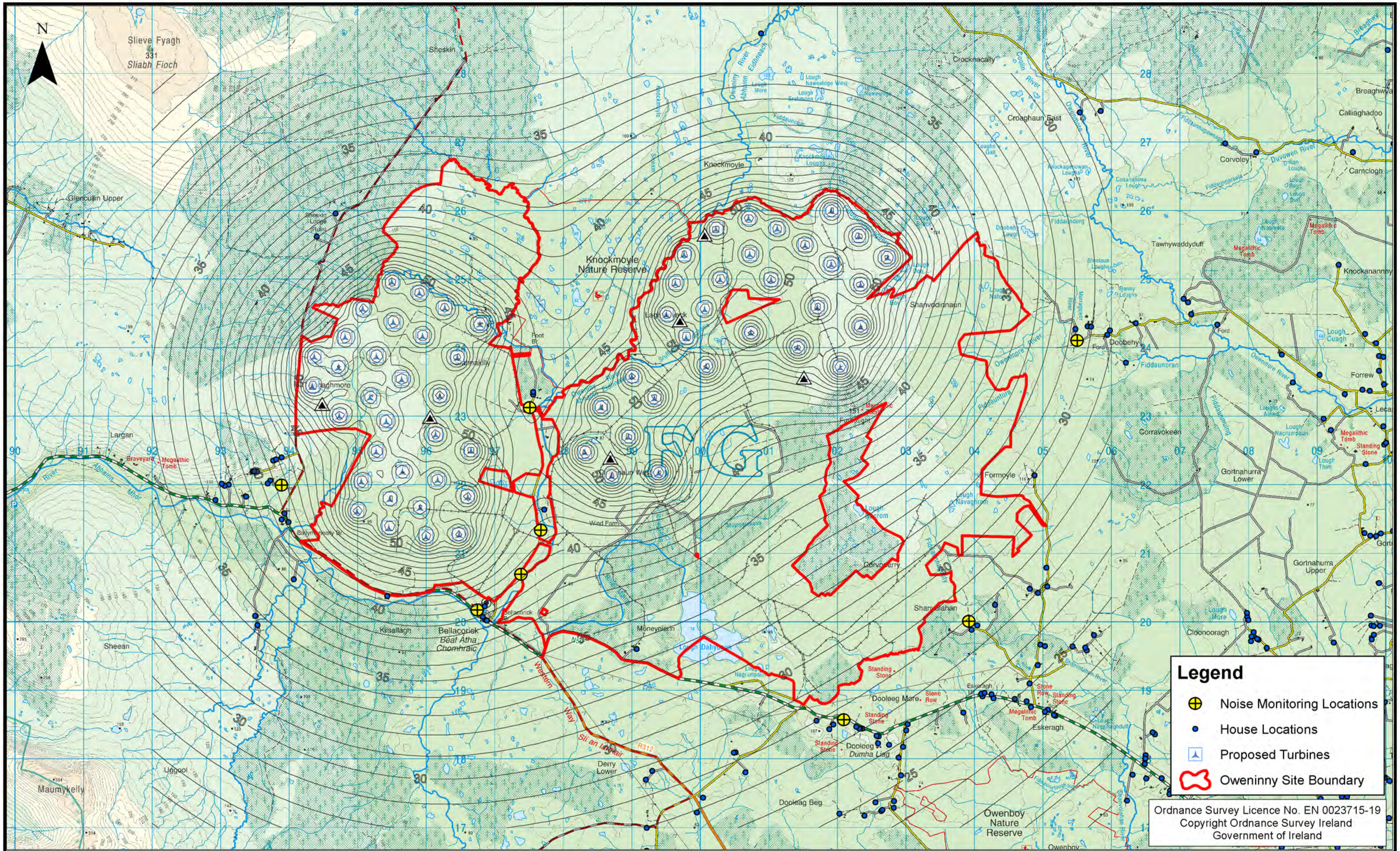


Figure 7-5: Predicted long term wind speed and direction at Mast 3 @ 50m



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Predicted Noise Level Contour Map with Siemens SWT-3-101 wind turbines – Oweninny only - Phasing 1 & 2
Project	**Production Unit**
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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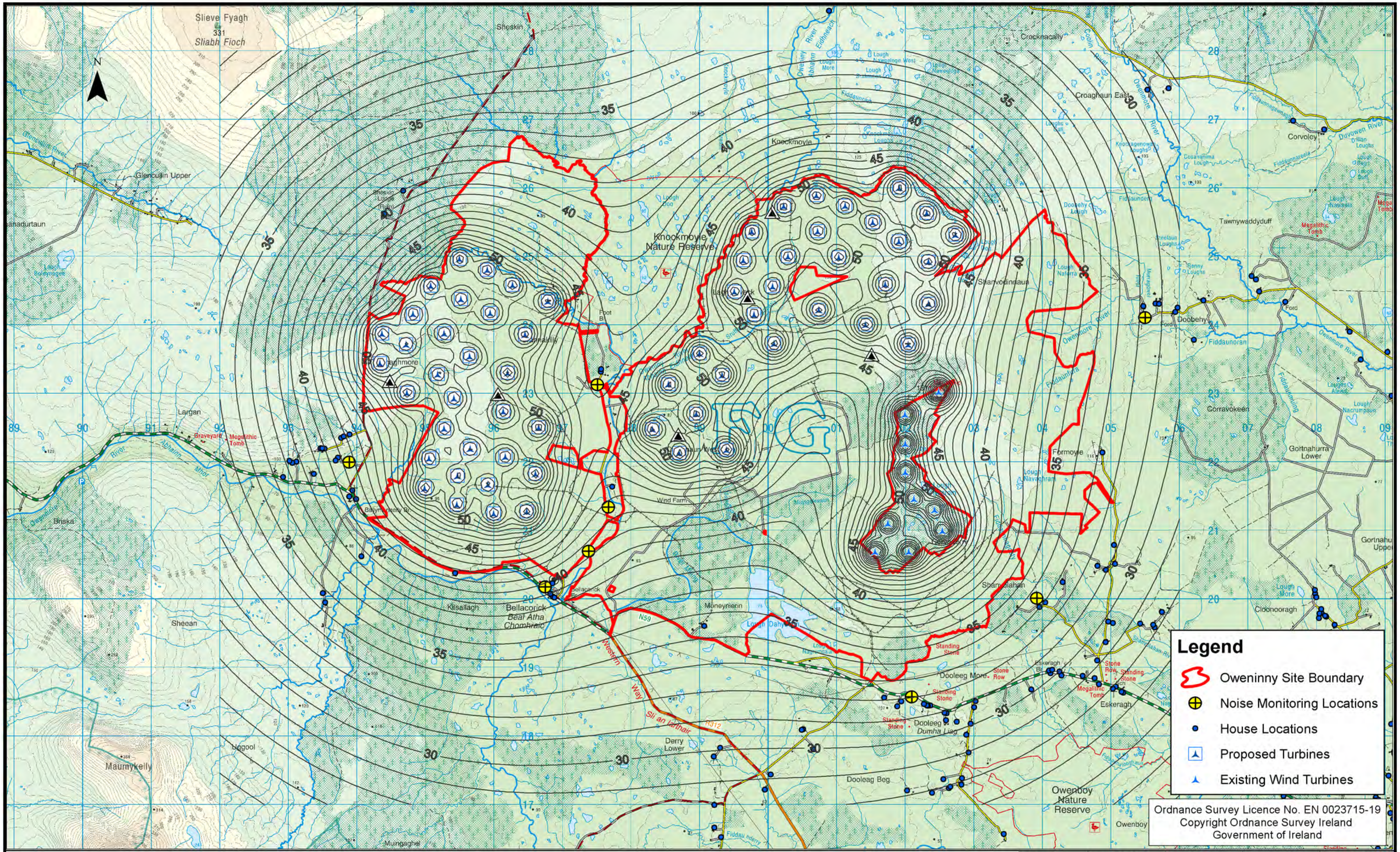
MAP REFERENCE

FIGURE 7.6



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Predicted Cumulative Noise Level Contour Map with Siemens SWT-3-101 wind turbines –Oweninny and Corvoderry - Phasing 1 & 2
Project	**Production Unit**
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
C.F	C.F	P.K	N.Q	12/10/2015

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MAP REFERENCE

FIGURE 7.7

International

Oweninny Wind Farm

Oweninny
Environmental Impact Statement
Appendix 7

Noise Monitoring Report

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ESB International
Stephen Court,
18 - 21 St. Stephen's Green,
Dublin 2.

Noise Report

Proposed Wind Farm

at Oweninny

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Noise Report

Proposed
Wind Farm
At Oweninny
Co. Mayo

Report to:

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Report submitted by:

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1 INTRODUCTION

Biospheric Engineering Ltd has been engaged by ESB International to assess the potential noise impact of the Oweninny Wind Farm. This report details the methodology and findings of the potential noise impact of the proposed wind farm.

Wind farm operational noise has been assessed in accordance with the Guidelines published by the Department of Environment, Heritage and Local Government, (DoE Guidelines) which is the current guideline for wind farm noise assessment in Ireland.

ESB International have identified 46 properties surrounding the site, which could be impacted by the proposed development. Two other proposed wind farm developments are located close by at Cloddaun and Corvoddery. These proposed developments are described as follows:

- Cluddaun: Coillte's proposed Cluddaun wind farm is located to the northeast of Oweninny and will comprise a total of 48 wind turbines.
- Corvoderry: Within the Oweninny site planning permission has been granted by Mayo County Council for a 10 turbine wind farm,

Background Noise Monitoring

In order to present a reasonable picture of prevailing background noise level monitoring was carried out over an extended period and long term background noise curves based on DoE periods were constructed for nine residences surrounding the proposed development. The nine locations were chosen as representative of the 46 according to the clustering outlined in Table 1. The sampling methodology of 10 minute intervals is as indicated in *The Assessment & Rating of Noise from* Windfarms, The Working Group on Noise from Wind Turbines, Final Report, *ETSU-R-97*, September 1996, (ETSU)

Monitoring Location	Cluster Represented
H6	H1, H2, H3, H4, H5, H7, H8, H9 and H10
H13	H11, H12, H14 and H15
H16	-
H17	H18
H19	H20
H23	H21, H22, H24, H25, H26, H27, H28, H29, H30, H31, H32, H33, H34 and H35
H38	H36, H37, H38, H39, H40 and H41
H42	H43, H44 and H45
H46	- (Monitored By Coillte for Cluddaun project)

Table 1: Background noise monitoring location and cluster represented

Wind speed at the site was measured using three existing wind masts, which record wind speeds on a continuous basis, also at 10 minute intervals. Each mast is equipped with an anemometer at 10m height. Noise measurements were taken over a minimum of a two week period at all locations. Monitoring at H19 was carried out in parallel with all other locations so that the data recorded at H 19 is for a total of 52 days in a variety of wind conditions. The timing of the noise measurements was synchronised with the wind speed measurements. The wind mast data was related to monitoring location according to the following arrangement.

Mast No	Coordinates (ITM)	Ground Level (m) AOD	Association with

	Easting	Northing		monitoring location
0001	501362	824459	101.00	Mast 1 for H46
0002	495803	822607	100.20	Mast 2 for H19, H17, H16, H13 and H6
0003	503456	801832	104.75	Mast 3 for H23 H38 and H42.

Table 2: Wind Masts and associated noise measuring locations

Wind speed was taken as the average wind speed over each 10 minute measurement period. Background noise level was determined using the L_{90} criteria as recommended in ETSU-R-97.

Wind Farm Proposed Site Design

A maximum of one hundred and twelve (112) turbines has been considered for the layout of the Oweninny Wind Farm. The proposed 112 turbine maximum layout considered in this study is shown in Figure 1.

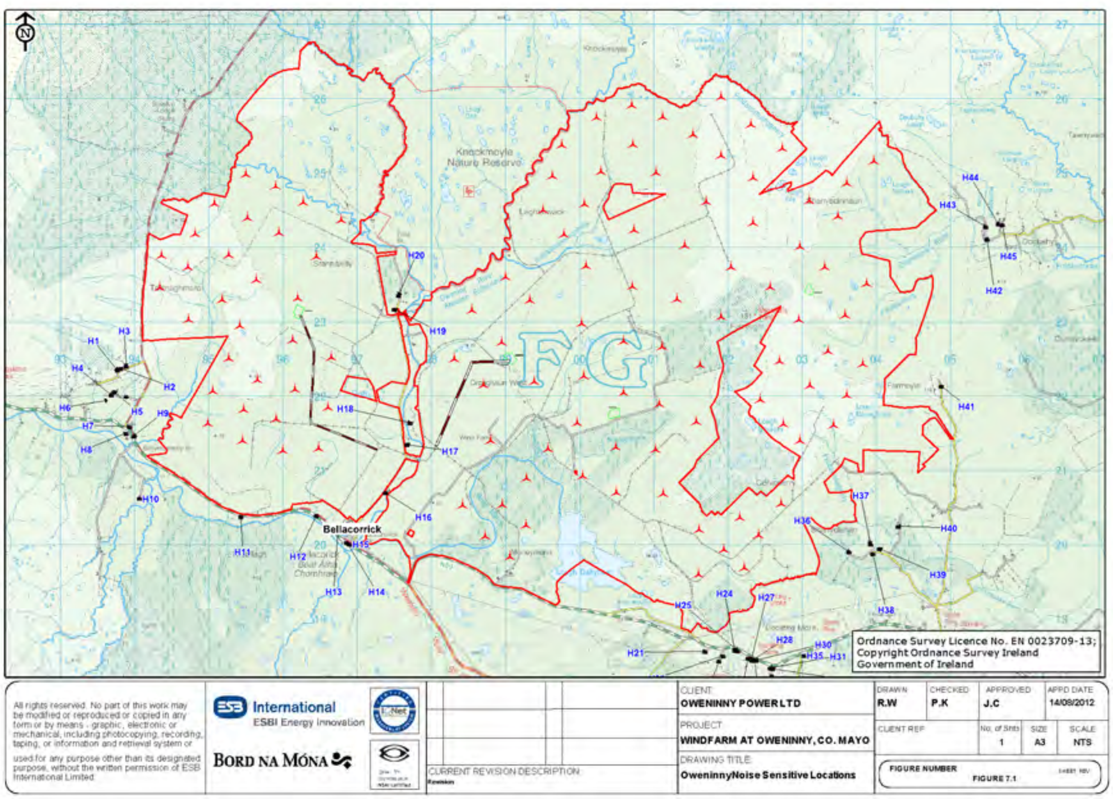


Figure 1: Proposed site layout with turbines and nearby residences.

The final turbine selection for the project would be made during the detailed design and procurement phase. It is therefore necessary for this assessment to consider the emissions of viable candidate turbine models which may be considered for the site. To this end, the application is based on seeking approval for a range of turbines, with varying hub heights, rotor diameters, generating capacity and noise emission levels.

ESB International has selected three (3) different makes of turbine which are representative of the range of turbines which could be considered for the site. All of the candidate turbines comprise three upwind rotor blades with variable blade pitch to control rotational speed, power generation and noise emissions. Table 3 summarises the relevant specifications of the 3 representative turbines.

Description	Candidate Turbines Vestas V112-3	 Siemens SWT-3-101	 Vestas V90-3
Rotor Diameter (m)	112	101	90
Hub Height (m)	120	120	90
Rotor speed range (rpm)	6.2 – 17.7	6 - 16	8.6 – 18.4
Cut-in Wind Speed (m/s)	3	3	3.5
Cut-out Wind Speed (m/s)	25	25	25
Maximum Sound Power LWA (Hz)	106.5	108	107

Table 3: Representative turbine specification

Depending on the final model of turbine selected for the site, a combined generating capacity of up to 339 MW may be achieved.

The sound power levels presented in Table 3 have been derived from manufacturer test data which we understand is based on the methodology of IEC-61400-11:2006 *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* (IEC61400-11:2006). This data is provided by The Hayes McKenzie Partnership Ltd, who prepared the noise prediction model for the site. Detailed sound power level data, including frequency characteristics, are provided in Appendix A of their report.

Table 3 indicates that there is a 30m variation in hub heights across the three turbine models. For simplicity, subsequent references to hub height in this report shall refer to 120m AGL (above ground level).

2 NOISE IMPACT FROM WIND FARMS

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 from wind farms 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, since renamed as the Department of Environment, Culture and Local Government. For simplicity these guidelines will be referred to as the DoE Guidelines.

The proposed development can be examined under the following phases:

- Construction Phase
- Operation Phase
- Decommissioning Phase

The construction phase is of limited duration and will require some significant noise generating activities, for short periods. The operational phase is an on-going phase with wind turbine noise being the dominant source. Other sources during the operational phase include sub-stations and site traffic, which are relatively minor in comparison to turbine noise, which is the principal noise during this phase. The decommissioning phase is similar to the construction phase.

The different phases give rise to different noise control measures. The operating phase will be a 24/7 operation requiring noise control both day and night and limiting impacts on amenities and wildlife. The construction phase is however a relatively short duration and will be carried out mainly by day so there is a balance between limiting noise and extending/shortening the duration of the construction phase. The noise control measures to be adopted must also be tailored to the activity. In either case we are dealing with noise levels that are in the 'nuisance' or 'annoyance' category rather than elevated noise levels that could have health or hearing implications.

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.

Operational 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.

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. In fact some of the turbine types proposed for this development have no gearbox in the nacelle.

It is accepted internationally that there are no audible tonal or impulsive emissions from modern turbines

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.

Continuing improvements in turbine blade design including fairing on the trailing edges and the turbine tips are leading to increasingly quiet large turbine designs. The link between turbine output and noise emissions has been broken and it is now possible to state that larger turbines are quieter turbines, based on noise/power ratio.

Low Frequency Noise

Low frequency noise is defined as noise in the frequency range 16 Hz to 125 Hz (or 20 Hz to 200 Hz depending on definitions). Noise at frequencies below 20 Hz is generally referred to as Infrasound and regarded as inaudible. There is concern among some members of the public that new large wind turbines might have a larger impact on the environment, associated with significantly more low frequency noise than that experienced from earlier generation smaller wind turbines. This concern is largely fuelled by publications on the internet and has led to several studies by government agencies to review the scientific evidence for such concerns.

A recent major study for the Danish Energy Authority prepared by DELTA Acoustics and Electronics[1] on low frequency noise from wind turbines compared sound power outputs from small (2.0 MW or under) and large (greater than 2.0 MW) wind turbines. The study concluded the following:

- *"The emitted A-weighted sound power level from wind turbines increases with the nominal power of the turbines. As the size of turbines increases the sound power increases. Doubling the power out from 2MW to 4 MW would give a 2.9 dB increase in the sound power level of the turbine indicating that certain amount of electrical power can be produced by larger turbines with slightly less noise emissions than smaller ones.*

- *Emitted low frequency sound power levels also increases with wind turbine size. Increasing the power output from 2MW to 4 MW would result in a 3.9 dB increase in sound power level meaning generally that the total low frequency noise emission increases slightly more with wind turbine size than the A weighted*

---

[1] DELTA, EFP-06 Project, Low Frequency Noise from Large Wind Turbines, Final Report, Performed for Danish Energy Authority, Novenber 2010

total sound power level."

Infrasonic Noise

Low frequency noise is defined as noise in the frequency range below 20 Hz. Infrasonic noise was historically a problem for older turbines with the rotor down-wind of the tower, from pulses created by the passage of the blades through the wake of the tower. Propagation of infrasonic noise was also found to be cylindrical rather than spherical meaning that the level decreases by 3 dB per doubling of distance rather than 6 dB. This led to significant issues with older turbines. Modern turbine design, even though the turbines are significantly higher and larger in output, results in significantly quieter turbines per kilowatt generated. The noise levels have been reduced by 10 to 30 dB (Jakobsen 2005)[2].

Health effects and low frequency noise impacts related to wind turbine noise has been the subject of significant speculation on the internet. This has led to Government Agencies initiating independent studies in the UK[3] and Denmark[2].The conclusions of these studies are in line with the conclusion of the World Health Organisation review (Berglund et al 1995)[4]. Although this review was not related specifically to wind turbine noise, it provided the most comprehensive review of the health effects of noise exposure and concluded that there is no reliable evidence of physiological or psychological effects from infrasound or low-frequency sound below the hearing threshold.

[2] Jakobsen, J., Infrasound Emission from Wind Turbines, Journal of Low Frequency Noise, Vibration and Active Control, 24(3), 2005.

[3] Leventhall, G., A review of Published Research on Low Frequency Noise and its Effects, DEFRA, 2003

[4]

3 NOISE PLANNING GUIDANCE

Acceptable Noise Levels

The "acceptable" level of noise arising from industrial activity in Ireland is determined by the Environmental Protection Agency. They license a diverse range of activities from waste management facilities to power plants and many different industrial sites. Their guidance for licensed activities is based on World Health Organisation standards and best international practice. The levels adopted by the Environmental Protection Agency have been used by the Department of Environment, Heritage and Local Government to set levels for all significant industrial developments in Ireland.

In summary the Environmental Protection Agency limits for industrial activity are as follows:

Daytime	55 dBA re 20 μPa
Night time	45 dBA re 20 μPa

These levels are recognised as striking a reasonable balance between competing land uses such as industrial activity and residential amenity.

Sleep Disturbance Criteria

The World Health Organisation recommendation for noise levels in a bedroom for an undisturbed nights rest are 30 dBA. Allowing for noise attenuation through an open window in the room, this equates to a level of 45 dBA outside the building. The Environmental Protection Agency have set a general night time noise limit of 45 dBA (externally) as an acceptable night time noise level for all activities they license. The European Noise Directive, while not stating explicit limits, adopts criteria requiring a 10 dB lower level at night, similar to the 55 dBA (daytime) and 45 dBA (night time) criteria adopted by the Environmental Protection Agency.

Environmental Noise Directive

In 2002, Directive 2002/49 relating to the assessment and management of environmental noise was adopted by the European Parliament and Council. This Directive guides activities on noise in Member States of the EU.

The directive describes environmental noise as "unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity" (Directive 2002/49/EC, article 3). Ambient or environmental noise covers long-term noise, from transport and industry sources, as distinct from noise caused by neighbours, construction sites, etc.

One of the features of the Directive is the introduction of the Lden noise criteria. This criteria is used to assess noise on a long term round the clock basis (day, evening & night on an annual basis) and provides penalties for noise created during the evening and night periods. The Environmental Noise Directive has been implemented in Ireland by the Environmental Noise Regulations 2006 (SI 140/2006).

Construction Noise

Construction noise is a special case because of the temporary nature of its activities. A certain amount of noise is inherent in all types of building and it can never be completely eliminated. Many items of plant and equipment can be effectively silenced but there are also many other items of equipment that are not so easily silenced, e.g. pile driving equipment.

The problems of site noise control can often be complex and there are a number of practical implications including the pace of the works if unduly restrictive noise conditions are imposed. Practical noise reduction measures such as those outlined in British Standard 5228 *Code of practice for Noise Control on Construction and Open Sites*, can be implemented. The hours of work for noisy activities can be limited to avoid interference with residential amenity. It is not usual to impose a numerical noise limit on construction activity as equipment may need to operate near the site boundary for short periods and thus not be able to comply with a fixed numerical noise limit.

The only published construction noise limits by a government agency in Ireland are those adopted by the National Roads Authority (NRA) for the construction of road schemes. These guidelines set maximum noise levels for different times of day.

Day & Time		**LAeq (1 hr) dB re 20 µPa**	**LpA (max) slow dB re 20 µPa**
Monday to Friday	07:00 to 19:00 hrs	70	80
Monday to Friday	19:00 to 22:00 hrs	60	65
Saturday	08:00 to 16:30 hrs	65	75
Sundays and Bank Holidays	08:00 to 16:30 hrs	60	65

Table 4: Construction Noise Guideline Limits

The construction noise controls set out above represent best international practice and will form the core of the measures to be adopted for this project.

Operational Noise

Noise Planning Guidelines for Wind Farm development have been published by the Department of the Environment, Culture and Local Government. These Guidelines state:

In general, a lower fixed limit of 45 dB(A) 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).

The Guidelines reflect Government policy which seeks to strike a balance between offering a '*reasonable degree of protection',* while not, *'unduly restrict wind energy developments which should be recognised as having wider national and global benefits'.*

Reaction to environmental noise is dependent on a wide range of factors such as the level and character of the noise. Importantly, it is also influenced by an individual's attitude to the noise source in question.

The proposed wind farm site at Oweninny is a former peat production facility and electric power generating plant. The structures have been recently demolished and these included the power station buildings and a rail network serving the bog area. During the Summer 'campaign' period heavy peat harvesting equipment operated throughout the site. Both of these operations were carried out under an Integrated Pollution and Prevention Control Licences issued by the Environmental Protection Agency. The noise limits set out in this licence were 55 dBA during the day period and 45 dBA during the night period. In fact the licence issued to the ESB for the power station initially (until 31st Dec 2004) had a derogation on night time noise at an elevated level of 47 dBA.

Recent An Bord Pleanala decisions have reflected the lower fixed limit of 45 dBA(Leq or 43 dBA L_{90}). In this regard we note the following decisions:

Planning Reference	Location	Planning Noise Limit
221656	Cashel, Co. Tipperary	43 dB LA 90
236212	Killala, Mayo	45 dB LA eq
238762	Cloosh, Galway	43 dB LA 90
239743	Sliabh Bawn, Roscommon	Higher of 43 dB LA 90 or 5 dB above ambient
239118	Deradda, Co. Galway	43 dB LA 90
239133	Carrickeeney, Leitrim	43 dB LA 90
239594	Cappawhite, Tipperary	Higher of 43dB LA90 or 5 dB above ambient
239473	Saorgus Project, Kerry	Higher of 43dB LA90 or 5 dB above ambient

Table 5: Recent an Bord Pleanála decisions with respect to planning

The equivalence of 43 dB LA_{90} and 45 dB L_{Aeq} is based on measurements taken during the development of the ETSU-R-97 document in the UK and reported in Table 6 of that document. The ETSU-R-97 limit of 45dBA is consistent with the WHO criterion for the protection of amenity and avoidance of sleep disturbance, as published in the document *Guidelines for Community Noise* (1999).

Wind turbine noise is directly related to wind speed. Therefore, the DoEHLG Wind Farm Planning Guidelines are based on the principle that turbine noise should be controlled with reference to fixed limits when background noise is low, or relative to background noise itself as it increases with wind speed, whichever is the greater. The common interpretation of these limits is that turbine-attributable noise should be limited to:

- 43 dB LA90 for night-time hours
- 45 dB LA90 or 5 dB above background noise, whichever is the greater, at the NSL for daytime hours
- 35 to 40 dB LA90 or 5 dB above background noise, whichever is the greater, at the NSL for daytime hours where the prevailing background noise is less than 30 dB L_{A90}.

4 ASSESSMENT METHODOLOGY

Assessment Methodology for Operational Noise

Preliminary predictions of wind farm noise levels are calculated at each receiver using the method detailed in ISO9613-2: 1996- *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613 2:1996). ISO9613-2:1996 is recognised as an appropriate method for use in calculating wind farm noise the DoE Guidelines and ETSU. Further discussion of ISO9613-2 and its application to this assessment is provided in the Hayes McKenzie noise modelling report.

The preliminary predictions are used to identify potentially affected residential properties in the vicinity of the wind farm. Specifically, properties are identified where the predicted noise level is likely to exceed a base noise level of approximately 35dBA at 8m/s. These are termed noise sensitive properties and are indicated in Figure 1 above.

Background noise monitoring was carried out at a selection of nine representative noise sensitive properties. Where a cluster of dwellings occurs, one receiver was selected as being a worst-case representation of the cluster as a whole.

Background Noise Monitoring

Background noise monitoring was carried out at the identified noise sensitive properties. The data gathered from each site is analysed together with wind speed data collected within the proposed site.

Selection of Relevant Receivers

In order to present a Prevailing Background Noise Level curve similar to that indicated in The Assessment & Rating of Noise from Windfarms, The Working Group on Noise from Wind Turbines, Final Report, ETSU-R-97, September 1996, nine locations surrounding this site were selected for monitoring. The locations were chosen as representing the clusters of noise sensitive locations outline in Table 1. Curves were constructed for 9 residences surrounding the proposed development. Noise levels were measured for a minimum of a two week period at each residence in order to obtain a representative mix of background noise conditions over an extended period, see Table 6.

Location	Coordinates (ITM)		Nearest Turbine	Distance to Nearest Turbine (m)
	Easting	Northing		
H6	493863.00	822000.00	T51	1,165
H13	496430.84	820401.08	T87	1,120
H16	497356.07	820704.65	T111	1,057
H17	497643.45	821350.42	T111	1,119
H19	497478.03	823177.58	T45	1,043
H23	502574.57	818338.27	T110	1,390
H38	503929.02	819889.25	T101	1,394
H42	505448.23	824278.28	T16	1,744
H46	505504.56	827435.45	T16	2,770

Table 6: Noise sensitive locations monitored for background noise

Corrections for Existing Wind Farm Noise

Background noise in the area is influenced by noise from an existing wind farm on the Oweninny site. The existing Bellacorick Wind Farm has twenty 300kW turbines and one 450kW turbine. This wind farm was modelled by Biospheric Engineering Ltd. using the same methodology and parameters used in the Hayes McKenzie model for the proposed wind farm.

Modelling was carried out for wind speeds in the range 4m/s to 8m/s for the nine background noise monitoring locations and compared against background levels at those locations at the same wind speeds. A correction factor for the total noise level was calculated on the basis of logarithmic addition of noise levels. The correction factors are tabulated as follows:

	Correction factor dB				
Location	**4m/s**	**5m/s**	**6m/s**	**7m/s**	**8m/s**
H6	0	0	0	0	0
H13	0	0	0	0	0
H16	0	0	0	0	0
H17	-0.5	-1.0	-1.0	-1.0	-0.5
H19	-1.0	-1.0	-1.0	-1.0	-1.0
H23	0	0	0	0	0
H38	0	0	-0.5	-0.5	0
H42	0	0	0	0	0
H46	0	0	0	0	0

Table 7: Correction factor for background noise due to existing wind farm

Background noise level data is presented in a set of plots of L_{A90} background noise level v wind speed for both day and night periods. The data was averaged for each 0.5m/s interval in wind speed and a trend-line plotted along with correlation factors. This data is presented in Appendix A to this report. Tables of the background noise levels at the measured locations, corrected for existing wind farm noise are presented below.

Due to the shorter night time period some wind speed bands have a small number of samples at high wind speeds and this can lead to an erratic result in interpolating the data. Fortunately this is not a significant issue as at wind speeds above 8 m/s background noise tends to dominate and this is certainly the case for wind speeds in excess of 12 m/s.

Wind Speed m/s	H6	H13	H16	H17	H19	H23	H38	H42	H46
1	30	37	30	31	24	29	24	21	19
2	31	37	31	32	25	31	25	24	20
3	31	38	31	33	27	33	26	26	21
4	32	38	32	33	27	35	27	28	22
5	33	39	33	34	29	37	28	31	24
6	34	40	34	35	30	39	28	33	26
7	35	41	35	36	32	41	30	35	29
8	36	43	36	38	34	43	31	38	31
9	38	45	38	40	37	44	33	40	34
10	39	47	39	41	39	46	34	43	38
11	41	49	41	42	42	48	35	45	42
12	43	52	43	43	44	50	37	47	46
13	45	54	45	45	47	52	38	50	50
14	47	57	47	46	49	54	40	52	55
15	49	61	49	47	52	56	42	55	60

Table 8: Corrected day time background noise levels

Wind Speed m/s	H6	H13	H16	H17	H19	H23	H38	H42	H46
1	30	34	34	31	21	29	18	19	18
2	30	35	34	32	22	31	19	20	20
3	30	35	34	33	23	33	20	21	22
4	31	36	35	33	24	35	21	22	24
5	31	37	36	34	25	37	22	24	25
6	32	37	37	35	27	39	23	25	27
7	33	38	39	36	29	41	25	27	29
8	34	39	41	38	31	43	26	29	31
9	35	40	43	40	33	44	28	31	33
10	36	40	46	41	35	46	29	34	34
11	37	41	49	42	38	48	31	37	36
12	38	42	52	43	40	50	32	40	38
13	40	43	56	45	42	52	34	43	40
14	42	44	60	46	44	54	36	46	42
15	43	45	64	47	47	56	38	49	43

Table 9: Corrected night time background noise levels

Based on the above background noise level measurements (corrected for noise from the existing turbines) a table of limit values was prepared and is outlined below:

NSL	Cluster	Noise Condition	Wind Speed 4	5	6	7	8	9	10
H6	H1 – H10	Background	32	33	34	35	36	38	39
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	*43*
H13	H11, H12, H14 and H15	Background	38	39	40	41	43	45	47
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	*43*
H16	-	Background	37	38	39	40	41	43	47
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	*43*
H17	H18	Background	33	34	35	36	38	39	40
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	*43*
H19	H20	Background	27	29	30	32	34	36	38
		Limit	*37.5*	*37.5*	*43*	*43*	*43*	*43*	*43*
H23	H21, H22, H23, H24, H25, H26, H27, H28, H29, H30, H31, H33, H34 and H35	Background	35	37	39	41	43	44	46
		Limit	*43*	*43*	*43*	*43*	*43*	*43*	*43*
H38	H36, H37, H38, H39, H40 and H41	Background	27	28	28	30	31	33	34
		Limit	*37.5*	*37.5*	*37.5*	*43*	*43*	*43*	*43*
H42	H43, H44 and H45	Background	28	31	33	35	38	40	43
		Limit	*37.5*	*43*	*43*	*43*	*43*	*43*	*43*
H46*	-	Background	22	24	26	29	31	34	38
		Limit	*37.5*	*37.5*	*37.5*	*37.5*	*43*	*43*	*43*

Table 10: Corrected wind speed and day time limit values dB(A) at Oweninny

5 RESULTS

Establishment of Noise Limits

Noise criteria for the development are outlined in section 3 as follows:

- 43 dB LA90 for night-time hours
- 45 dB LA90 or 5 dB above background noise, whichever is the greater, at the NSL for daytime hours
- 35 to 40 dB LA90 or 5 dB above background noise, whichever is the greater, at the NSL for daytime hours where the prevailing background noise is less than 30 dB L_{A90}.

The noise assessment presented in the following sections demonstrates that the Oweninny Wind Farm achieves compliance with the appropriate noise limits. The measured background noise data, and any derived limits, are therefore only provided for reference purposes, and do not alter the assessment outcomes according to the DoE Guideline noise criteria.

Noise Prediction Model

The noise prediction model on which this report is based was prepared by The Hayes McKenzie Partnership in accordance with ISO9613-2: 1996- *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613 2:1996).

Modelling was carried out for the Oweninny wind farm and the cumulative impact of the Oweninny, Cloddaun and Corvoddery windfarms. Details of the parameters used in the model are outlined in Appendix A. The parameters chosen are all in line with international good practice.

Worst Case Scenario

In order to consider the worst case scenario noise prediction, the following factors are built into the worst case model:

1. The turbine with the highest noise emissions was used on all windfarms
2. The wind direction was assumed to be downwind to every receiver with a correction for wind angle, This situation could not arise in practice as turbines at H18 are either downwind from an easterly direction or downwind from a westerly direction but not both simultaneously.
3. The wind speed used in the modelling is 8 m/s (at 10m)which is maximum noise condition
4. All turbines on all three wind farms acting simultaneously
5. No account taken of screening/absorption through the forestry

Noise predicted levels are set out in the following 6 tables and compared against design noise criteria.

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	39.0	38.1	37.6	37.5	39.4	39.8	40.2	39.0	38.7	37.9	37.1	36.7	36.0	36.2	36.7	32.4	37.9
15	39.0	38.3	37.8	37.7	39.5	39.8	40.2	39.4	38.6	37.4	36.5	36.2	35.6	35.8	35.7	30.9	38.5
30	39.1	38.3	37.8	37.7	39.5	39.9	40.2	39.1	38.9	36.6	35.8	35.4	34.8	34.8	34.7	29.0	38.7
45	39.1	38.0	37.4	37.4	39.3	39.6	40.2	39.0	38.8	35.8	34.8	34.3	33.7	33.9	32.9	26.9	39.0
60	38.9	37.6	36.9	36.9	38.8	39.5	40.0	39.2	38.7	34.7	33.7	33.0	32.6	32.5	31.2	24.2	39.0
75	38.7	36.7	36.2	36.2	38.4	39.5	40.0	39.0	38.8	33.3	32.0	31.3	30.8	30.8	29.2	23.3	39.0
90	38.1	36.1	35.7	35.6	38.1	39.4	39.9	39.0	38.8	31.8	30.4	29.6	29.0	28.6	27.9	23.4	39.0
105	37.4	35.2	34.9	34.9	37.8	39.1	39.8	39.1	38.9	29.9	27.9	27.1	26.1	26.0	27.6	24.5	38.8
120	36.2	34.6	34.4	34.5	37.6	39.0	39.5	39.4	39.1	28.6	26.8	25.9	24.9	25.1	28.3	27.4	38.5
135	35.0	34.1	34.0	34.1	37.4	38.7	39.4	39.6	39.3	28.7	27.0	25.9	25.0	25.5	30.0	29.2	38.0
150	33.9	33.5	33.1	33.2	36.9	38.5	39.0	39.8	39.6	29.9	28.3	27.0	26.1	27.6	32.0	31.4	37.5
165	32.4	32.4	32.0	32.1	36.6	38.2	38.9	39.9	39.8	31.9	30.8	29.6	28.8	29.8	33.9	32.6	36.5
180	31.3	31.6	30.9	30.8	35.7	38.1	38.7	40.1	39.7	33.6	32.6	31.7	31.3	31.6	35.2	33.8	35.7
195	30.6	30.7	29.5	29.4	35.7	38.4	38.6	40.0	39.9	34.9	33.9	33.2	32.6	32.8	36.4	34.5	34.1
210	30.5	31.3	30.1	30.0	35.7	38.3	38.8	39.9	39.9	36.0	35.0	34.4	33.9	34.4	37.2	35.0	32.8
225	31.3	32.9	32.1	31.9	35.9	38.2	38.4	39.7	39.6	36.6	36.1	35.4	35.0	35.2	37.7	35.2	30.6
240	32.9	34.4	33.5	33.3	36.6	38.1	38.5	39.6	39.5	37.5	36.7	36.2	35.6	36.0	37.9	35.3	29.5
255	34.6	35.5	34.7	34.5	36.9	38.0	38.3	39.5	39.3	37.9	37.2	36.7	36.1	36.5	38.1	35.3	29.3
270	35.8	36.0	35.4	35.2	37.1	38.0	38.3	39.4	39.1	38.2	37.5	37.0	36.4	36.7	38.1	35.3	30.5
285	36.8	36.8	35.8	35.6	37.3	38.2	38.6	39.3	39.0	38.4	37.7	37.1	36.6	36.8	38.1	35.3	32.2
300	37.8	37.0	36.1	35.9	37.6	38.5	38.9	39.3	38.9	38.4	37.7	37.2	36.6	36.8	38.1	35.1	33.6
315	38.2	37.2	36.4	36.2	38.0	39.0	39.3	39.0	38.8	38.4	37.7	37.2	36.6	36.8	38.1	35.0	35.1
330	38.7	37.5	36.9	36.8	38.5	39.4	39.8	39.0	38.8	38.4	37.7	37.2	36.6	36.8	37.9	34.4	36.3
345	38.9	37.9	37.3	37.2	38.9	39.6	40.0	39.2	38.7	38.3	37.5	37.0	36.5	36.6	37.4	33.7	37.2
Max	**39.1**	**38.3**	**37.8**	**37.7**	**39.5**	**39.9**	**40.2**	**40.1**	**39.9**	**38.4**	**37.7**	**37.2**	**36.6**	**36.8**	**38.1**	**35.3**	**39.0**

Table 11: – Noise Predictions for Oweninny (112T – V112-3) Acting Alone (dB L_{A90})

Using Vestas V112-3 Turbines on the Oweninny site complies with the noise limit of 43 dB LA 90 (freefield).

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	39.0	38.2	37.7	37.7	39.5	39.9	40.4	39.1	38.9	39.1	38.4	37.9	37.4	37.4	37.4	34.5	37.9
15	39.1	38.4	38.0	37.9	39.6	40.0	40.3	39.5	38.8	38.7	37.9	37.5	36.9	36.9	36.4	33.6	38.6
30	39.1	38.4	37.9	37.8	39.7	40.0	40.4	39.3	39.1	38.0	37.1	36.6	36.1	36.0	35.4	32.7	38.8
45	39.1	38.1	37.6	37.5	39.4	39.8	40.3	39.2	39.0	37.0	36.0	35.6	35.0	34.8	33.8	31.7	39.1
60	39.0	37.8	37.1	37.1	39.0	39.7	40.2	39.4	38.9	36.0	34.7	34.1	33.6	33.4	32.3	30.6	39.1
75	38.8	36.9	36.5	36.5	38.6	39.7	40.2	39.2	39.0	34.1	32.9	32.3	31.8	31.6	30.7	29.8	39.1
90	38.2	36.3	35.9	35.9	38.3	39.6	40.1	39.2	39.0	32.6	31.3	30.6	30.0	29.7	29.5	29.1	39.0
105	37.5	35.5	35.2	35.2	38.0	39.3	40.0	39.3	39.1	30.7	29.0	28.3	27.5	27.4	28.9	28.4	38.8
120	36.4	34.9	34.7	34.8	37.8	39.2	39.7	39.6	39.3	29.5	27.9	27.2	26.4	26.6	29.4	29.6	38.6
135	35.1	34.4	34.3	34.4	37.6	38.9	39.6	39.8	39.5	29.4	27.9	27.0	26.2	26.7	30.9	30.5	38.1
150	34.0	33.8	33.4	33.5	37.1	38.7	39.2	40.0	39.7	30.4	29.1	27.9	27.2	28.5	32.9	32.2	37.6
165	32.5	32.7	32.3	32.4	36.8	38.4	39.1	40.0	39.9	32.3	31.4	30.3	29.6	30.6	34.7	33.3	36.6
180	31.5	31.8	31.2	31.2	35.9	38.2	38.8	40.2	39.8	34.0	33.2	32.3	31.9	32.7	36.0	34.5	35.8
195	30.8	30.9	29.8	29.7	35.8	38.5	38.7	40.1	39.9	35.6	34.8	34.1	33.6	34.2	37.1	35.1	34.2
210	30.6	31.5	30.3	30.1	35.8	38.3	38.8	39.9	39.9	36.8	36.2	35.6	35.1	35.6	37.9	35.5	32.8
225	31.3	33.0	32.2	32.0	36.0	38.2	38.5	39.8	39.7	37.8	37.3	36.5	36.2	36.6	38.3	35.9	30.7
240	33.0	34.4	33.6	33.4	36.6	38.1	38.5	39.7	39.5	38.5	38.0	37.4	36.9	37.2	38.6	36.1	29.5
255	34.6	35.6	34.7	34.5	36.9	38.0	38.4	39.6	39.3	39.1	38.5	37.9	37.4	37.7	38.8	36.3	29.3
270	35.8	36.0	35.4	35.2	37.1	38.0	38.4	39.4	39.1	39.3	38.7	38.1	37.6	37.9	38.8	36.5	30.6
285	36.9	36.8	35.9	35.7	37.4	38.3	38.7	39.3	39.0	39.5	38.9	38.3	37.8	38.0	38.9	36.6	32.3
300	37.8	37.0	36.2	36.0	37.7	38.6	39.0	39.3	39.0	39.6	38.9	38.3	37.8	38.0	38.9	36.5	33.7
315	38.3	37.3	36.5	36.3	38.1	39.1	39.4	39.1	38.9	39.6	38.9	38.3	37.8	38.0	38.8	36.4	35.1
330	38.7	37.6	37.0	36.9	38.6	39.5	39.9	39.1	38.8	39.6	38.9	38.3	37.8	37.9	38.6	36.0	36.3
345	39.0	38.0	37.4	37.3	39.0	39.7	40.1	39.3	38.8	39.4	38.7	38.2	37.7	37.8	38.1	35.5	37.3
Max	**39.1**	**38.4**	**38.0**	**37.9**	**39.7**	**40.0**	**40.4**	**40.2**	**39.9**	**39.6**	**38.9**	**38.3**	**37.8**	**38.0**	**38.9**	**36.6**	**39.1**

Table 12 – Noise Predictions for Oweninny (112T – V112-3), Cluddaun and Corvoderry (dB LA90)

The cumulative impact of the Oweninny, Cluddaun and Corvoddery wind farms complies with the noise limit of 43 dB LA 90 (freefield).

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	41.6	40.7	40.2	40.1	41.9	42.4	42.8	41.5	41.2	40.5	39.7	39.2	38.6	38.7	39.2	34.7	40.5
15	41.6	40.9	40.4	40.3	42.1	42.4	42.7	41.9	41.1	40.0	39.0	38.8	38.1	38.3	38.1	33.1	41.1
30	41.6	40.9	40.3	40.3	42.1	42.4	42.8	41.7	41.4	39.0	38.3	37.8	37.2	37.3	37.1	30.8	41.3
45	41.6	40.6	40.0	39.9	41.9	42.2	42.7	41.6	41.3	38.2	37.2	36.7	36.1	36.3	35.1	28.0	41.6
60	41.5	40.2	39.5	39.4	41.4	42.0	42.5	41.7	41.2	37.0	36.1	35.3	34.9	34.8	33.1	23.8	41.6
75	41.3	39.2	38.7	38.7	40.9	42.0	42.5	41.5	41.3	35.6	34.1	33.3	32.8	32.8	30.5	22.1	41.6
90	40.6	38.5	38.1	38.0	40.6	41.9	42.4	41.5	41.3	33.9	32.2	31.3	30.6	30.0	28.7	22.3	41.6
105	39.9	37.5	37.2	37.3	40.3	41.7	42.4	41.6	41.4	31.3	28.7	27.7	26.3	26.1	28.3	24.1	41.4
120	38.6	36.9	36.7	36.8	40.1	41.5	42.0	41.9	41.6	29.6	27.1	25.8	24.4	24.6	29.2	28.7	41.1
135	37.2	36.4	36.3	36.4	39.9	41.3	41.9	42.2	41.9	29.8	27.4	25.9	24.5	25.2	31.6	31.0	40.6
150	36.0	35.7	35.3	35.4	39.4	41.0	41.5	42.4	42.1	31.4	29.4	27.7	26.4	28.7	34.0	33.5	40.0
165	34.3	34.5	34.1	34.2	39.1	40.7	41.4	42.5	42.4	33.9	32.7	31.3	30.4	31.7	36.3	34.8	39.0
180	33.0	33.5	32.7	32.7	38.0	40.6	41.2	42.7	42.3	35.9	34.9	33.9	33.4	33.8	37.6	36.2	38.1
195	32.2	32.3	30.8	30.7	38.0	41.0	41.1	42.6	42.4	37.3	36.3	35.6	34.9	35.1	38.9	37.0	36.4
210	32.0	33.1	31.7	31.5	38.1	40.8	41.3	42.4	42.4	38.5	37.4	36.8	36.3	36.8	39.8	37.5	34.9
225	33.0	35.1	34.3	34.0	38.4	40.7	41.0	42.3	42.2	39.1	38.6	37.9	37.4	37.7	40.3	37.7	32.2
240	35.0	36.8	35.9	35.7	39.0	40.6	41.0	42.2	42.0	40.0	39.2	38.7	38.1	38.5	40.5	37.8	30.7
255	36.9	38.1	37.2	37.0	39.4	40.4	40.8	42.1	41.8	40.5	39.8	39.3	38.7	39.0	40.7	37.8	30.5
270	38.3	38.5	37.9	37.7	39.6	40.4	40.8	42.0	41.6	40.7	40.1	39.5	38.9	39.3	40.7	37.8	32.1
285	39.4	39.3	38.3	38.1	39.8	40.7	41.1	41.9	41.5	41.0	40.3	39.7	39.2	39.4	40.7	37.8	34.3
300	40.3	39.5	38.6	38.4	40.1	41.0	41.4	41.8	41.5	41.0	40.3	39.7	39.2	39.4	40.7	37.6	35.9
315	40.8	39.7	38.9	38.7	40.5	41.5	41.9	41.6	41.3	41.0	40.3	39.7	39.2	39.4	40.6	37.5	37.5
330	41.2	40.1	39.4	39.3	41.0	41.9	42.3	41.6	41.3	41.0	40.3	39.7	39.2	39.3	40.4	36.8	38.7
345	41.5	40.5	39.9	39.7	41.5	42.2	42.5	41.7	41.2	40.8	40.1	39.5	39.0	39.1	39.9	36.1	39.8
Max	**41.6**	**40.9**	**40.4**	**40.3**	**42.1**	**42.4**	**42.8**	**42.7**	**42.4**	**41.0**	**40.3**	**39.7**	**39.2**	**39.4**	**40.7**	**37.8**	**41.6**

Table 13 – Noise Predictions for Oweninny (112T – SWT-3-101) Acting Alone (dB LA90)

Using Siemens SWT-3-101 Turbines on the Oweninny site complies with the noise limit of 43 dB LA 90 (freefield).

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	41.6	40.7	40.2	40.2	42.0	42.4	42.9	41.6	41.3	41.2	40.5	40.0	39.4	39.4	39.6	36.1	40.5
15	41.7	40.9	40.5	40.4	42.2	42.5	42.8	42.0	41.2	40.7	39.8	39.5	38.8	38.9	38.6	34.9	41.2
30	41.7	40.9	40.4	40.3	42.2	42.5	42.9	41.8	41.5	39.9	39.1	38.6	38.0	38.0	37.5	33.5	41.3
45	41.7	40.6	40.1	40.0	41.9	42.3	42.8	41.7	41.4	38.9	38.0	37.5	36.9	36.9	35.7	32.1	41.7
60	41.5	40.2	39.6	39.5	41.5	42.1	42.6	41.8	41.3	37.8	36.6	36.0	35.5	35.3	33.8	30.5	41.7
75	41.3	39.3	38.8	38.8	41.0	42.1	42.6	41.6	41.4	36.1	34.7	34.0	33.5	33.3	31.7	29.6	41.7
90	40.7	38.6	38.2	38.2	40.7	42.0	42.5	41.6	41.4	34.3	32.8	32.0	31.4	30.8	30.1	28.8	41.6
105	40.0	37.7	37.4	37.4	40.4	41.8	42.4	41.7	41.5	31.9	29.6	28.8	27.6	27.5	29.5	28.3	41.4
120	38.7	37.0	36.9	37.0	40.2	41.6	42.1	42.0	41.8	30.3	28.1	27.1	26.0	26.2	30.1	30.4	41.1
135	37.3	36.6	36.5	36.6	40.0	41.4	42.0	42.2	42.0	30.4	28.3	27.0	25.9	26.5	32.2	31.9	40.6
150	36.1	35.9	35.5	35.6	39.5	41.1	41.6	42.4	42.2	31.8	30.0	28.5	27.4	29.5	34.6	34.1	40.1
165	34.4	34.6	34.3	34.4	39.1	40.8	41.5	42.5	42.5	34.2	33.1	31.8	30.9	32.2	36.7	35.3	39.0
180	33.1	33.6	32.9	32.9	38.1	40.7	41.2	42.7	42.3	36.1	35.3	34.2	33.8	34.5	38.1	36.6	38.2
195	32.3	32.5	31.0	30.9	38.1	41.0	41.2	42.6	42.5	37.7	36.8	36.1	35.5	36.0	39.3	37.3	36.4
210	32.1	33.2	31.8	31.6	38.1	40.8	41.3	42.5	42.5	38.9	38.2	37.5	37.0	37.5	40.1	37.8	34.9
225	33.0	35.2	34.3	34.1	38.4	40.8	41.0	42.3	42.2	39.8	39.3	38.6	38.1	38.5	40.6	38.1	32.3
240	35.0	36.9	35.9	35.8	39.1	40.6	41.0	42.2	42.1	40.6	40.0	39.4	38.8	39.2	40.9	38.3	30.8
255	36.9	38.1	37.2	37.0	39.4	40.5	40.9	42.1	41.8	41.2	40.5	40.0	39.4	39.7	41.1	38.4	30.5
270	38.3	38.6	37.9	37.7	39.6	40.5	40.9	42.0	41.6	41.4	40.8	40.2	39.6	39.9	41.1	38.5	32.2
285	39.4	39.3	38.4	38.2	39.8	40.8	41.2	41.9	41.6	41.6	41.0	40.4	39.8	40.1	41.1	38.6	34.3
300	40.4	39.5	38.6	38.4	40.1	41.1	41.5	41.8	41.5	41.7	41.0	40.4	39.8	40.1	41.1	38.5	35.9
315	40.8	39.8	38.9	38.8	40.5	41.6	41.9	41.6	41.4	41.7	41.0	40.4	39.9	40.1	41.1	38.3	37.5
330	41.3	40.1	39.5	39.4	41.1	42.0	42.4	41.6	41.3	41.7	41.0	40.4	39.9	40.0	40.9	37.8	38.8
345	41.5	40.5	39.9	39.8	41.5	42.2	42.6	41.8	41.3	41.5	40.8	40.2	39.7	39.8	40.3	37.2	39.8
Max	**41.7**	**40.9**	**40.5**	**40.4**	**42.2**	**42.5**	**42.9**	**42.7**	**42.5**	**41.7**	**41.0**	**40.4**	**39.9**	**40.1**	**41.1**	**38.6**	**41.7**

Table 14 – Noise Predictions for Oweninny (112T SWT-3-101), Cluddaun and Corvoderry (dB LA90)

The cumulative impact of the Oweninny, Cluddaun and Corvoddery wind farms using Seimens SWT-3-101 Turbines complies with the noise limit of 43 dB LA 90 (freefield).

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	39.1	38.2	37.7	37.7	39.5	39.9	40.4	39.2	38.9	38.0	37.3	36.8	36.2	36.3	36.8	32.7	38.0
15	39.2	38.4	37.9	37.9	39.6	40.0	40.3	39.6	38.8	37.6	36.7	36.4	35.7	35.9	35.9	31.3	38.7
30	39.2	38.4	37.9	37.8	39.6	40.0	40.4	39.3	39.1	36.7	36.0	35.6	35.0	35.1	35.0	29.6	38.8
45	39.2	38.1	37.6	37.5	39.4	39.8	40.3	39.2	39.0	36.0	35.0	34.6	34.0	34.2	33.3	27.8	39.2
60	39.1	37.8	37.1	37.0	39.0	39.6	40.2	39.4	38.9	34.9	34.0	33.3	32.9	32.9	31.8	25.8	39.2
75	38.9	36.9	36.4	36.4	38.6	39.7	40.2	39.2	39.0	33.7	32.4	31.8	31.3	31.3	30.1	25.1	39.2
90	38.3	36.3	35.9	35.9	38.3	39.6	40.1	39.2	39.0	32.3	31.0	30.3	29.7	29.4	29.0	25.2	39.1
105	37.6	35.5	35.2	35.2	38.0	39.3	40.0	39.3	39.1	30.7	29.0	28.3	27.5	27.4	28.8	26.1	38.9
120	36.5	34.9	34.7	34.8	37.8	39.2	39.7	39.6	39.3	29.7	28.1	27.4	26.6	26.7	29.3	28.3	38.7
135	35.3	34.4	34.3	34.4	37.6	38.9	39.6	39.8	39.5	29.7	28.2	27.3	26.6	27.0	30.7	29.8	38.2
150	34.2	33.8	33.4	33.5	37.2	38.7	39.2	40.0	39.7	30.6	29.3	28.2	27.4	28.6	32.5	31.8	37.7
165	32.9	32.8	32.4	32.5	36.9	38.4	39.1	40.1	40.0	32.4	31.4	30.3	29.6	30.4	34.2	32.9	36.7
180	31.9	32.1	31.5	31.5	36.0	38.3	38.9	40.3	39.9	33.9	33.0	32.1	31.7	32.1	35.4	34.0	36.0
195	31.4	31.4	30.4	30.3	36.0	38.6	38.8	40.2	40.0	35.1	34.2	33.5	32.9	33.2	36.6	34.7	34.4
210	31.2	32.0	30.9	30.7	36.0	38.5	39.0	40.0	40.0	36.2	35.3	34.7	34.2	34.6	37.4	35.2	33.2
225	31.9	33.3	32.5	32.3	36.2	38.4	38.6	39.9	39.8	36.8	36.3	35.6	35.2	35.4	37.8	35.4	31.3
240	33.4	34.7	33.8	33.6	36.8	38.3	38.7	39.8	39.6	37.6	36.8	36.4	35.8	36.2	38.1	35.5	30.4
255	34.9	35.7	34.9	34.7	37.1	38.2	38.6	39.7	39.4	38.0	37.4	36.9	36.3	36.6	38.2	35.5	30.2
270	36.0	36.2	35.6	35.4	37.3	38.2	38.6	39.6	39.2	38.3	37.6	37.1	36.5	36.9	38.3	35.5	31.2
285	37.0	37.0	36.0	35.8	37.5	38.5	38.9	39.5	39.2	38.6	37.8	37.3	36.8	37.0	38.3	35.5	32.7
300	37.9	37.2	36.3	36.1	37.8	38.7	39.1	39.4	39.1	38.6	37.8	37.3	36.8	37.0	38.3	35.3	34.0
315	38.4	37.4	36.6	36.4	38.2	39.2	39.5	39.2	39.0	38.6	37.8	37.3	36.8	37.0	38.2	35.1	35.4
330	38.8	37.7	37.1	36.9	38.6	39.5	39.9	39.2	38.9	38.6	37.8	37.3	36.8	36.9	38.0	34.6	36.5
345	39.1	38.0	37.5	37.3	39.0	39.7	40.1	39.3	38.9	38.4	37.6	37.1	36.6	36.7	37.5	33.9	37.4
Max	39.1	38.2	37.7	37.7	39.5	39.9	40.4	39.2	38.9	38.0	37.3	36.8	36.2	36.3	36.8	32.7	38.0

Table 15 – Noise Predictions for Oweninny (112T – V90-3) Acting Alone (dB L_{A90})

Using Enercon V90 Turbines on the Oweninny site complies with the noise limit of 43 dB LA 90 (freefield).

Angle	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17
0	39.2	38.4	37.9	37.8	39.6	40.1	40.5	39.3	39.1	39.3	38.6	38.1	37.5	37.5	37.5	34.7	38.1
15	39.3	38.6	38.1	38.0	39.7	40.1	40.4	39.7	39.0	38.8	38.0	37.6	37.0	37.0	36.6	33.9	38.7
30	39.3	38.6	38.0	38.0	39.8	40.2	40.5	39.5	39.3	38.2	37.2	36.8	36.2	36.2	35.7	33.0	38.9
45	39.3	38.3	37.7	37.7	39.6	40.0	40.5	39.4	39.2	37.1	36.2	35.8	35.2	35.0	34.1	32.0	39.2
60	39.2	37.9	37.3	37.2	39.1	39.8	40.3	39.6	39.1	36.2	34.9	34.4	33.9	33.7	32.7	31.0	39.2
75	39.0	37.1	36.6	36.6	38.8	39.9	40.3	39.4	39.2	34.4	33.2	32.7	32.1	32.1	31.3	30.3	39.2
90	38.3	36.5	36.1	36.1	38.5	39.7	40.2	39.4	39.2	33.0	31.8	31.2	30.6	30.4	30.3	29.7	39.2
105	37.7	35.8	35.5	35.5	38.2	39.5	40.2	39.5	39.3	31.3	29.9	29.3	28.5	28.5	29.8	29.1	39.0
120	36.6	35.2	35.0	35.1	38.0	39.4	39.9	39.7	39.5	30.3	29.0	28.3	27.6	27.8	30.2	30.1	38.7
135	35.4	34.7	34.6	34.7	37.8	39.1	39.7	39.9	39.7	30.3	29.0	28.1	27.5	27.9	31.5	31.0	38.3
150	34.4	34.1	33.7	33.8	37.4	38.9	39.4	40.1	39.9	31.1	29.9	28.9	28.2	29.3	33.3	32.5	37.7
165	33.0	33.1	32.7	32.8	37.0	38.6	39.3	40.2	40.1	32.8	31.9	30.9	30.2	31.2	35.0	33.5	36.8
180	32.1	32.3	31.7	31.7	36.2	38.4	39.0	40.4	40.0	34.3	33.6	32.7	32.3	33.0	36.2	34.6	36.0
195	31.5	31.6	30.6	30.5	36.1	38.7	38.9	40.2	40.1	35.8	35.1	34.3	33.9	34.5	37.3	35.2	34.5
210	31.3	32.1	31.0	30.9	36.1	38.5	39.0	40.1	40.1	37.0	36.4	35.8	35.3	35.8	38.0	35.7	33.3
225	32.0	33.4	32.6	32.4	36.2	38.4	38.7	39.9	39.8	37.9	37.4	36.7	36.3	36.7	38.5	36.0	31.4
240	33.4	34.7	33.9	33.7	36.8	38.3	38.7	39.8	39.6	38.6	38.1	37.6	37.0	37.4	38.7	36.3	30.4
255	34.9	35.8	35.0	34.7	37.2	38.2	38.6	39.7	39.5	39.2	38.6	38.0	37.5	37.8	38.9	36.4	30.3
270	36.0	36.2	35.6	35.4	37.3	38.2	38.6	39.6	39.3	39.4	38.8	38.2	37.7	38.0	39.0	36.6	31.3
285	37.0	37.0	36.1	35.9	37.6	38.5	38.9	39.5	39.2	39.6	39.0	38.4	37.9	38.1	39.0	36.8	32.7
300	38.0	37.2	36.4	36.2	37.9	38.8	39.2	39.5	39.1	39.7	39.0	38.4	37.9	38.1	39.0	36.7	34.0
315	38.4	37.4	36.7	36.5	38.2	39.2	39.6	39.3	39.0	39.7	39.0	38.4	37.9	38.1	38.9	36.6	35.4
330	38.9	37.8	37.2	37.1	38.7	39.6	40.0	39.3	39.0	39.7	39.0	38.4	37.9	38.0	38.7	36.1	36.5
345	39.1	38.1	37.6	37.5	39.2	39.9	40.2	39.4	39.0	39.5	38.8	38.3	37.8	37.9	38.2	35.6	37.4
Max	**39.3**	**38.6**	**38.1**	**38.0**	**39.8**	**40.2**	**40.5**	**40.4**	**40.1**	**39.7**	**39.0**	**38.4**	**37.9**	**38.1**	**39.0**	**36.8**	**39.2**

Table 16 – Noise Predictions for Oweninny (112T V90-3), Cluddaun and Corvoderry (dB L_{A90})

The cumulative impact of the Oweninny, Cluddaun and Corvoddery wind farms using Seimens V90-3 Turbines complies with the noise limit of 43 dB LA 90 (freefield) at 8m/s wind speeds. in accordance with the recommendations in the DoEHLG Wind Farm Planning Guidelines.

During night-time the protection of external amenity becomes less important and the emphasis is placed on preventing sleep disturbance. A fixed limit of 43 dB(A) LA_{90} will protect sleep inside properties during the night at all locations. Therefore 43 dB(A) LA_{90} is the required design noise level limit for the development at night.

In summary under worst case conditions the impact of both the Oweninny and the cumulative impact of the Oweninny, Cluddaun and Corvoddery wind farms combined are within the noise limit of 43 dB LA 90 (freefield).

5 ASSESSMENT OF POTENTIAL NOISE EFFECTS

Assessment of Acceptability of Wind Farm Noise

Noise predictions for the proposed turbine layout are compared with the relevant noise limits for each receiver in order to establish acceptability of wind farm noise. As noted above earlier, the assessment is to be based on a common wind speed height reference, of 10m. The same wind speed height reference is therefore used when predicting variations in wind turbine noise levels with changing wind speed. The predicted noise levels are then considered in combination with predicted noise levels from existing wind turbines in the area in order to assess any potential cumulative noise effects.

Airborne noise impacts

Noise may have various effects on human beings exposed to it ranging from discomfort and annoyance to various psychological and pathological conditions. The degree to which it affects people depends on its nature and intensity, its duration, the frequency and time of its occurrence, the activity being undertaken by different individuals at the time of exposure, and their degree of sensitivity. Noise can be measured by way of its sound energy and frequency characteristics. However, sound measurement does not necessarily give a guide to what is noise - noise is subjective and depends on the factors mentioned above.

The susceptibility of people to noise, and the level of annoyance they experience, varies widely; indeed the degree of annoyance is dependent on the quality of the sound and the recipient's attitude towards it. Measurable psychological and pathological effects have been shown to be attributable to noise. They include effects on health, sleep, communications, working efficiently, industrial accidents and mental stress.

The levels of noise attributable to the proposed development are such that significant health effects outside the site boundary (such as occupational deafness, etc.) can be ruled out. Impacts such as interference with sleep, communications and mental stress must however be examined as part of this study.

Wind speed

The noise prediction model has been prepared using a wind speed of 8 m/s, which is relatively high, resulting in full power output (and maximum noise levels) from the turbines. The mean wind speed for the site is lower than this and the wind rose for the site indicates that wind direction, while between South and West almost 30% of the time does vary considerably on an annual basis, wind direction data is provided in Appendix B of this report. The factors used to prepare the noise level prediction are based on a worst case scenario as outlined in section 3 above.

Construction Noise & Vibration

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. The following table indicates the source noise level and typical numbers of equipment on site during sub-station construction. The actual noise levels will depend on equipment duty cycles and site activity at any stage during construction.

Description	Purpose	Notes	Lw (dB)
Earth moving Dozer	Site clearance	Diesel Engine Powered	108
Tracked Excavator	Site works	Diesel Engine Powered	105
Rig for Bored Piles	Foundations	Diesel Engine Powered	115
Rock-breaker	Break up top layers and fractured rock	Diesel Engine Powered	115
Crawler Crane	Lifting plant, materials and equipment into position. Two may be required for some heavy plant	Heavy Plant. Tracked. Diesel engine powered	105
Dumper Truck	Transport of material on site	Typically wheeled (6 wheel drive) Diesel engine powered.	117
Concrete Truck	Mixing, transport of concrete to site and placement.	Diesel engine powered	109
Compressors & pumps	General construction purposes,	Mobile, diesel engine powered enclosed and silenced	95
Concrete batching Plant	On site concrete batching	Lower than truck alternative (worst case)	109
Generator	Provide electricity for equipment, hand tools and site lighting during construction.	Diesel engine powered enclosed and silenced	97
Concrete mixer	Mixing of concrete on site	Diesel engine powered	105
Trucks, vans, 4x4 vehicles	Transport of materials & personnel	Generally diesel powered	101
Hand tools	Cutting, fixing, welding and general construction	Generally 110V powered by Generator	102

Table 17: Construction and decommissioning noise sources

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.

Noise levels for various distances were calculated from the sound power data for a typical construction plant types. The results, which are shown in Table 18, are expressed as dB(A) L_{eq} (12 hour) equivalent continuous noise levels, the standard units for construction noise.

Distance	**500 m**	**1,000 m**	**1,500 m**	**2,000 m**
Earth Moving	45.2 dB(A)	37.7 dB(A)	33.3 dB(A)	30.2 dB(A)
Concreting	42.3 dB(A)	34.8 dB(A)	30.4 dB(A)	27.3 dB(A)

Table 18: Noise Impact of Construction Activities

While no formal limits exist for construction noise, standards that have been applied to large civil engineering projects tend to fall in the range of 70 - 75 dB(A) L_{eq} (12 hour) for daytime construction activities. Construction noise will evidently not create significant impacts, particularly given the distances of the proposed turbine locations from any local residences.

There is no published Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. While acknowledging that planning authorities, where appropriate, should control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion, the National Roads Authority (NRA) considers that the noise levels in Table 18 are typically deemed acceptable.

Predicted construction noise levels at Oweninny are evidently well below relevant limit values and significant impacts will not arise.

Ground-borne vibration due to construction is very rapidly attenuated over distance. BS 5228-2: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration, discusses vibration attenuation at distances up to some tens of metres from the source. Vibration from construction activities, hundreds of metres from the receptors, and vibration from vehicle movements, with relatively low source levels, is considered to be not significant.

The only published construction noise limits by a government agency in Ireland are those adopted by the National Roads Authority (NRA) for the construction of road schemes Table 18. These guidelines set maximum noise levels for different times of day and for different days.

Day & Time		**LAeq (1 hr) dB re 20 µPa**	**LpA (max) slow dB re 20 µPa**
Monday to Friday	07:00 to 19:00 hrs	70	80
Monday to Friday	19:00 to 22:00 hrs	60	65
Saturday	08:00 to 16:30 hrs	65	75
Sundays and Bank Holidays	08:00 to 16:30 hrs	60	65

Table 18: National Roads Authority (NRA) Construction Noise Limits

The construction noise controls set out above represent best international practice and will form the core of the noise measures to be adopted for both the construction and decommissioning phases of this project.

As all of the noise sensitive locations are located at least one thousand meters from a turbine, the impact on any individual location is likely to be minimal and for short duration periods.

During the operational phase noise levels at worst case wind speed (8 m/s) will be as follows:

Location	**Cluster**	**Predicted L_{90} dB re 20 µPa (Hayes McKenzie) 8m/s Oweninny acting alone**	**Predicted L_{90} dB re 20 µPa (Hayes McKenzie) 8m/s Oweninny with Cluddaun and Corvoderry**	**Background Day Time Background L_{90} dB re 20 µPa (Measured) 8m/s**
H6	H1 – H10	41.8	41.8	36
H13	H11, H12, H14 and H15	40.3	40.4	43

H16	-	42.4	42.5	41
H17	H18	42.8	42.8	38
H19	H20	42.4	42.5	34
H23	H21, H22, H24, H25, H26, H27, H28, H29, H30, H31, H33, H34 and H35	42.1	41.0	43
H38	H36, H37, H38, H39, H40 and H41	39.4	39.5	31
H42	H43, H44, H45	41.6	41.7	38
H46	-	32.2	41.8	31

Table 19: Predicted and background noise levels at 8m/s

Therefore, in accordance with the recommendations in the DoE Wind Farm Planning Guidelines, the lower fixed daytime limit of 43 dB LA_{90} is met at all locations. In some cases, while meeting the DoE Guidelines, the turbines will be audible at some of the noise sensitive locations. For other locations it is likely that turbine noise will be audible under a limited range of weather conditions.The frequency of audibility will depend on wind direction and strength. The properties most impacted in this regard will be H38 and H46.

5 MITIGATION MEASURES

Mitigation During Construction

The site activity associated with the construction of the wind farm (placement of turbines) will be limited to a maximum hourly L_{eq} value as set out in Section 3 above at any nearby residence during normal working hours, while for most of the construction period the L_{eq} values will be considerably less than 55 dB (A).

Some construction activities will be required to take place on a round the clock basis, such as pumping water, treating fresh concrete surfaces and provision of security lighting. Such activities are very limited in scope and do not require the use of heavy machinery. Activities at this level of intensity will not cause any noise related impact outside the site boundary and are necessary for the efficient execution of works.

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 (typically a decrease of3-6 dBA) than those usually associated with construction projects can be attained.

Mitigation During Operation

The wind farm will operate in such a manner to limit noise at any noise sensitive residence in the area to below 43 dB LA 90 (freefield) at all times.

Noise reduction measures will be applied on a turbine specific basis where required by adjusting turbine speed and output.

A documented noise complaint procedure will be put in place for recording and reporting noise complaints.

Noise levels be monitored as required post commissioning to demonstrate compliance with the relevant guidance.

Mitigation During Decommissioning

Mitigation measures will be similar to those employed at the construction stage

5 CONCLUSIONS

The noise emission from wind farms tends to be steady broadband noise with some 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 43 dB LA 90 (freefield) at any noise sensitive location. The predicted operational noise levels are in many cases higher than existing background levels. While within planning guideline limits, turbine noise will be audible in some locations under certain weather conditions. However, the limits proposed of 43 dB $LA_{90}$where the day time Background noise is 30dB LA90 or greater and 37.5 dB LA_{90} where the day time background noise is less than 30 dB LA_{90} are appropriate noise level compliance targets. The Planning Guidelines for Wind Farm development published by the Department of the Environment reflect Government policy which seeks to strike a balance between offering a 'reasonable degree of protection', while also would not, 'unduly restrict wind energy.

The noise levels from the wind farm are at or below below the permitted level of a fossil fuelled equivalent electrical generator.

5 REFERENCES

Bord Na Mona Energy IPPC Licence Reference P505-01

Electricity Supply Board IPPC Licence Reference P627-01

Mayo Wind Energy Strategy, Mayo County Council.

European Working Group on Noise from Wind Turbines document ETSU R-97
The Assessment and Rating of Noise from Wind Farms (ETSU R-97)

Planning Guidelines for Wind Energy Developments, Department of Environment, Heritage and Local Government.

Best Practice Guidelines for the Irish Wind Energy Industry, Irish Wind Energy Association, 2008
Dept of Trade & Industry UK (ETSU), The Assessment and Rating of Noise from Wind Farms Energy Technology Support Unit, 1996.

ISO 1996-1 Acoustics – Description and measurement of environmental noise – Part 1: Basic quantities and procedures

ISO 1996-2 Acoustics – Description and measurement of environmental noise – Part 2: Acquisition of data pertinent to land use

ISO 1996-3 Acoustics – Description and measurement of environmental noise – Part 3: Application to noise limits

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;

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

6 DEFINITIONS

A-weighted sound pressure, in Pascals: The root mean square sound pressure determined by use of frequency network "A" (see IEC Publication 651).

Sound pressure level in decibels: The sound pressure level is given by the formula
$L_p = 10 \text{ Log } (p/p_o)^2$ where, P is the root mean square sound pressure in Pascals
p_o is the reference sound pressure (20 uPa)

Percentile level: The A-weighted sound pressure level obtained by using time-weighting "F" (see IEC Publication 651) that is exceeded for N% of the time interval considered. e.g. $L_{A90,1\ hour}$ is the A-weighted level exceeded for 90% of 1 hour.

Equivalent continuous A-weighted sound pressure level in decibels: Value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval T, has the same mean square sound pressure as a sound under consideration whose level varies with time.

Rating level: The equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound.

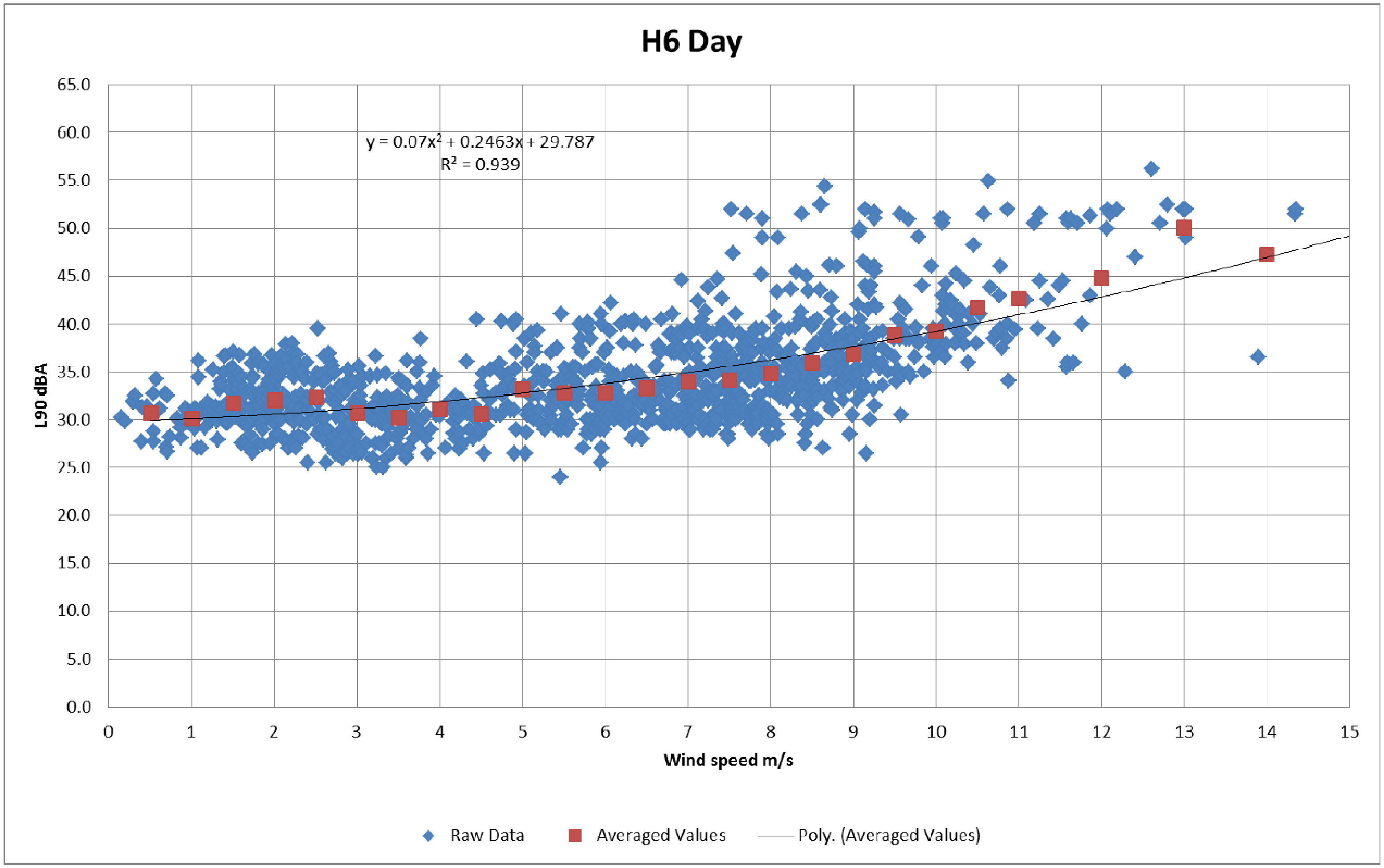
Symbols for sound levels:

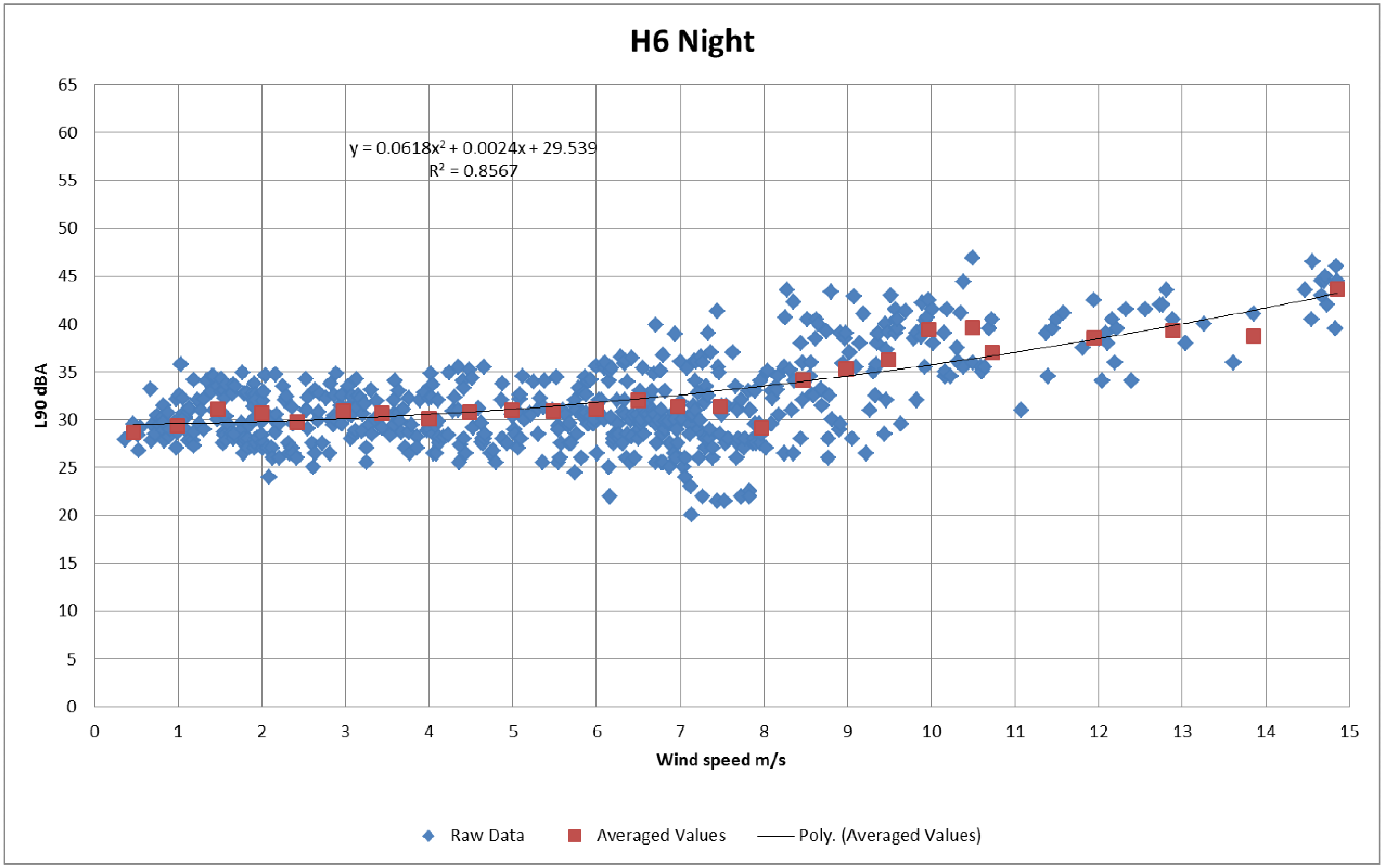
Quantity	***Symbol***	***Unit***
Sound Pressure Level	L_p	dB
A-weighted sound pressure level	L_{pA}	dB
Percentile level, level exceeded for N% of the time	$L_{AN,T}$	dB
Equivalent continuous A-weighted		
Sound pressure level	$L_{Aeq,T}$	dB
Rating level	$L_{Ar,T}$	dB

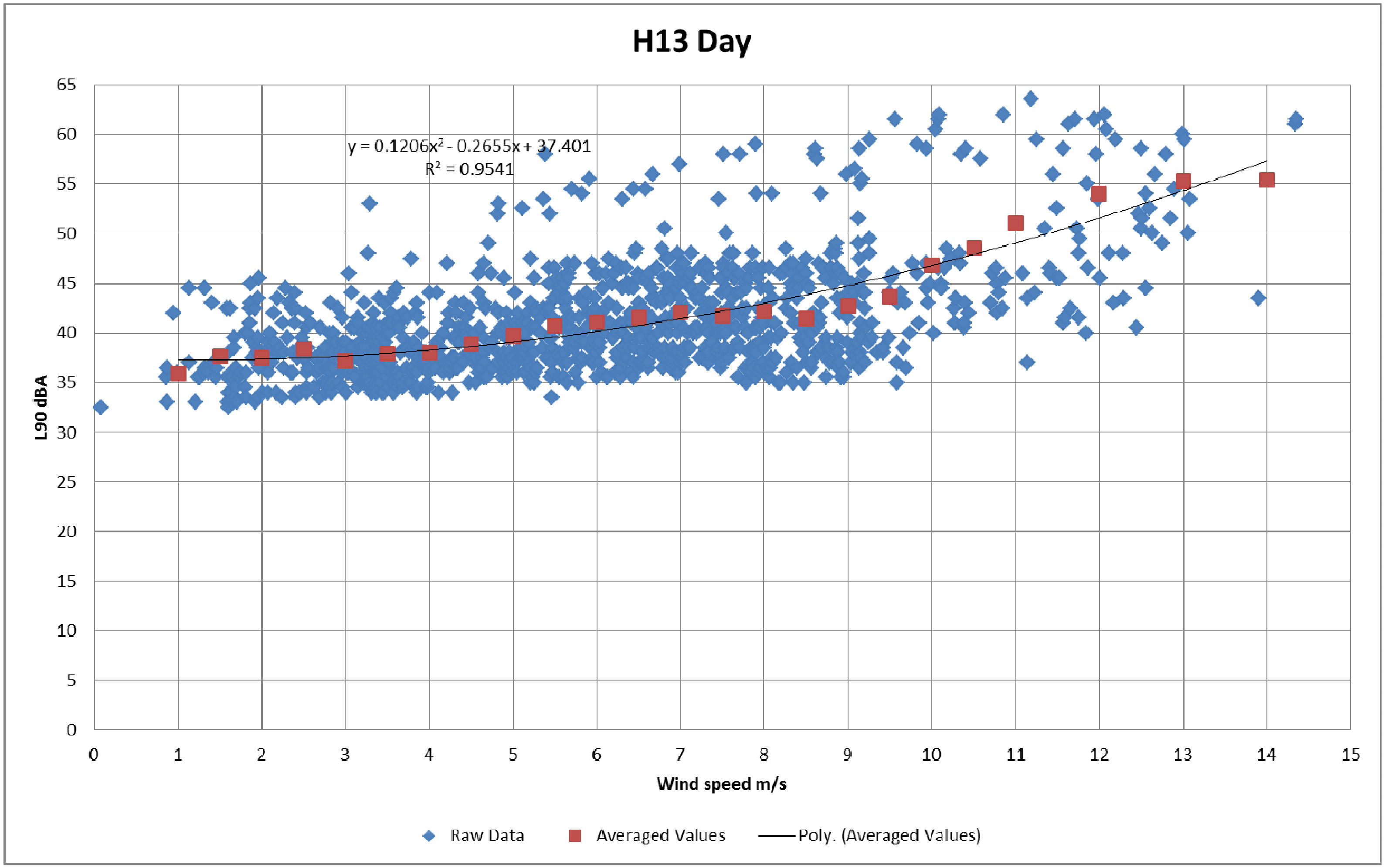
Approximate sound pressure levels in dB

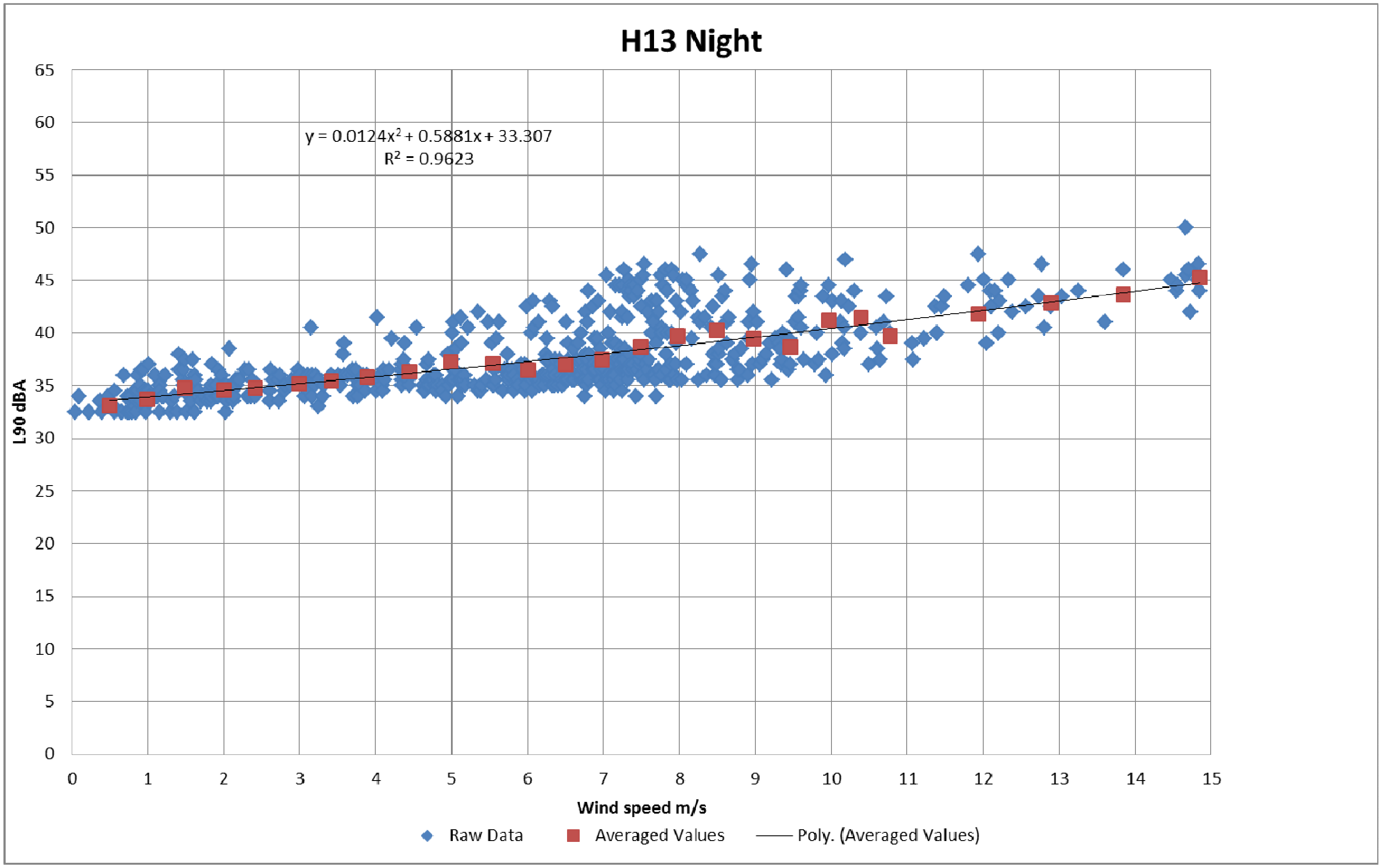
Location	***Level (dB)***	***Comment***
	140	Threshold of pain
Airport	125	Jet take-off
	120	Uncomfortably loud
Construction site	115	Pneumatic drill
Disco or Rock concert	110	
Motorway	90	Heavy truck passing
Very busy pub	85	Voice has to be raised to be heard
		Conversation difficult
Busy restaurant	70	
Business office	65	Normal conversation possible
0.5 km from busy roadway	55	Daytime
Library	35	Whispering
	35	Quiet countryside
	20	Very Quiet area
	0	Threshold of hearing

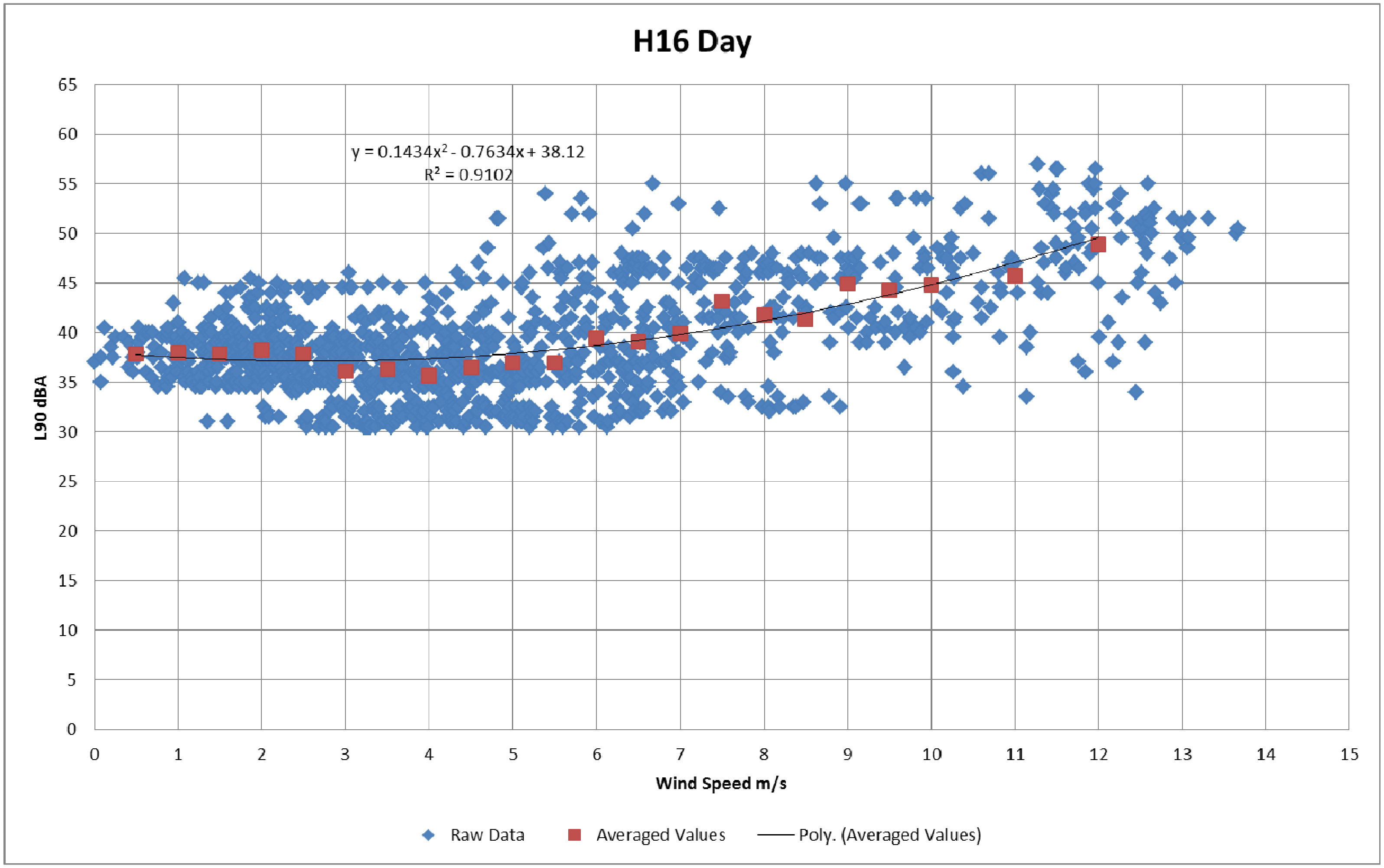
APPENDIX A BACKGROUND NOISE MONITORING CURVES


H6 Day
y = 0.07x² + 0.2463x + 29.787
R² = 0.939
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
L90 dBA
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)


H6 Night
y = 0.0618x² + 0.0024x + 29.539
R² = 0.8567
L90 dBA
Wind speed m/s
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Raw Data
Averaged Values
Poly. (Averaged Values)


H13 Day
y = 0.1206x² - 0.2655x + 37.401
R² = 0.9541
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Raw Data
Averaged Values
Poly. (Averaged Values)


H13 Night
y = 0.0124x² + 0.5881x + 33.307
R² = 0.9623
L90 dBA
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)


H16 Day
y = 0.1434x² - 0.7634x + 38.12
R² = 0.9102
L90 dBA
Wind Speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
1
2
3
4
5
6
7
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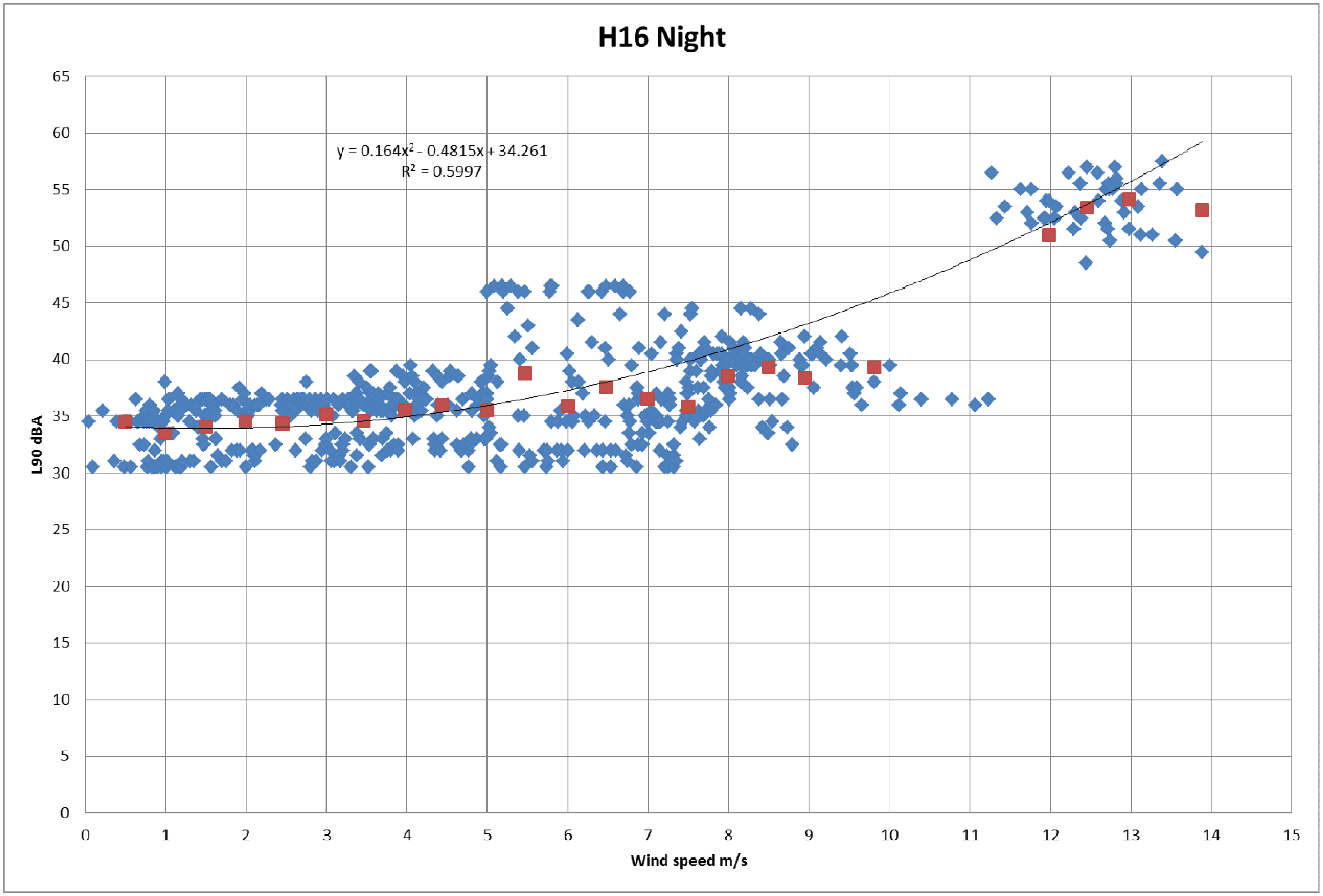
10
11
12
13
14
15
Raw Data
Averaged Values
Poly. (Averaged Values)



H16 Night
y = 0.164x² - 0.4815x + 34.261
R² = 0.5997
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
1
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4
5
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9
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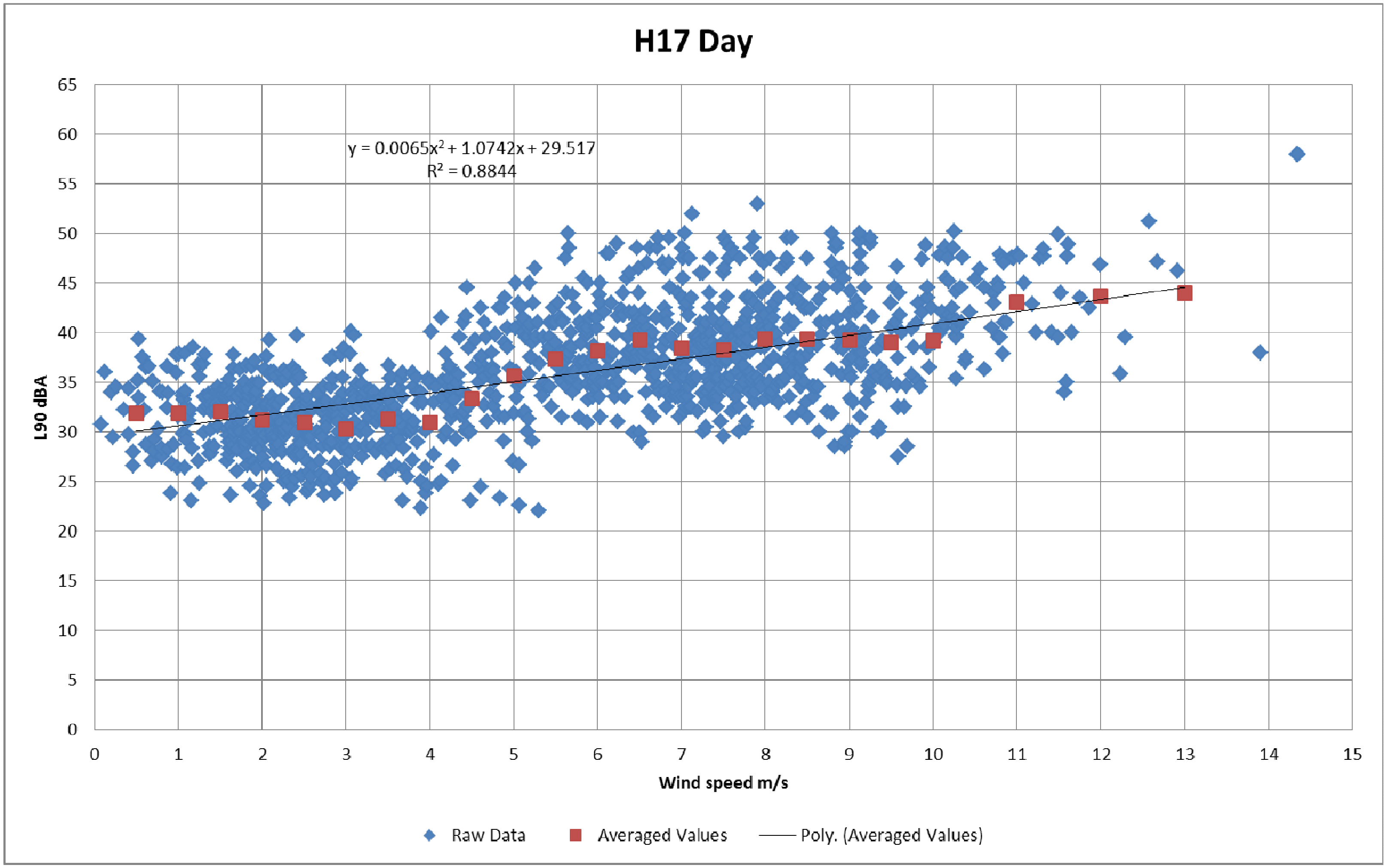
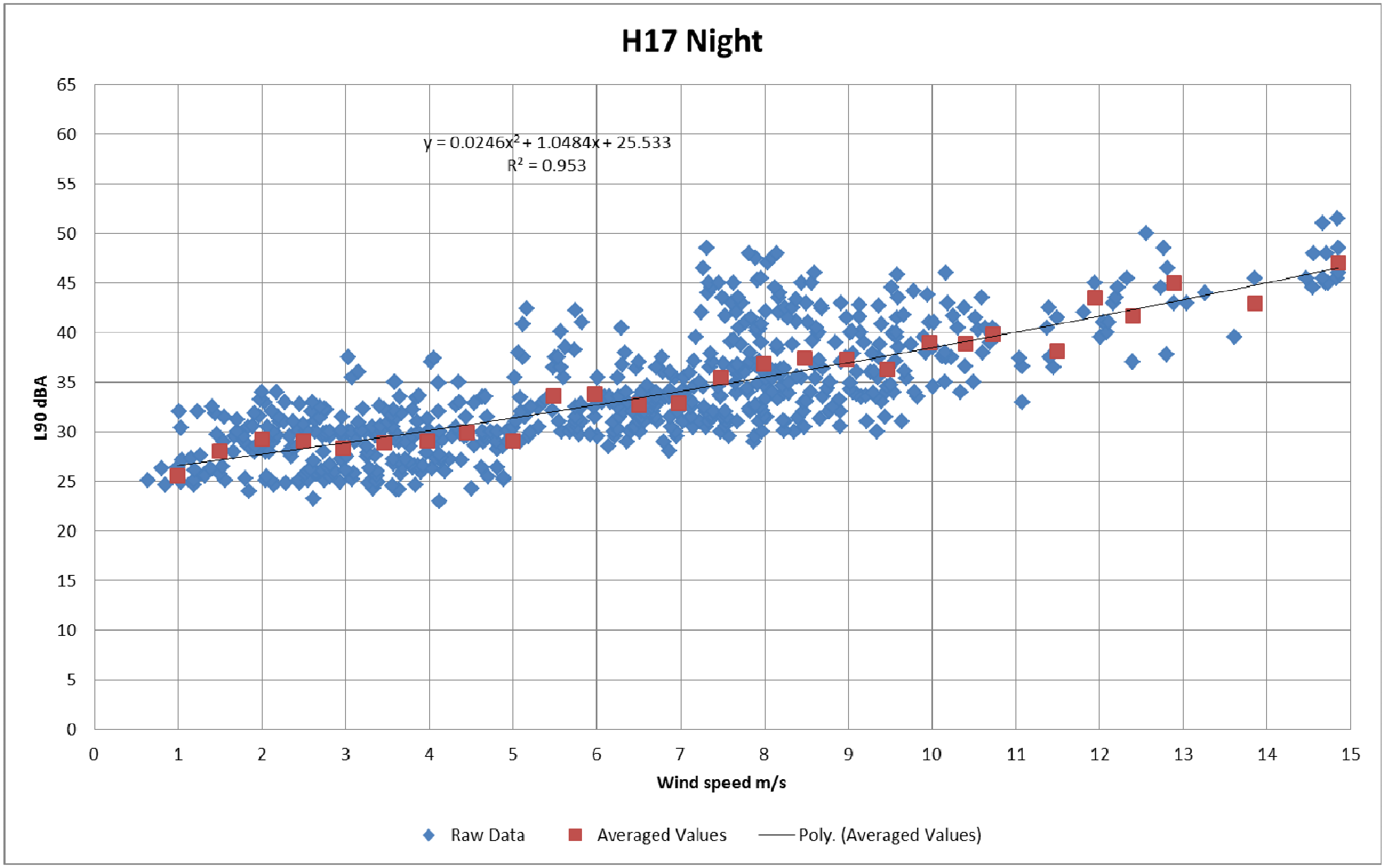
14
15



H17 Day
y = 0.0065x² + 1.0742x + 29.517
R² = 0.8844
L90 dBA
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)



H17 Night
y = 0.0246x² + 1.0484x + 25.533
R² = 0.953
L90 dBA
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
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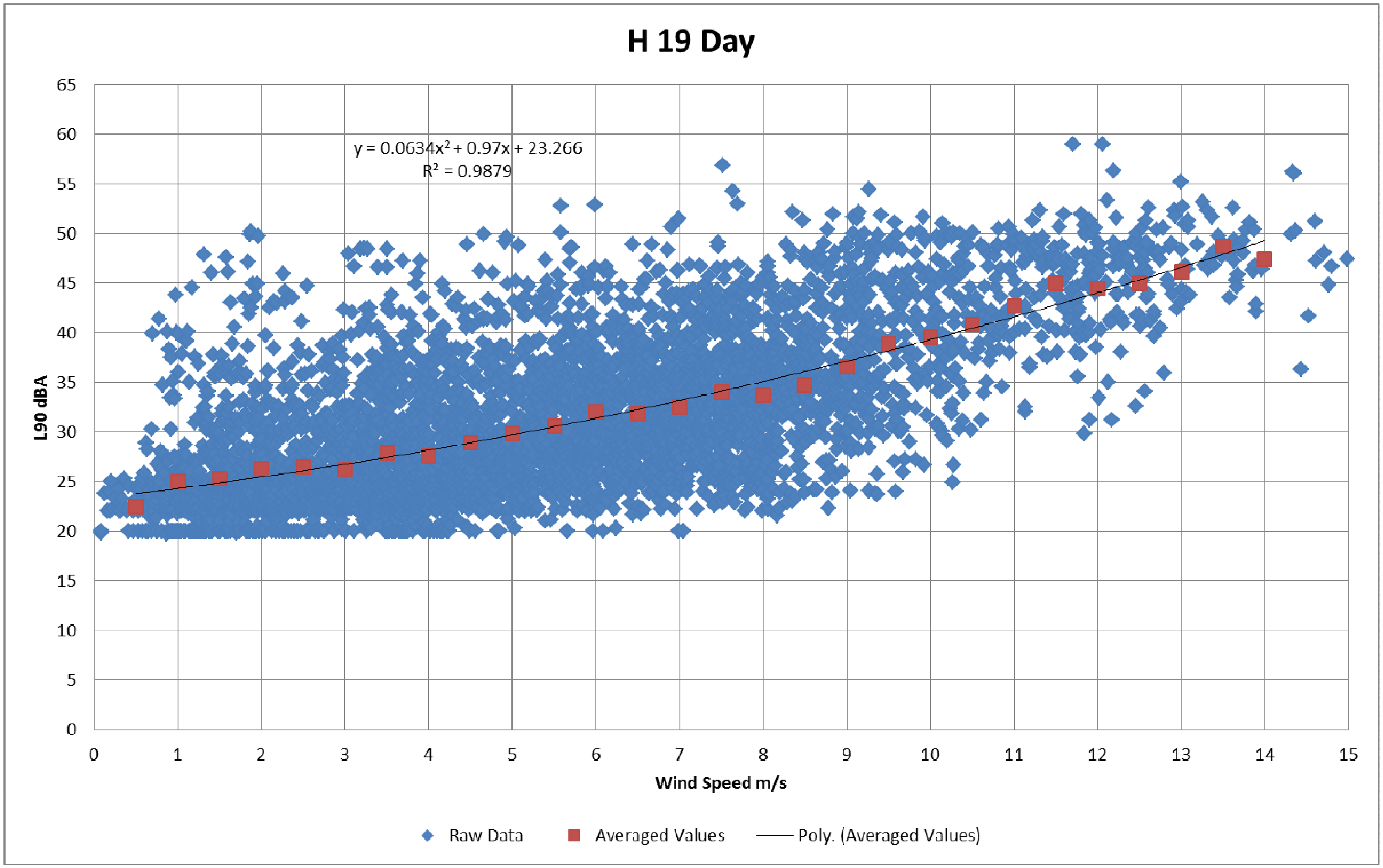
11
12
13
14
15
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)



H 19 Day
y = 0.0634x² + 0.97x + 23.266
R² = 0.9879
L90 dBA
Wind Speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
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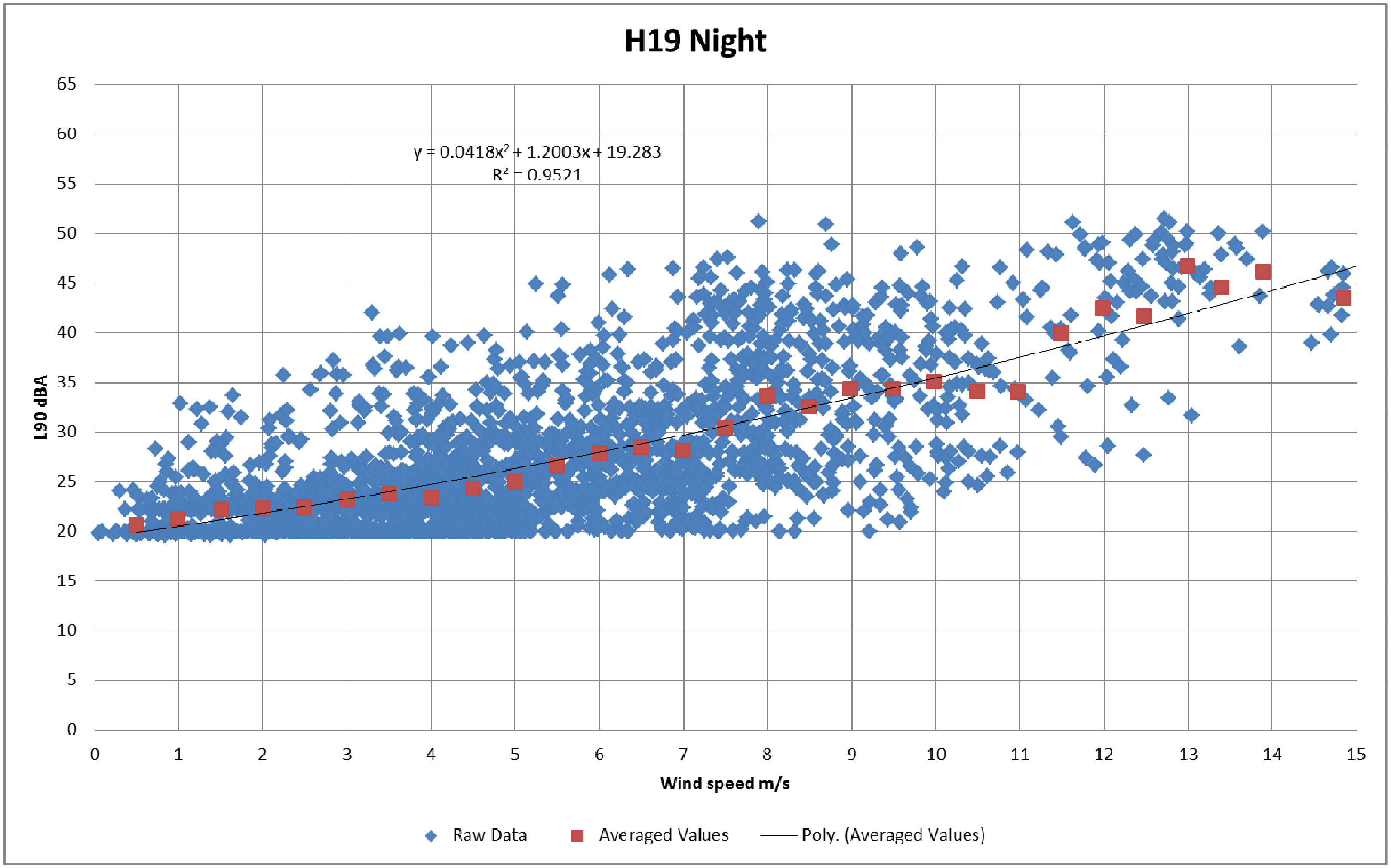
15
Raw Data
Averaged Values
Poly. (Averaged Values)



H19 Night
y = 0.0418x² + 1.2003x + 19.283
R² = 0.9521
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
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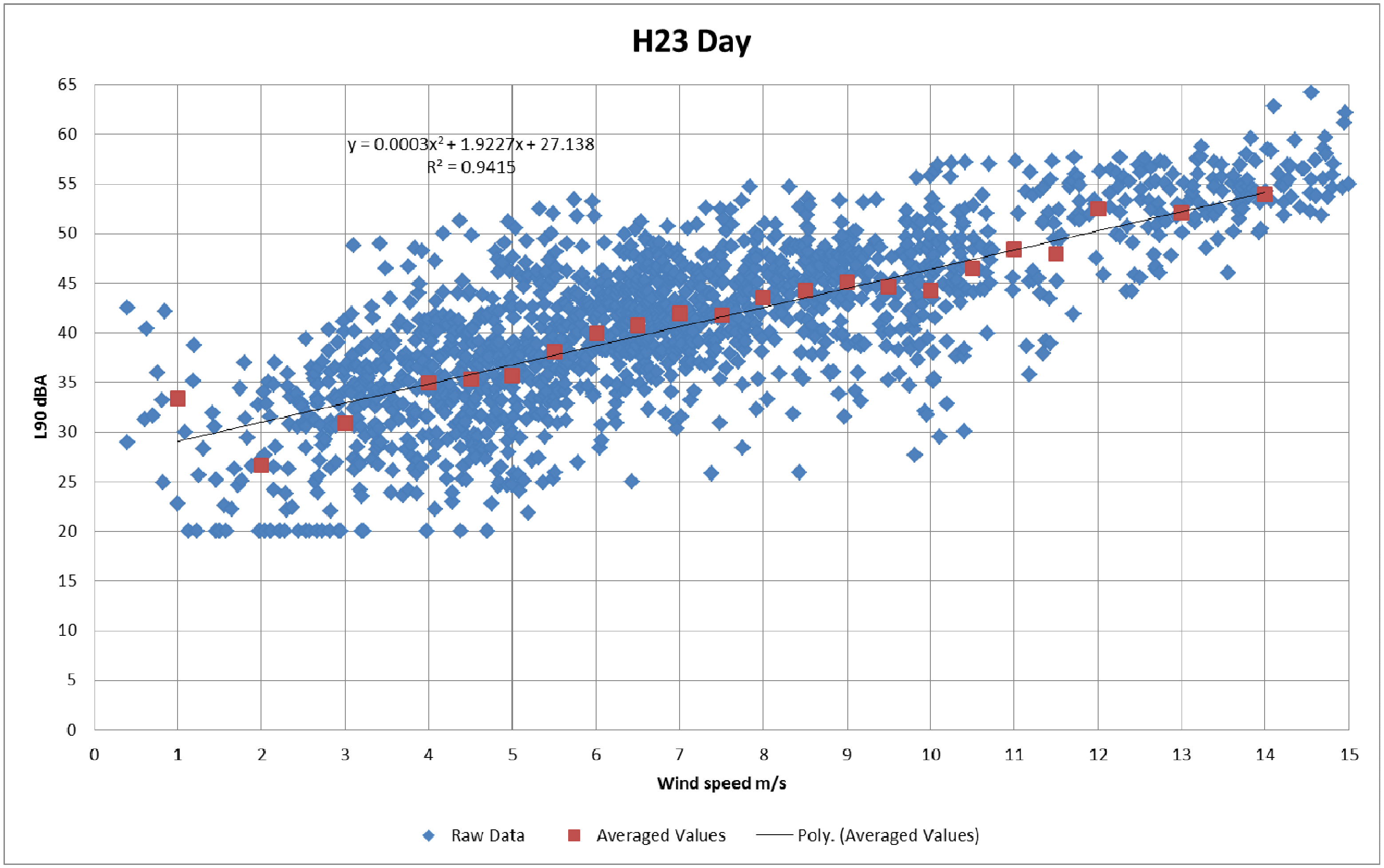
Raw Data
Averaged Values
Poly. (Averaged Values)


H23 Day
y = 0.0003x² + 1.9227x + 27.138
R² = 0.9415
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
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60
65
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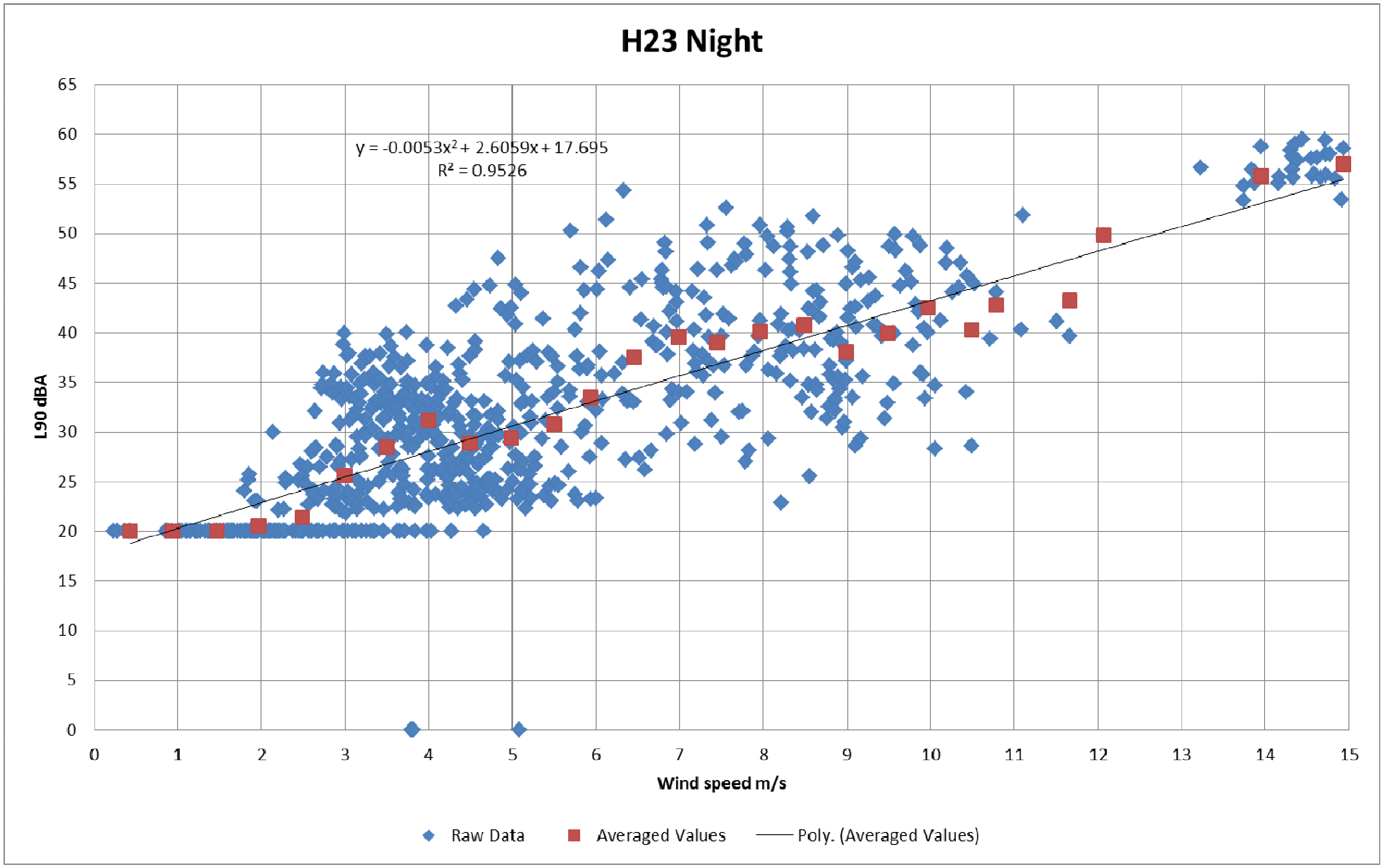
Raw Data
Averaged Values
Poly. (Averaged Values)



H23 Night
y = -0.0053x² + 2.6059x + 17.695
R² = 0.9526
L90 dBA
Wind speed m/s
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
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12
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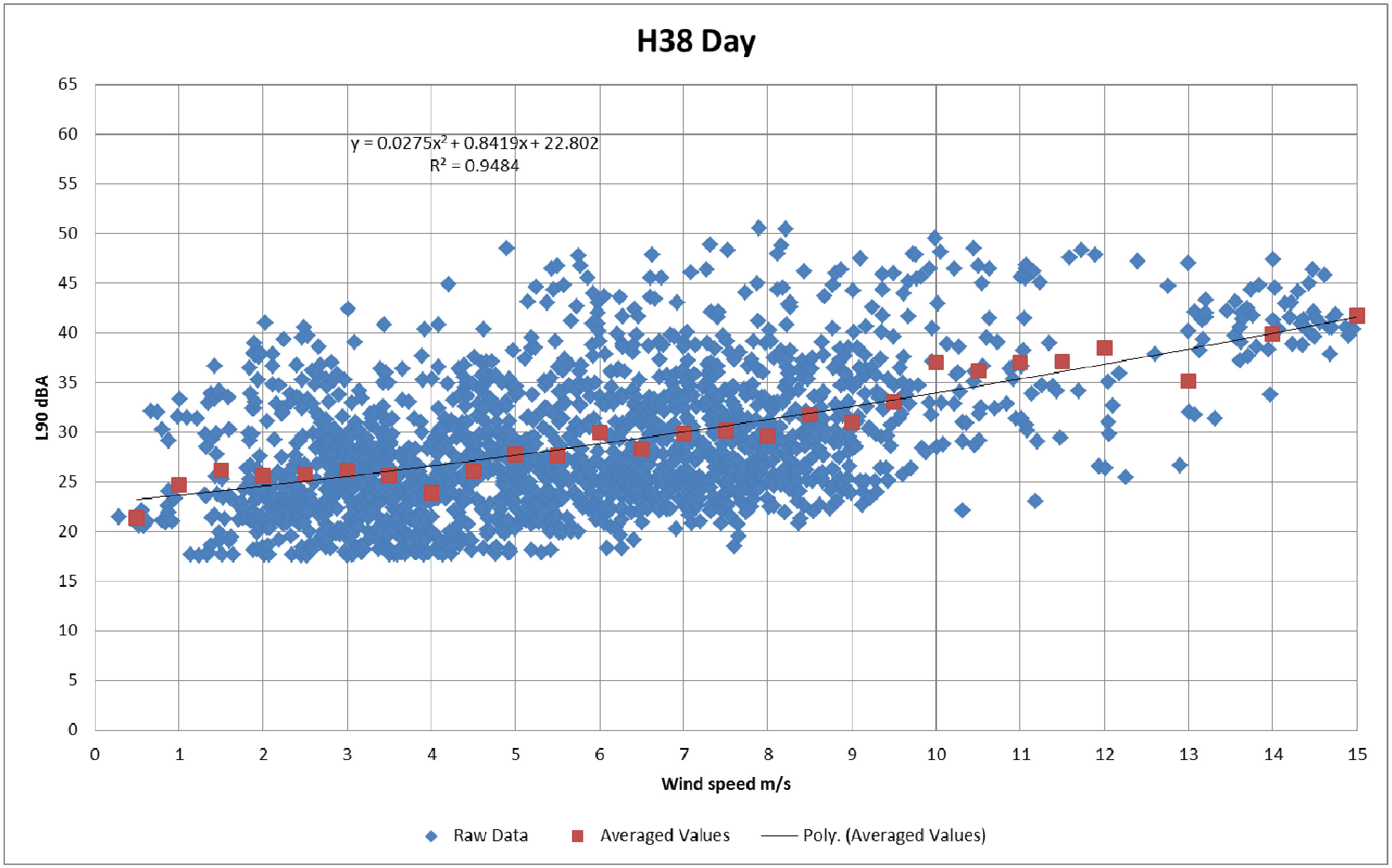
14
15
Raw Data
Averaged Values
Poly. (Averaged Values)



H38 Day
y = 0.0275x² + 0.8419x + 22.802
R² = 0.9484
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
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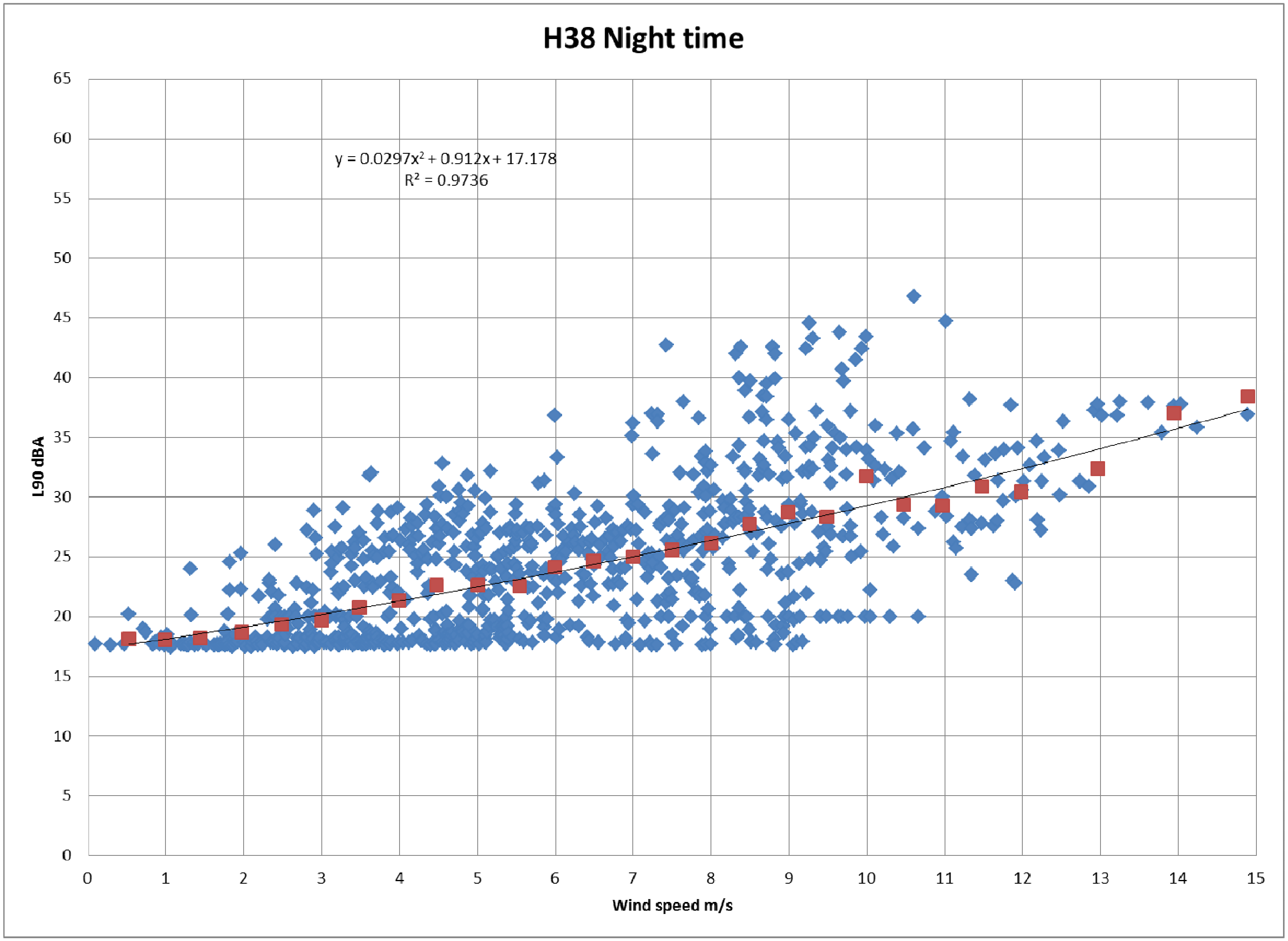
Raw Data
Averaged Values
Poly. (Averaged Values)



H38 Night time
y = 0.0297x² + 0.912x + 17.178
R² = 0.9736
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
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3
4
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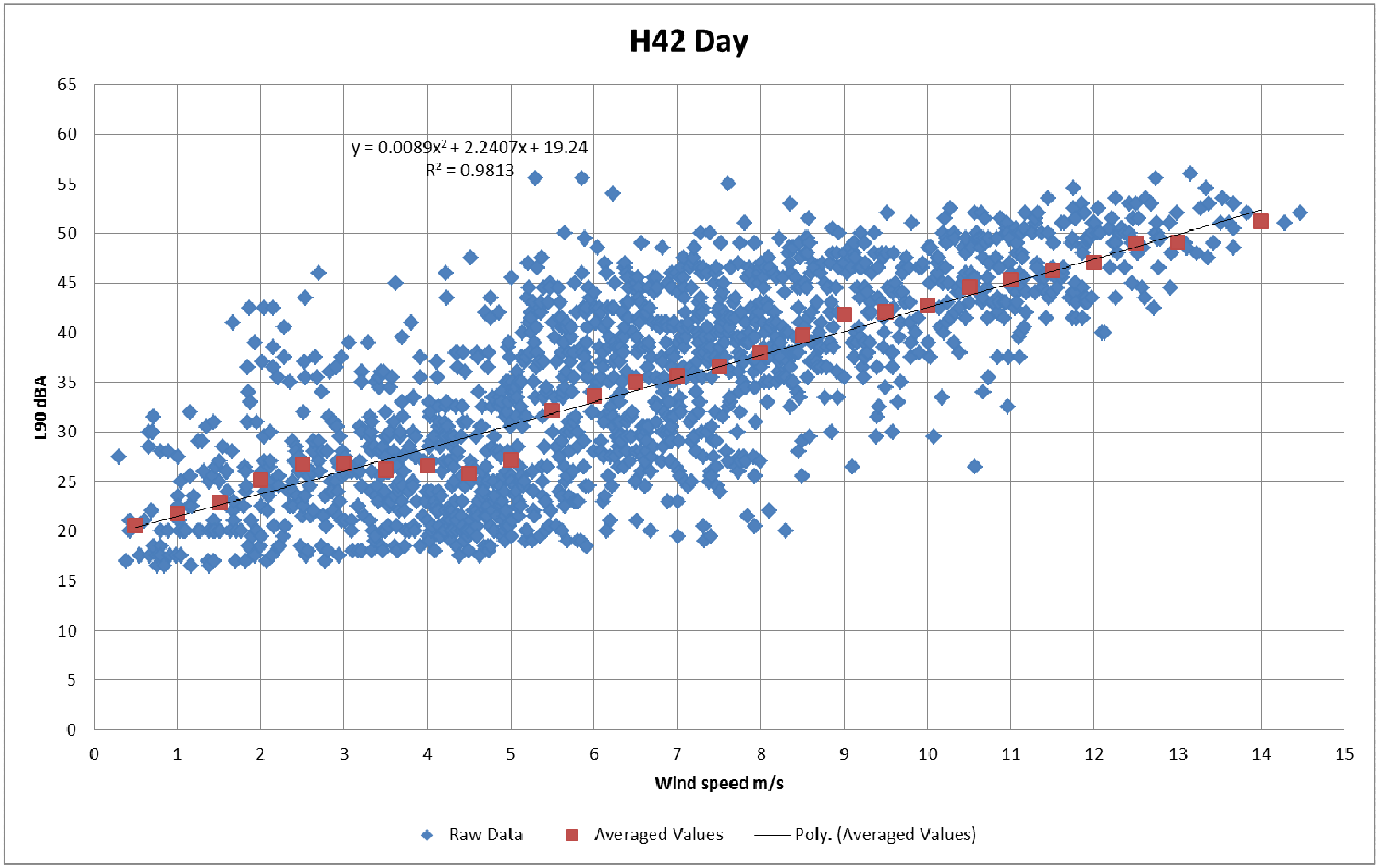
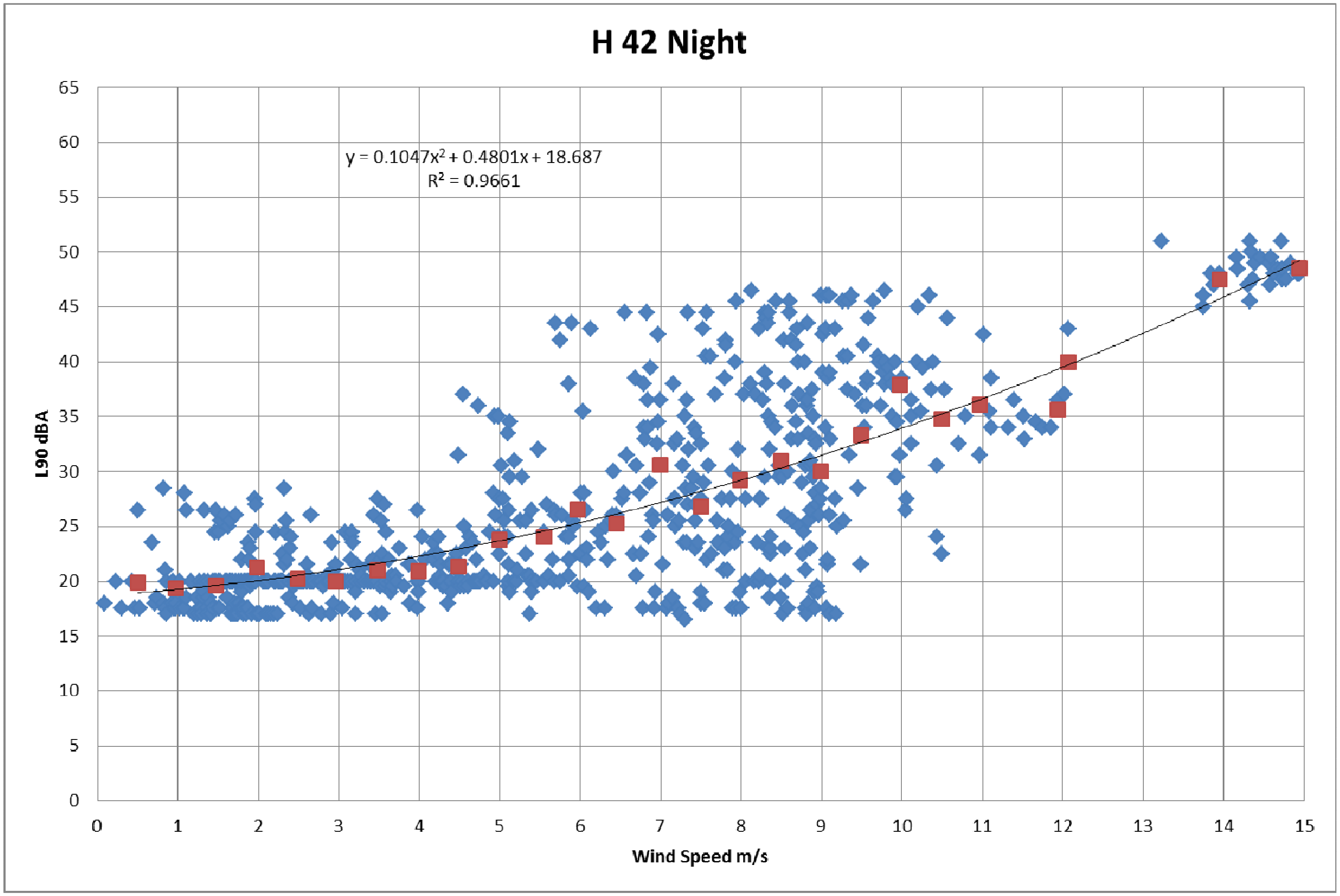
15


H42 Day
y = 0.0089x² + 2.2407x + 19.24
R² = 0.9813
L90 dBA
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)



H 42 Night
y = 0.1047x² + 0.4801x + 18.687
R² = 0.9661
L90 dBA
Wind Speed m/s
0
5
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25
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35
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45
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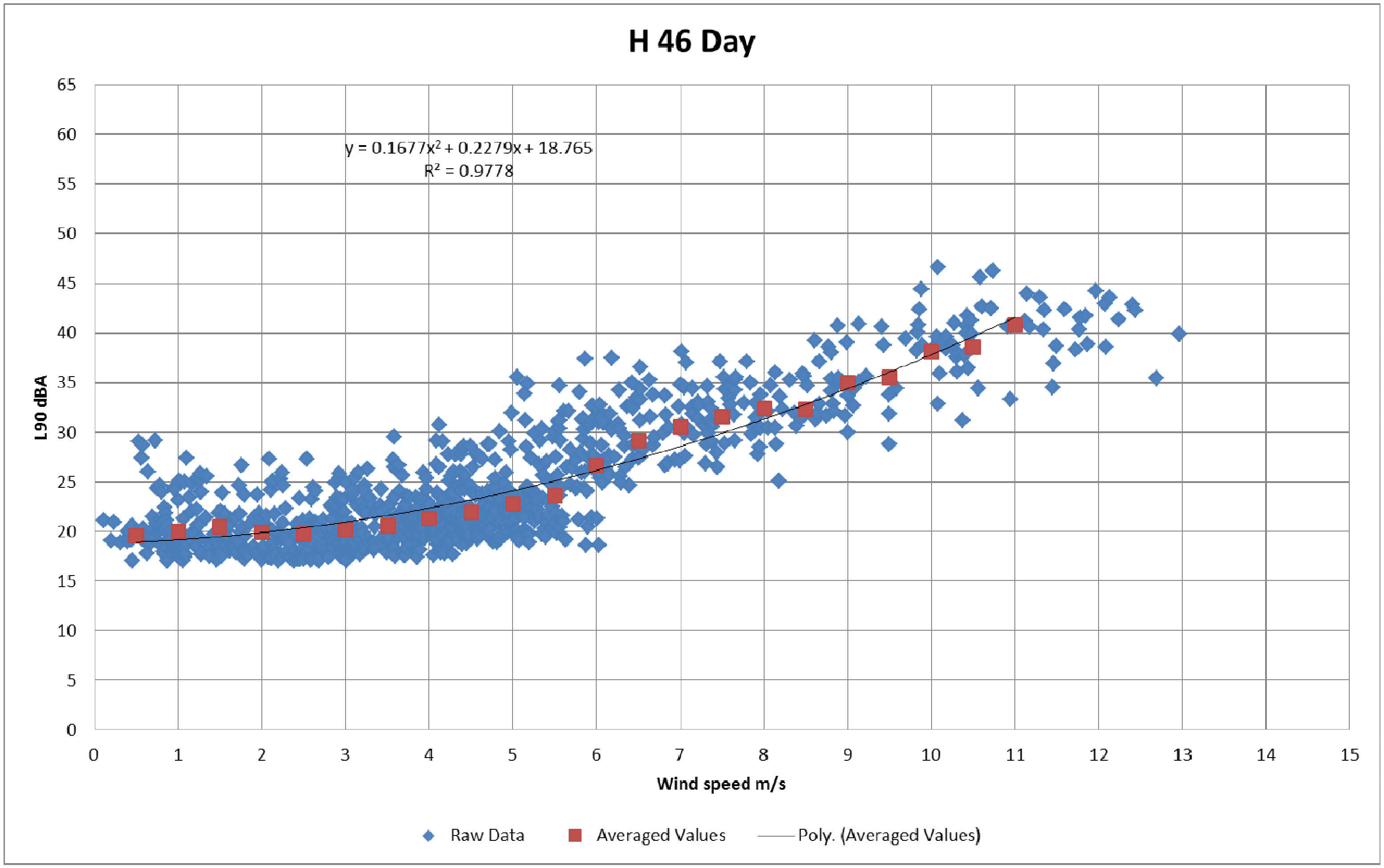
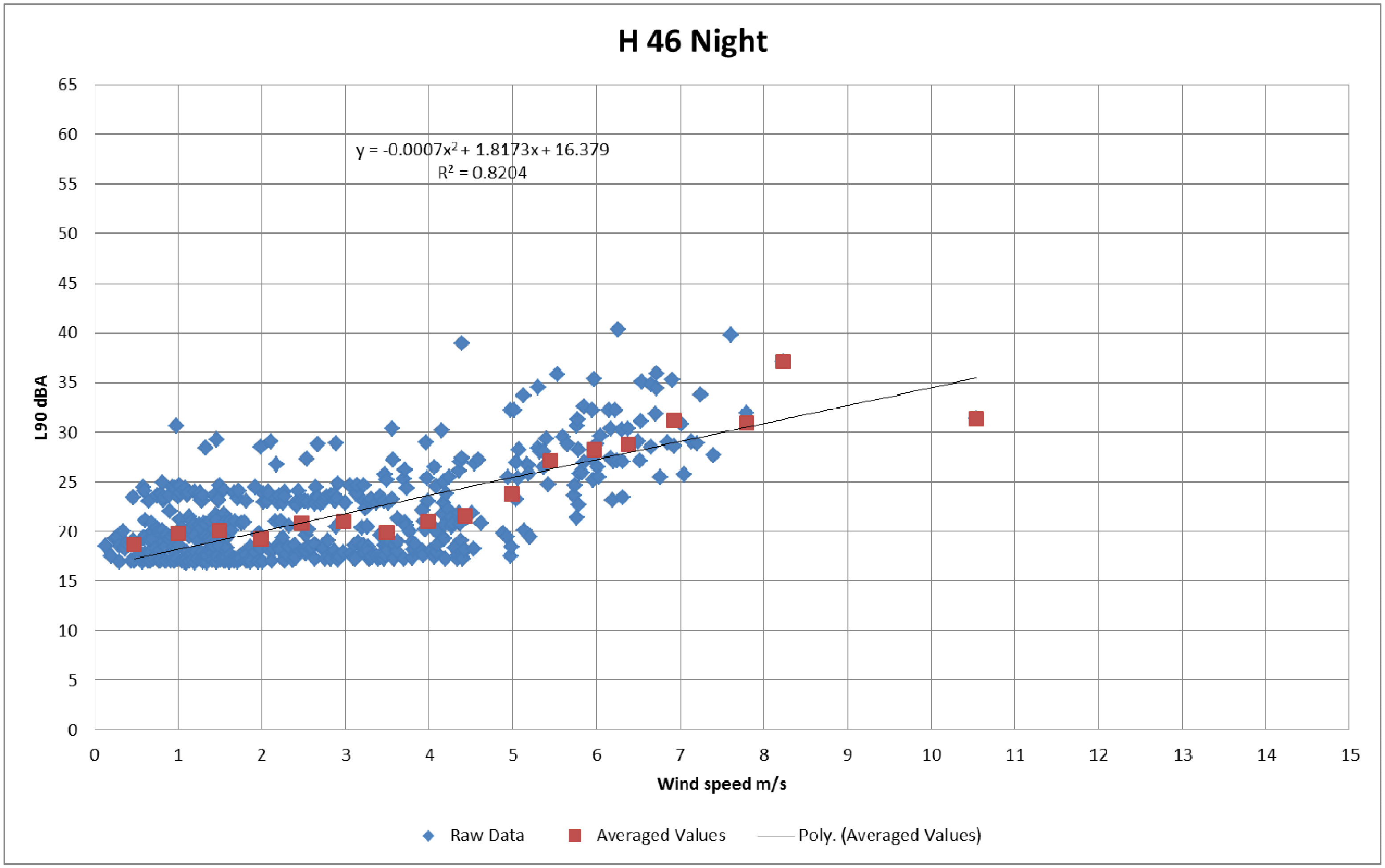


H 46 Day
y = 0.1677x² + 0.2279x + 18.765
R² = 0.9778
65
60
55
50
45
40
35
30
25
20
15
10
5
0
L90 dBA
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Wind speed m/s
Raw Data
Averaged Values
Poly. (Averaged Values)



H 46 Night
y = -0.0007x2 + 1.8173x + 16.379
R² = 0.8204
L90 dBA
Wind speed m/s
0
5
10
15
20
25
30
35
40
45
50
55
60
65
0
1
2
3
4
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6
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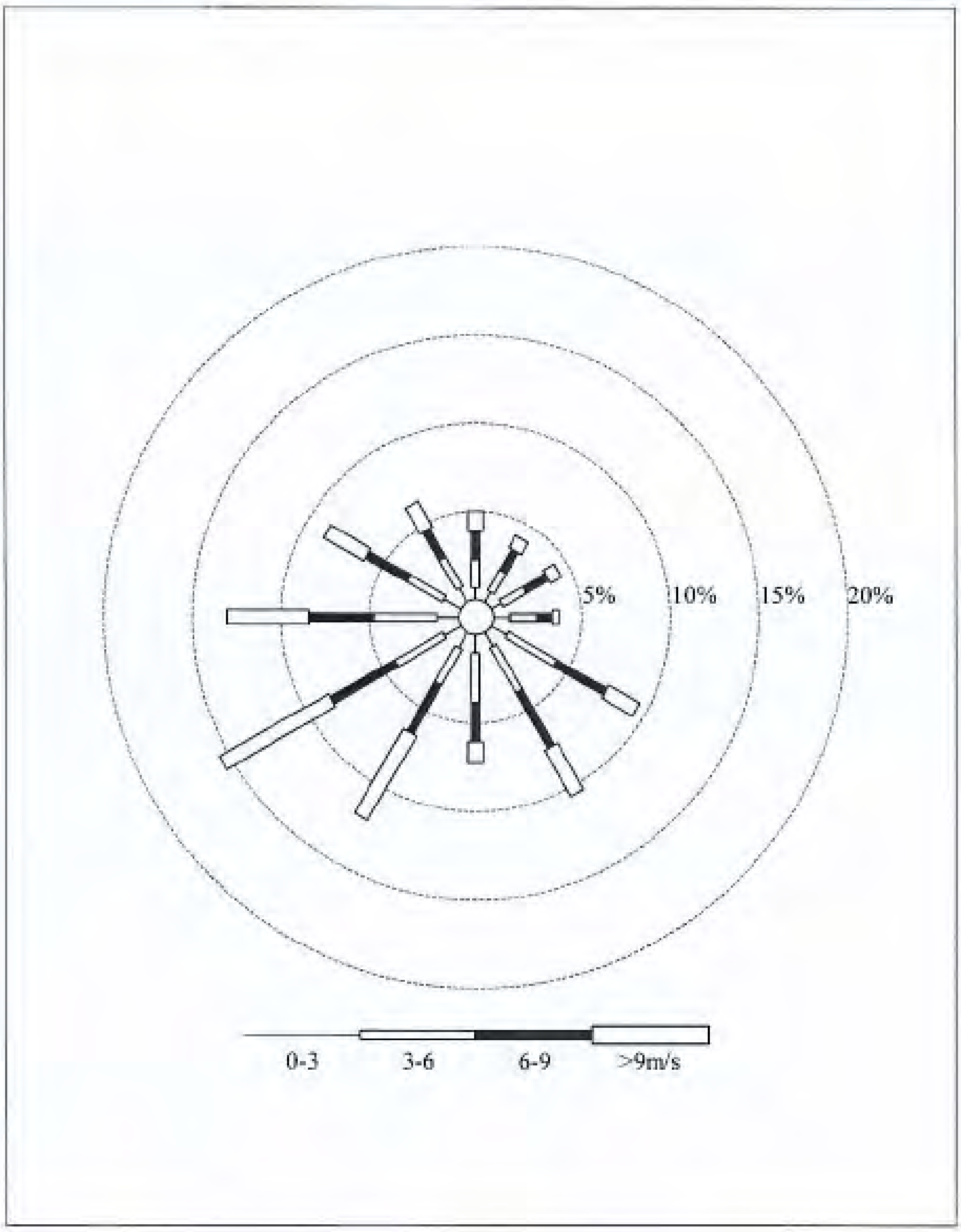
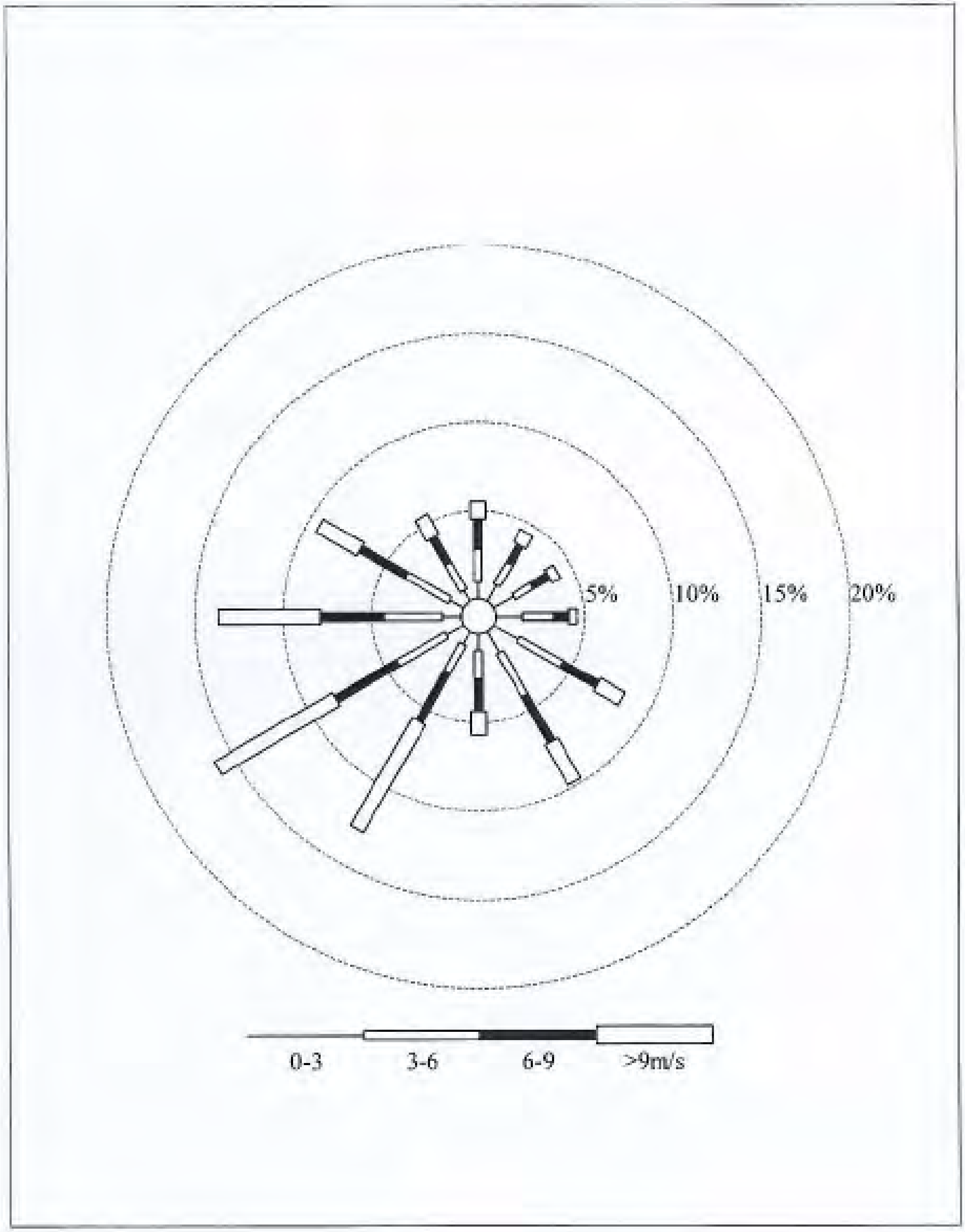
8
9
10
11
12
13
14
15
Raw Data
Averaged Values
Poly. (Averaged Values)

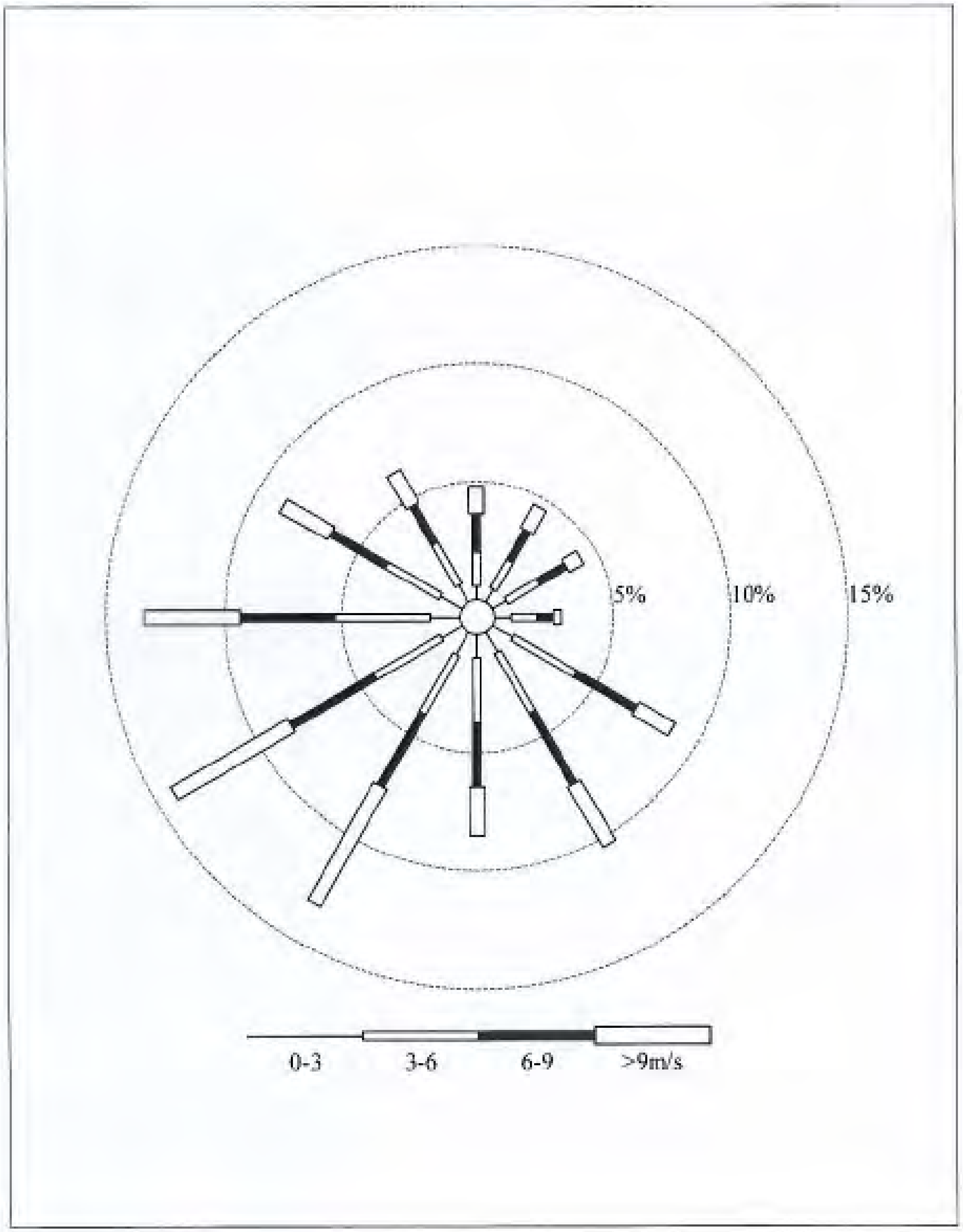
APPENDIX B WIND ROSE DATA

Predicted long term wind speed and direction at Mast 1 @ 50m



Predicted long term wind speed and direction at Mast 2 @ 50m





Predicted long term wind speed and direction at Mast 3 @ 50m

APPENDIX C NEAREST RESIDENCES

House No.	Easting_ITM	Northing_ITM
H1	493743.05	822357.88
H2	493784.69	822376.34
H3	493865.81	822407.93
H4	493662.23	822024.51
H5	493698.77	822063.08
H6	493863.00	822000.00
H7	493909.85	821590.16
H8	493864.22	821499.88
H9	493964.43	821462.07
H10	494043.17	820630.97
H11	495405.92	820383.37
H12	496430.84	820401.08
H13	496718.07	820183.88
H14	496833.10	820037.68
H15	496870.18	820016.72
H16	497356.07	820704.65
H17	497643.45	821350.42
H18	497694.02	821645.42
H19	497478.03	823177.58
H20	497536.38	823360.48
H21	501666.86	818565.45
H22	501914.87	818508.68
H23	501855.21	818442.19
H24	502067.20	818581.69
H25	502102.57	818572.73
H26	502246.75	818476.39
H27	502288.03	818454.96
H28	502305.49	818449.40
H29	502338.83	818452.57
H30	502354.49	818443.60
H31	502546.79	818344.62
H32	502574.57	818338.27
H33	502565.26	818236.03
H34	502725.99	818214.21
H35	502999.84	818515.17
H36	503610.47	819907.69
H37	503894.10	820016.25
H38	503929.02	819889.25
H39	504015.54	819954.34
H40	504270.34	820253.58
H41	504848.94	822143.46
H42	505466.62	824120.67
H43	505448.23	824278.28
H44	505622.89	824318.78
H45	505671.51	824309.80

OWENINNY WIND FARM

STAND-ALONE AND CUMULATIVE NOISE PREDICTIONS FOR PHASE 1 & 2 ONLY

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HM:2588_N08_EXT, Draft 31st July 2015

1. Hayes McKenzie have been asked to update the noise predictions, previously carried out in 2013, for the Oweninny site acting both alone and cumulatively with the Corvoderry site for the Phase 1 and Phase 2 turbines only and incorporating 3 alternative turbine types for Oweninny.

2. As for the previous set of predictions, the wind turbines for Oweninny have been specified as either Vestas V112 3MW, Siemens SWT-3-101 or Vestas V90 3MW machines, each with hub heights of 120 metres. The wind turbines for Corvoderry have been assumed as Vestas V90 3MW turbines with hub heights 55 metres as advised by ESBI. It should be noted that the Cluddaun site, also considered in the previous cumulative predictions, has been refused planning permission by An Bord Pleanála and has not, therefore been included here.

3. Source noise level for the 3 turbines for Oweninny has been taken from manufacturers' data sheets as supplied by ESBI with no correction for any uncertainty. The highest level occurring for wind speeds up to standardised 10 metre height wind speeds up to 10 m/s has been used in each case, as agreed with ESBI, with octave band data also taken from manufacturers' data or test report for a wind speed of 8 m/s and normalised to the overall level used. The values used are shown in Table 1.

Table 1 – Assumed Overall & Octave Band Sound Power Levels

		Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Turbine	**Overall**	**Octave Band Sound Power Level (Hz)**							
Vestas V112-3	106.5	88.5	95.5	97.9	100.0	101.1	99.1	94.5	86.0
Siemens SWT-3-101	108.0	82.8	94.7	101.4	104.7	101.4	93.5	82.6	79.3
V90-3	107.0	91.8	94.0	97.3	99.6	101.8	100.5	96.7	86.7

4. For the previous work, two sets of predictions were carried out for Oweninny acting alone, and in conjunction with Corvoderry and Cluddaun, for each of the 3 turbine types. The first predictions take the form of noise contours assuming downwind propagation in all directions simultaneously which is not possible in practice. These are shown at Figures 1 – 6 together with slightly updated house locations provided by ESBI. The second takes account of wind direction effects which, particularly in respect of upwind propagation, can reduce noise level considerably, in 15 degree increments around the site. The results are shown in tabular form for each of the 17 properties shown on the contour plots, together with the predicted noise level for the worst case wind direction, in Tables 1-6.

5. Full details of the prediction assumptions are included as an Appendix to this note. It should be noted that the results of all predictions are expressed as dB L_{A90} values by subtracting 2 dB from the calculated L_{Aeq} values.

Table 1 – Noise Predictions for Oweninny (Phase 1&2 – V112-3) Acting Alone (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	38.9	37.0	35.9	35.8	37.7	38.6	39.3	38.7	38.4	26.5	26.2	26.0	26.0	26.1	27.6	27.3	37.8
15	38.9	37.0	35.9	35.8	37.4	38.0	38.9	38.7	38.2	26.1	25.9	25.6	25.6	25.7	27.1	25.9	38.4
30	38.9	36.8	35.8	35.7	36.8	37.5	38.3	38.5	38.3	25.8	25.5	25.3	25.3	25.4	26.1	24.3	38.5
45	38.9	36.4	35.3	35.2	36.0	36.8	37.8	38.2	38.1	25.0	24.6	24.4	24.3	24.1	24.6	21.1	38.9
60	38.7	35.9	34.4	34.3	35.0	36.2	37.3	38.2	37.8	23.5	23.1	22.9	22.9	22.8	22.9	19.0	38.9
75	38.5	34.5	33.2	33.1	33.9	35.6	37.0	37.9	37.9	22.3	21.9	21.7	21.6	21.2	20.0	17.6	38.9
90	37.8	33.4	32.0	31.8	32.8	35.2	36.8	37.9	37.8	20.2	19.5	19.3	19.2	18.8	18.2	17.0	38.8
105	37.1	31.6	30.1	30.0	31.9	34.6	36.6	38.0	37.9	18.0	17.6	17.4	17.3	17.1	17.2	17.0	38.6
120	35.7	30.0	28.4	28.3	31.0	34.2	35.9	38.3	38.2	16.8	16.5	16.4	16.3	16.2	16.9	17.7	38.3
135	34.2	29.0	27.5	27.4	30.1	33.5	35.7	38.6	38.5	16.4	16.2	16.1	16.0	16.1	17.4	19.0	37.8
150	33.0	27.7	25.8	25.6	29.1	32.8	35.1	38.9	38.7	16.7	16.6	16.4	16.4	16.6	18.5	21.0	37.3
165	31.4	26.7	24.7	24.5	28.9	33.1	35.1	39.3	39.1	17.8	17.7	17.5	17.5	17.8	20.4	23.6	36.3
180	30.4	26.9	24.9	24.7	30.1	33.6	35.5	39.3	39.0	19.6	19.6	19.3	19.4	19.7	22.3	25.6	35.5
195	30.1	28.0	26.0	25.9	32.4	35.1	36.0	39.3	39.2	21.4	21.4	21.2	21.2	21.4	24.4	27.1	33.8
210	30.5	30.5	28.8	28.7	33.5	35.8	36.8	39.3	39.4	22.7	22.7	22.5	22.5	22.7	26.0	27.9	32.5
225	31.4	32.6	31.5	31.4	35.0	36.7	37.2	39.3	39.3	24.4	24.4	24.2	24.2	24.6	27.1	28.5	30.4
240	33.1	34.2	33.2	33.1	36.1	37.0	37.6	39.4	39.2	25.4	25.3	25.1	25.1	25.2	27.6	28.5	29.3
255	34.8	35.4	34.4	34.3	36.6	37.3	37.8	39.4	39.1	25.9	25.8	25.5	25.6	25.9	28.0	28.5	29.1
270	35.9	35.9	35.1	35.0	36.8	37.5	38.0	39.3	39.0	26.4	26.3	26.1	26.1	26.2	28.0	28.5	30.4
285	37.0	36.6	35.5	35.4	37.1	37.9	38.4	39.2	38.9	26.6	26.4	26.1	26.1	26.2	28.0	28.5	32.1
300	37.9	36.8	35.7	35.6	37.3	38.1	38.7	39.2	38.8	26.6	26.4	26.1	26.1	26.2	28.0	28.5	33.6
315	38.3	36.8	35.7	35.6	37.5	38.5	39.0	39.0	38.7	26.6	26.4	26.1	26.1	26.2	28.0	28.5	35.0
330	38.7	36.9	35.9	35.8	37.6	38.7	39.3	38.9	38.7	26.6	26.4	26.1	26.1	26.2	28.0	28.5	36.2
345	38.9	37.0	35.9	35.8	37.7	38.7	39.4	39.0	38.5	26.6	26.4	26.1	26.1	26.2	27.9	28.1	37.1
Max	**38.9**	**37.0**	**35.9**	**35.8**	**37.7**	**38.7**	**39.4**	**39.4**	**39.4**	**26.6**	**26.4**	**26.1**	**26.1**	**26.2**	**28.0**	**28.5**	**38.9**

Table 2 – Noise Predictions for Oweninny (Phase 1&2 – V112-3) plus Corvoderry (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	38.9	37.1	36.1	36.0	37.8	38.7	39.4	38.7	38.5	33.8	33.1	32.6	32.5	32.0	30.2	27.9	37.8
15	38.9	37.1	36.1	36.0	37.6	38.2	39.0	38.8	38.3	33.4	32.5	32.1	32.0	31.1	29.1	26.5	38.4
30	38.9	37.0	36.0	35.9	37.0	37.7	38.5	38.6	38.4	33.2	31.6	31.3	31.1	30.4	27.9	24.9	38.6
45	38.9	36.6	35.5	35.4	36.2	37.0	38.0	38.4	38.2	31.4	30.5	30.1	29.9	28.4	26.0	22.2	38.9
60	38.8	36.1	34.7	34.6	35.3	36.4	37.5	38.4	37.9	30.5	27.9	27.9	27.5	26.5	24.4	20.6	38.9
75	38.6	34.7	33.6	33.5	34.2	35.9	37.2	38.1	38.0	27.0	25.9	25.8	25.5	24.5	22.3	19.8	38.9
90	37.9	33.7	32.4	32.3	33.3	35.6	37.0	38.0	37.9	24.8	23.7	23.6	23.3	22.6	21.4	19.9	38.9
105	37.1	32.1	30.8	30.7	32.5	35.0	36.8	38.2	38.1	23.1	22.3	22.1	21.9	21.5	21.4	20.6	38.7
120	35.8	30.6	29.3	29.2	31.7	34.6	36.2	38.5	38.4	22.2	21.6	21.3	21.2	21.0	22.1	22.2	38.4
135	34.4	29.7	28.6	28.5	31.0	34.0	36.1	38.8	38.6	21.9	21.5	21.2	21.2	21.3	23.8	24.0	37.9
150	33.2	28.6	27.1	27.0	30.1	33.4	35.5	39.0	38.9	22.3	22.1	21.7	21.8	22.1	26.5	25.5	37.3
165	31.6	27.6	26.0	25.9	29.8	33.6	35.4	39.4	39.2	23.4	23.4	22.9	23.0	23.7	27.6	27.2	36.3
180	30.6	27.6	25.9	25.8	30.7	33.9	35.8	39.4	39.1	25.2	25.5	24.9	25.1	26.6	29.4	28.5	35.5
195	30.3	28.4	26.5	26.4	32.7	35.3	36.1	39.4	39.3	28.4	28.4	27.9	27.9	29.1	30.4	29.4	33.9
210	30.5	30.6	29.0	28.9	33.6	35.9	36.9	39.4	39.4	29.9	30.5	29.9	29.9	30.2	31.1	29.9	32.6
225	31.5	32.6	31.6	31.5	35.0	36.8	37.3	39.3	39.3	32.2	31.6	31.2	31.1	31.6	31.6	30.2	30.4
240	33.1	34.2	33.2	33.1	36.1	37.0	37.7	39.4	39.2	32.6	32.7	32.1	32.1	31.9	31.8	30.2	29.3
255	34.8	35.4	34.4	34.3	36.6	37.3	37.8	39.4	39.1	33.6	32.9	32.5	32.3	32.2	31.9	30.2	29.2
270	35.9	35.9	35.2	35.0	36.8	37.5	38.0	39.3	39.0	33.8	33.1	32.6	32.5	32.3	31.9	30.2	30.4
285	37.0	36.6	35.5	35.4	37.1	37.9	38.4	39.2	38.9	33.8	33.1	32.6	32.5	32.3	31.9	30.2	32.2
300	37.9	36.8	35.7	35.6	37.3	38.2	38.7	39.2	38.8	33.8	33.1	32.6	32.5	32.3	31.9	30.2	33.6
315	38.4	36.9	35.8	35.7	37.5	38.6	39.0	39.0	38.7	33.8	33.1	32.6	32.5	32.3	31.9	29.9	35.0
330	38.7	37.0	36.0	35.9	37.7	38.8	39.4	39.0	38.7	33.8	33.1	32.6	32.5	32.3	31.4	29.6	36.2
345	38.9	37.1	36.1	36.0	37.8	38.7	39.4	39.0	38.5	33.8	33.1	32.6	32.5	32.3	31.2	29.0	37.1
Max	**38.9**	**37.1**	**36.1**	**36.0**	**37.8**	**38.8**	**39.4**	**39.4**	**39.4**	**33.8**	**33.1**	**32.6**	**32.5**	**32.3**	**31.9**	**30.2**	**38.9**

Table 3 – Noise Predictions for Oweninny (Phase 1&2 – SWT-3-101) Acting Alone (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	41.5	39.6	38.5	38.4	40.3	41.2	41.9	41.2	41.0	28.0	27.8	27.5	27.5	27.6	29.6	29.4	40.4
15	41.5	39.6	38.5	38.4	40.0	40.6	41.5	41.3	40.7	27.7	27.5	27.2	27.1	27.3	29.1	27.9	41.0
30	41.5	39.4	38.4	38.3	39.4	40.1	40.9	41.1	40.9	27.4	27.1	26.8	26.8	26.9	28.1	25.9	41.2
45	41.5	39.0	37.9	37.8	38.5	39.3	40.4	40.8	40.6	26.5	26.1	25.8	25.8	25.5	26.3	21.3	41.5
60	41.3	38.4	37.0	36.9	37.4	38.6	39.8	40.8	40.3	24.9	24.5	24.2	24.1	24.1	24.1	18.0	41.5
75	41.1	36.9	35.6	35.5	36.2	38.0	39.4	40.4	40.4	23.5	22.9	22.7	22.6	21.9	19.6	15.8	41.5
90	40.4	35.7	34.2	34.0	35.0	37.6	39.2	40.3	40.3	20.3	19.2	18.9	18.7	17.9	16.7	14.7	41.5
105	39.6	33.7	32.0	31.9	34.0	37.0	39.0	40.5	40.4	16.6	16.0	15.7	15.6	15.2	15.1	14.7	41.3
120	38.2	31.8	30.0	29.9	33.0	36.6	38.4	40.8	40.7	14.6	14.2	14.0	13.9	13.7	14.5	15.6	41.0
135	36.6	30.7	29.0	28.9	32.0	35.8	38.2	41.2	41.0	13.8	13.6	13.4	13.3	13.4	15.1	17.6	40.5
150	35.2	29.0	26.4	26.2	30.6	34.9	37.4	41.4	41.3	14.2	14.1	13.9	13.9	14.1	16.8	20.7	39.9
165	33.3	27.6	24.7	24.5	30.3	35.3	37.5	41.8	41.7	15.8	15.7	15.5	15.5	15.9	19.8	24.6	38.8
180	32.2	27.9	25.1	24.8	31.9	35.9	37.9	41.9	41.6	18.7	18.9	18.5	18.5	19.0	22.7	27.4	37.9
195	31.8	29.4	26.8	26.7	34.7	37.6	38.4	41.9	41.9	21.8	21.7	21.5	21.4	21.7	25.7	29.1	36.2
210	32.2	32.5	30.6	30.5	36.0	38.3	39.4	41.9	42.0	23.4	23.4	23.1	23.2	23.4	27.6	30.0	34.7
225	33.3	34.9	33.9	33.7	37.5	39.3	39.8	41.9	41.9	25.4	25.5	25.2	25.2	25.8	29.0	30.6	32.1
240	35.3	36.7	35.7	35.6	38.7	39.6	40.2	42.0	41.8	26.8	26.7	26.5	26.5	26.6	29.5	30.6	30.6
255	37.2	38.0	37.0	36.9	39.2	39.9	40.4	42.0	41.7	27.4	27.3	27.0	27.0	27.3	29.9	30.6	30.4
270	38.4	38.5	37.7	37.6	39.4	40.1	40.6	41.9	41.6	28.0	27.8	27.6	27.5	27.7	29.9	30.6	32.1
285	39.5	39.2	38.1	38.0	39.7	40.5	41.0	41.8	41.5	28.1	27.9	27.6	27.6	27.7	29.9	30.6	34.3
300	40.5	39.4	38.3	38.2	39.9	40.8	41.3	41.8	41.4	28.1	27.9	27.6	27.6	27.7	29.9	30.6	35.9
315	41.0	39.4	38.3	38.2	40.1	41.2	41.6	41.6	41.3	28.1	27.9	27.6	27.6	27.7	29.9	30.6	37.5
330	41.3	39.5	38.5	38.4	40.2	41.4	42.0	41.5	41.2	28.1	27.9	27.6	27.6	27.7	29.9	30.6	38.7
345	41.5	39.6	38.5	38.4	40.3	41.3	42.0	41.5	41.1	28.1	27.9	27.6	27.6	27.7	29.9	30.2	39.7
Max	**41.5**	**39.6**	**38.5**	**38.4**	**40.3**	**41.4**	**42.0**	**42.0**	**42.0**	**28.1**	**27.9**	**27.6**	**27.6**	**27.7**	**29.9**	**30.6**	**41.5**

Table 4 – Noise Predictions for Oweninny (Phase 1&2 – SWT-3-101) plus Corvoderry (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	41.5	39.7	38.6	38.5	40.3	41.3	42.0	41.2	41.0	34.1	33.4	33.0	32.9	32.4	31.5	29.8	40.4
15	41.5	39.7	38.6	38.5	40.1	40.7	41.6	41.3	40.8	33.7	32.9	32.5	32.4	31.6	30.5	28.3	41.0
30	41.5	39.5	38.5	38.4	39.5	40.2	41.0	41.2	40.9	33.5	32.1	31.7	31.5	31.0	29.3	26.4	41.2
45	41.5	39.1	38.0	37.9	38.7	39.4	40.5	40.9	40.7	31.8	30.9	30.5	30.4	29.0	27.3	22.3	41.5
60	41.4	38.5	37.1	37.0	37.6	38.8	39.9	40.8	40.4	30.8	28.4	28.4	27.9	27.1	25.4	19.9	41.5
75	41.2	37.1	35.8	35.7	36.4	38.2	39.6	40.5	40.4	27.5	26.4	26.2	25.9	24.9	22.1	18.8	41.5
90	40.4	35.9	34.4	34.3	35.3	37.8	39.4	40.4	40.4	24.8	23.6	23.4	23.1	22.3	20.8	18.8	41.5
105	39.6	33.9	32.4	32.3	34.4	37.2	39.2	40.6	40.5	22.7	21.8	21.6	21.4	20.9	20.7	19.8	41.3
120	38.2	32.2	30.7	30.6	33.5	36.8	38.5	40.9	40.8	21.6	21.0	20.7	20.6	20.4	21.5	21.6	41.0
135	36.6	31.2	29.8	29.8	32.6	36.1	38.3	41.3	41.1	21.3	20.9	20.5	20.5	20.6	23.3	23.6	40.5
150	35.3	29.7	27.6	27.5	31.3	35.3	37.7	41.5	41.4	21.7	21.5	21.1	21.1	21.6	26.2	25.4	39.9
165	33.4	28.3	26.0	25.9	31.0	35.6	37.7	41.9	41.7	22.9	22.9	22.4	22.5	23.3	27.5	27.6	38.8
180	32.3	28.5	26.1	25.9	32.3	36.1	38.1	42.0	41.7	25.0	25.3	24.6	24.9	26.5	29.5	29.5	38.0
195	31.9	29.6	27.2	27.1	34.8	37.7	38.5	41.9	41.9	28.4	28.4	27.9	27.9	29.2	30.7	30.7	36.2
210	32.3	32.6	30.8	30.6	36.0	38.4	39.4	41.9	42.0	30.0	30.6	30.0	30.0	30.4	31.6	31.3	34.8
225	33.4	35.0	33.9	33.8	37.6	39.3	39.8	41.9	41.9	32.4	31.9	31.4	31.3	31.9	32.3	31.7	32.1
240	35.3	36.7	35.7	35.6	38.7	39.6	40.2	42.0	41.8	32.9	33.0	32.5	32.4	32.3	32.6	31.7	30.7
255	37.2	38.0	37.0	36.9	39.2	39.9	40.4	42.0	41.7	33.9	33.3	32.8	32.7	32.6	32.8	31.7	30.4
270	38.4	38.5	37.7	37.6	39.4	40.1	40.6	41.9	41.6	34.1	33.4	33.0	32.9	32.7	32.8	31.7	32.1
285	39.5	39.2	38.1	38.0	39.7	40.5	41.0	41.8	41.5	34.1	33.5	33.0	32.9	32.7	32.8	31.7	34.3
300	40.5	39.4	38.3	38.2	39.9	40.8	41.3	41.8	41.4	34.1	33.5	33.0	32.9	32.7	32.8	31.7	35.9
315	41.0	39.5	38.4	38.3	40.1	41.2	41.7	41.6	41.3	34.1	33.5	33.0	32.9	32.7	32.8	31.5	37.5
330	41.3	39.6	38.6	38.5	40.3	41.4	42.0	41.5	41.2	34.1	33.5	33.0	32.9	32.7	32.4	31.3	38.7
345	41.5	39.6	38.6	38.5	40.3	41.3	42.0	41.6	41.1	34.1	33.5	33.0	32.9	32.7	32.2	30.8	39.7
Max	**41.5**	**39.7**	**38.6**	**38.5**	**40.3**	**41.4**	**42.0**	**42.0**	**42.0**	**34.1**	**33.5**	**33.0**	**32.9**	**32.7**	**32.8**	**31.7**	**41.5**

Table 5 – Noise Predictions for Oweninny (Phase 1&2 – V90-3) Acting Alone (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	39.0	37.1	36.1	36.0	37.8	38.7	39.4	38.8	38.6	27.0	26.8	26.6	26.6	26.6	28.0	27.6	37.9
15	39.0	37.1	36.1	36.0	37.5	38.1	39.0	38.9	38.4	26.6	26.4	26.2	26.2	26.2	27.4	26.4	38.5
30	39.0	37.0	35.9	35.8	36.9	37.7	38.5	38.7	38.5	26.3	26.1	25.9	25.8	25.9	26.6	25.0	38.7
45	39.0	36.6	35.4	35.3	36.1	36.9	38.0	38.4	38.3	25.6	25.2	25.1	25.0	24.8	25.2	22.5	39.0
60	38.9	36.0	34.6	34.5	35.2	36.4	37.5	38.5	38.0	24.3	23.9	23.7	23.6	23.6	23.7	20.8	39.0
75	38.7	34.7	33.5	33.4	34.1	35.8	37.2	38.2	38.1	23.2	22.8	22.7	22.6	22.3	21.5	19.7	39.0
90	38.0	33.7	32.3	32.2	33.2	35.5	37.0	38.1	38.0	21.6	21.0	20.9	20.8	20.4	20.1	19.2	38.9
105	37.2	32.1	30.6	30.5	32.3	34.9	36.8	38.2	38.1	19.9	19.6	19.4	19.3	19.2	19.3	19.2	38.7
120	36.0	30.5	29.1	29.0	31.4	34.5	36.2	38.5	38.4	19.0	18.7	18.6	18.5	18.5	19.2	19.8	38.5
135	34.5	29.6	28.2	28.2	30.7	33.8	36.0	38.8	38.6	18.7	18.5	18.4	18.3	18.4	19.5	20.8	38.0
150	33.4	28.6	26.9	26.8	29.9	33.2	35.4	39.0	38.9	19.0	18.9	18.7	18.7	18.8	20.5	22.5	37.4
165	32.0	27.8	26.1	26.0	29.7	33.6	35.4	39.4	39.2	19.8	19.8	19.6	19.6	19.8	22.0	24.5	36.5
180	31.1	28.0	26.2	26.1	30.8	34.0	35.8	39.5	39.2	21.2	21.2	21.0	21.0	21.2	23.4	26.1	35.7
195	30.8	28.9	27.1	27.0	32.8	35.4	36.2	39.5	39.4	22.6	22.5	22.3	22.3	22.5	25.1	27.5	34.1
210	31.1	31.0	29.5	29.3	33.8	36.0	37.0	39.4	39.5	23.6	23.7	23.5	23.5	23.7	26.5	28.3	32.9
225	32.0	32.9	31.8	31.7	35.1	36.9	37.4	39.4	39.4	25.1	25.1	24.9	24.9	25.3	27.5	28.8	31.1
240	33.5	34.4	33.4	33.2	36.2	37.1	37.8	39.5	39.3	26.0	25.9	25.7	25.7	25.8	28.0	28.8	30.1
255	35.0	35.5	34.5	34.4	36.7	37.4	38.0	39.5	39.2	26.4	26.4	26.1	26.2	26.4	28.4	28.8	30.0
270	36.1	36.0	35.3	35.2	37.0	37.6	38.2	39.4	39.1	27.0	26.9	26.7	26.6	26.8	28.4	28.8	31.1
285	37.1	36.7	35.6	35.5	37.2	38.0	38.5	39.4	39.1	27.1	26.9	26.7	26.7	26.8	28.4	28.8	32.6
300	38.0	36.9	35.8	35.7	37.4	38.3	38.8	39.3	39.0	27.1	26.9	26.7	26.7	26.8	28.4	28.8	33.9
315	38.5	36.9	35.9	35.8	37.6	38.7	39.1	39.1	38.9	27.1	26.9	26.7	26.7	26.8	28.4	28.8	35.3
330	38.8	37.1	36.0	35.9	37.7	38.9	39.5	39.1	38.8	27.1	26.9	26.7	26.7	26.8	28.4	28.8	36.4
345	39.0	37.1	36.1	36.0	37.8	38.8	39.5	39.1	38.7	27.1	26.9	26.7	26.7	26.8	28.3	28.4	37.3
Max	**39.0**	**37.1**	**36.1**	**36.0**	**37.8**	**38.9**	**39.5**	**39.5**	**39.5**	**27.1**	**26.9**	**26.7**	**26.7**	**26.8**	**28.4**	**28.8**	**39.0**

Table 6 – Noise Predictions for Oweninny (Phase 1&2 – V90-3) plus Corvoderry (dB L_{A90})

Angle	H11	H13	H14	H15	H16	H17	H18	H19	H20	H36	H37	H38	H39	H40	H41	H42	H6
0	39.1	37.2	36.2	36.1	37.9	38.8	39.5	38.9	38.7	33.9	33.2	32.7	32.6	32.1	30.4	28.2	37.9
15	39.1	37.3	36.2	36.1	37.7	38.3	39.2	39.0	38.5	33.5	32.7	32.2	32.1	31.2	29.4	26.9	38.5
30	39.1	37.1	36.1	36.0	37.1	37.9	38.7	38.8	38.6	33.3	31.7	31.4	31.2	30.6	28.2	25.5	38.7
45	39.1	36.7	35.6	35.5	36.4	37.2	38.2	38.6	38.4	31.5	30.6	30.3	30.1	28.6	26.5	23.3	39.0
60	38.9	36.2	34.8	34.7	35.5	36.6	37.7	38.6	38.1	30.7	28.2	28.2	27.7	26.9	25.1	21.9	39.0
75	38.7	34.9	33.8	33.7	34.5	36.1	37.4	38.3	38.2	27.3	26.3	26.2	25.9	25.1	23.3	21.2	39.0
90	38.0	33.9	32.7	32.6	33.6	35.8	37.2	38.2	38.2	25.3	24.4	24.2	24.0	23.4	22.4	21.1	39.0
105	37.3	32.5	31.2	31.1	32.8	35.3	37.1	38.4	38.3	23.8	23.1	22.9	22.7	22.4	22.3	21.7	38.8
120	36.1	31.1	29.9	29.8	32.1	34.9	36.5	38.7	38.6	22.9	22.4	22.2	22.1	21.9	22.9	23.1	38.5
135	34.7	30.3	29.2	29.1	31.5	34.3	36.3	38.9	38.8	22.7	22.3	22.1	22.0	22.1	24.4	24.7	38.0
150	33.6	29.3	28.0	27.9	30.7	33.7	35.7	39.1	39.0	23.0	22.9	22.5	22.5	22.9	26.8	26.1	37.5
165	32.1	28.5	27.1	27.0	30.4	34.0	35.7	39.5	39.4	24.0	24.0	23.6	23.7	24.3	27.9	27.6	36.5
180	31.3	28.5	27.0	26.9	31.2	34.2	36.0	39.6	39.3	25.7	26.0	25.4	25.6	27.0	29.6	28.8	35.7
195	30.9	29.2	27.5	27.4	33.0	35.5	36.3	39.5	39.5	28.6	28.6	28.2	28.2	29.4	30.6	29.6	34.2
210	31.2	31.1	29.6	29.5	33.9	36.1	37.1	39.5	39.6	30.1	30.7	30.1	30.1	30.4	31.2	30.1	33.0
225	32.0	32.9	31.9	31.8	35.2	36.9	37.4	39.5	39.4	32.3	31.8	31.4	31.2	31.8	31.7	30.5	31.1
240	33.5	34.4	33.4	33.3	36.2	37.2	37.8	39.5	39.4	32.7	32.8	32.3	32.2	32.1	31.9	30.5	30.1
255	35.0	35.6	34.6	34.4	36.8	37.5	38.0	39.5	39.2	33.7	33.0	32.6	32.5	32.3	32.1	30.5	30.0
270	36.1	36.0	35.3	35.2	37.0	37.7	38.2	39.5	39.1	33.9	33.2	32.8	32.6	32.4	32.1	30.5	31.1
285	37.1	36.8	35.7	35.6	37.2	38.0	38.6	39.4	39.1	33.9	33.2	32.8	32.7	32.4	32.1	30.5	32.6
300	38.1	36.9	35.8	35.7	37.4	38.3	38.9	39.4	39.0	33.9	33.2	32.8	32.7	32.4	32.1	30.4	33.9
315	38.5	37.0	35.9	35.8	37.6	38.7	39.2	39.1	38.9	33.9	33.2	32.8	32.7	32.4	32.1	30.2	35.3
330	38.9	37.1	36.1	36.0	37.8	38.9	39.5	39.1	38.8	33.9	33.2	32.8	32.7	32.4	31.6	29.9	36.4
345	39.0	37.2	36.2	36.1	37.9	38.9	39.5	39.2	38.7	33.9	33.2	32.8	32.7	32.4	31.4	29.3	37.3
Max	**39.1**	**37.3**	**36.2**	**36.1**	**37.9**	**38.9**	**39.5**	**39.6**	**39.6**	**33.9**	**33.2**	**32.8**	**32.7**	**32.4**	**32.1**	**30.5**	**39.0**

Figure 1 – Noise Contours (Simultaneous Downwind) for Phase 1&2 Oweninny Layout (V112-3) (dB L_{A90})

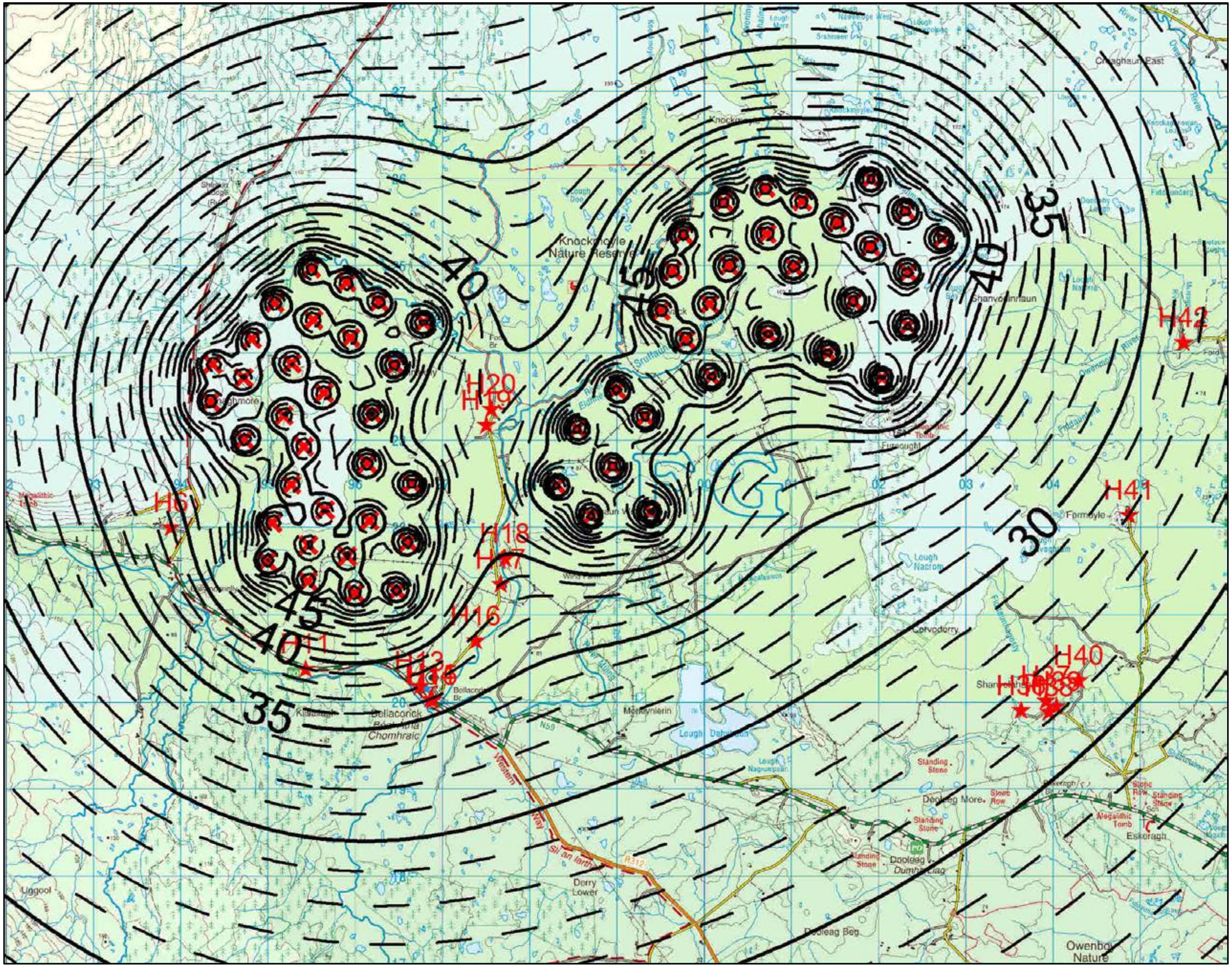


Figure 2 – Noise Contours (Simultaneous Downwind) for Oweninny Phase 1&2 Layout (V112-3) plus Corvoderry (dB L_{A90})

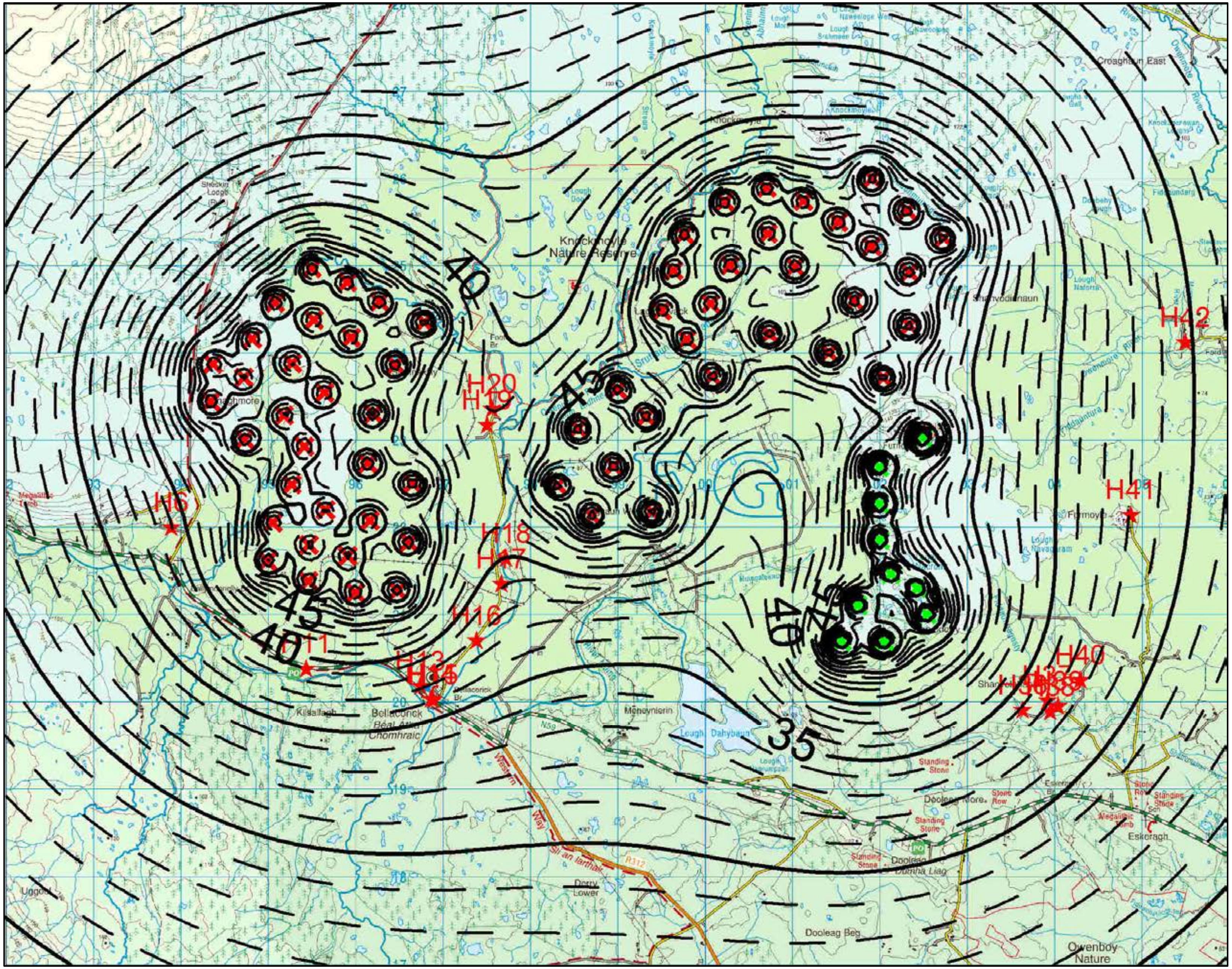


Figure 3 – Noise Contours (Simultaneous Downwind) for Oweninny Phase 1&2 Layout (SWT-3-101) (dB L_{A90})

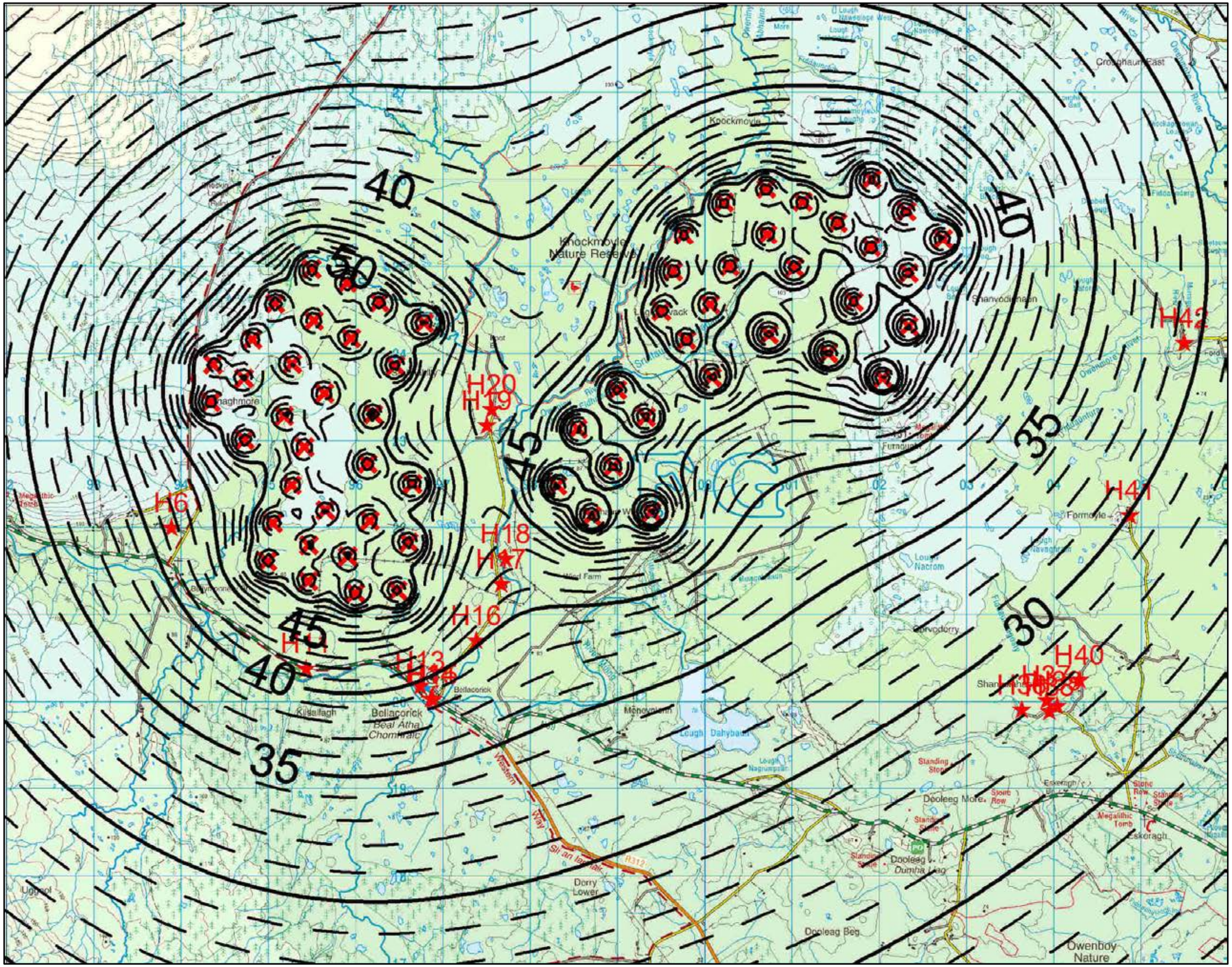


Figure 4 – Noise Contours (Simultaneous Downwind) for Oweninny Phase 1&2 Layout (SWT-3-101) plus Corvoderry (dB L_{A90})

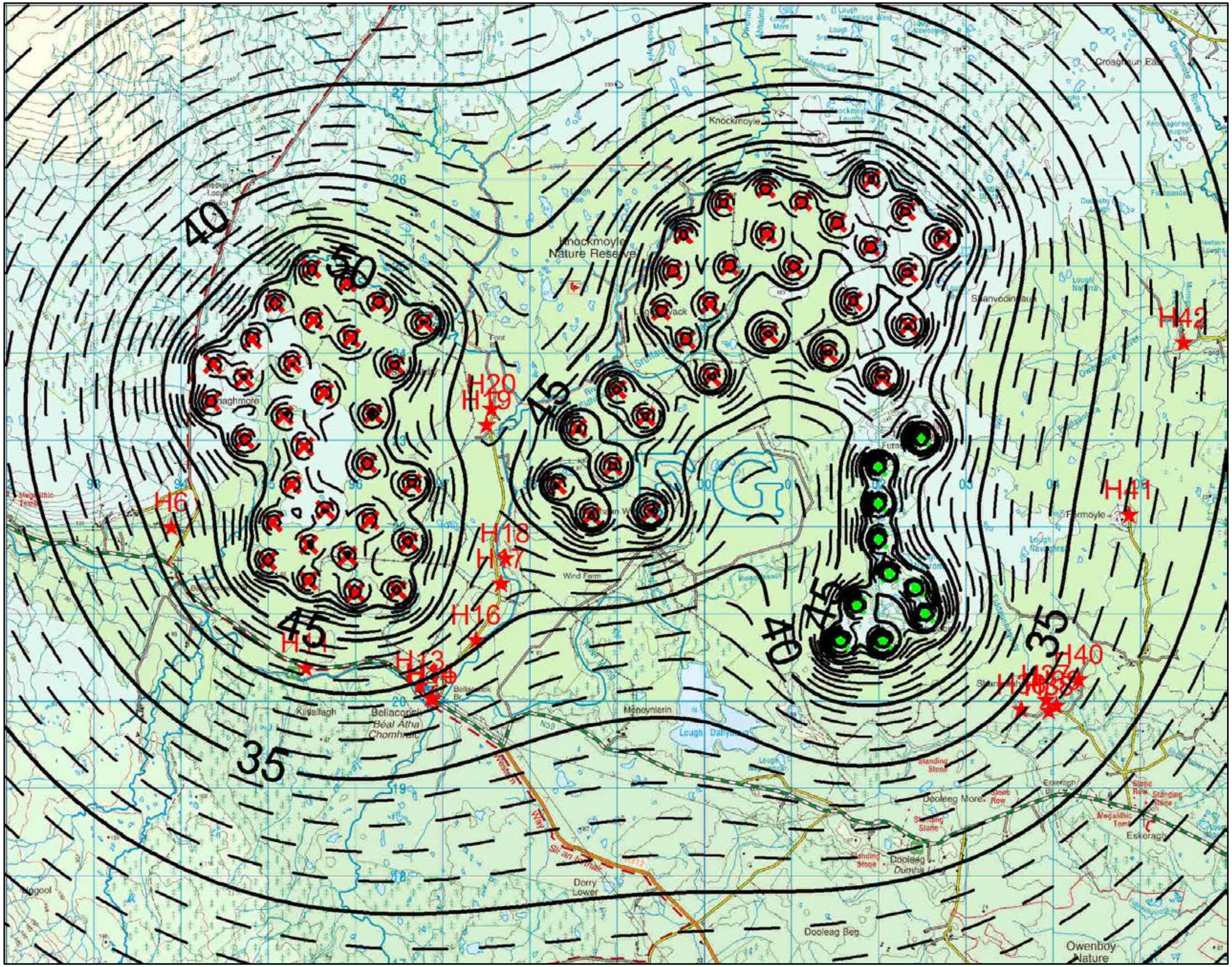


Figure 5 – Noise Contours (Simultaneous Downwind) for Oweninny Phase 1&2 Layout (V90-3) (dB L_{A90})

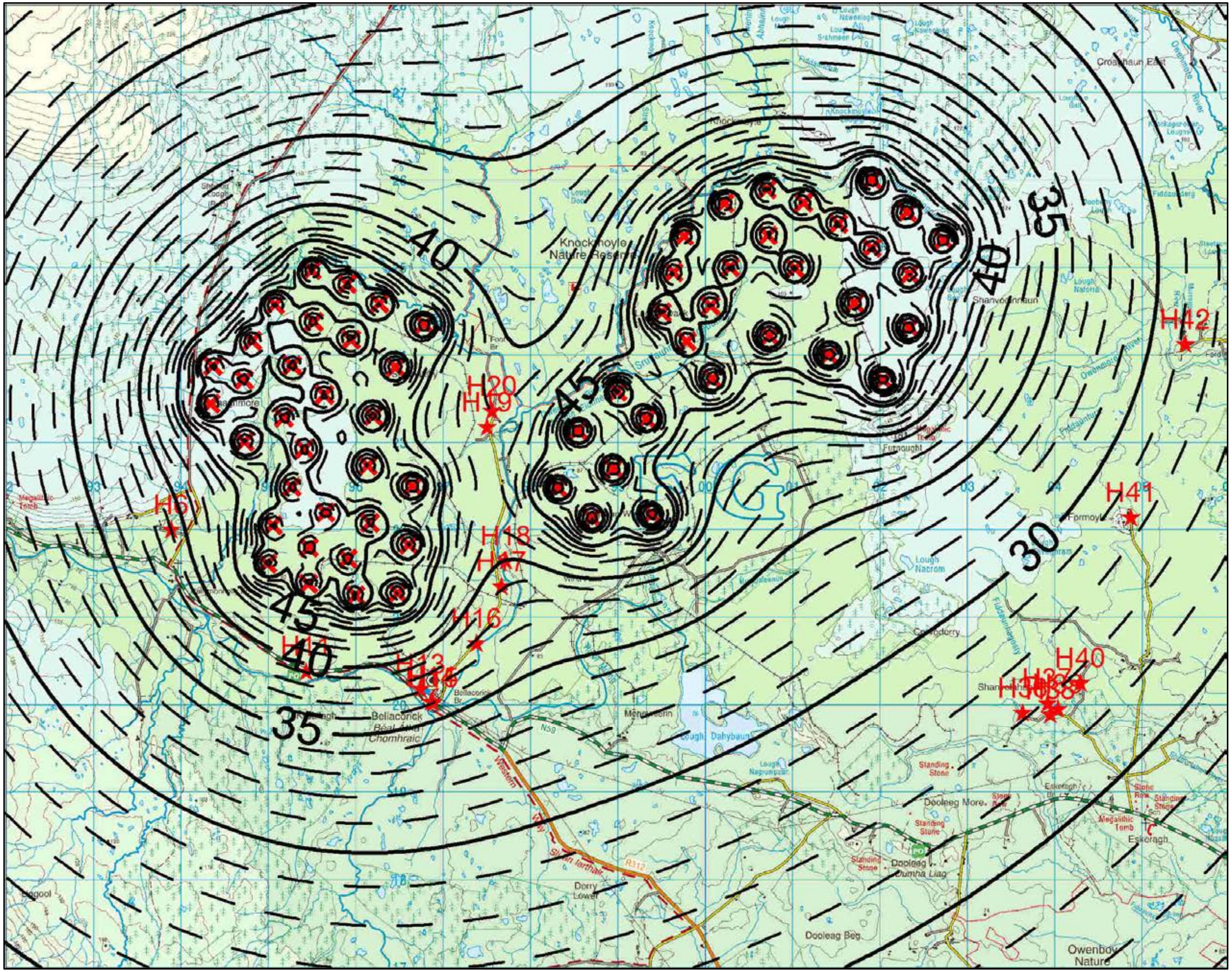
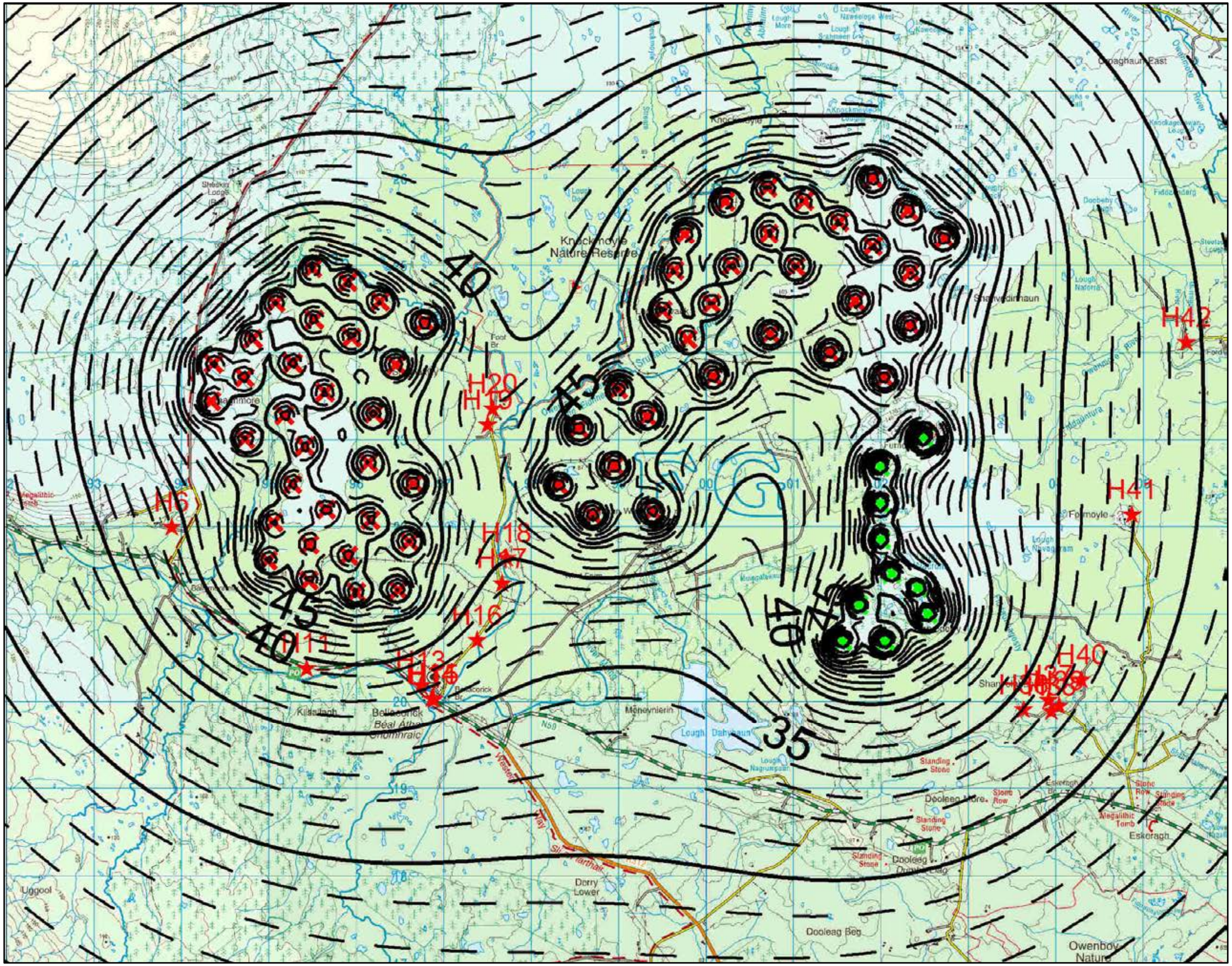


Figure 6 – Noise Contours (Simultaneous Downwind) for Oweninny Phase 1&2 Layout (V90-3) plus Corvoderry (dB L_{A90})



Appendix A

Noise Prediction Methodology

Appendix A – Noise Prediction Methodology

A.1. The ISO 9613-2 propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level =

$Lw + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

These factors are discussed in detail below. The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

L_W - Source Sound Power Level

A.2. The sound power level of a noise source is normally expressed in dB re:1pW. Noise predictions are based on sound power levels detailed in the main body of the report.

A.3. The octave band noise spectra used for the predictions have been taken from the results of a measurement on a sample turbine with the results shown in the main body of the report.

D – Directivity Factor

A.4. The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a down wind direction, corresponding to the worst case propagation conditions considered here and needs no further adjustment.

A_{geo} – Geometrical Divergence

A.5. The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in an attenuation depending on distance according to:

$A_{geo} = 20 \times \log(d) + 11$

where d = distance from the turbine

The wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A_{atm} - Atmospheric Absorption

A.6. Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. The attenuation depends on distance according to:

$A_{atm} = d \times \alpha$

where d = distance from the turbine
α = atmospheric absorption coefficient in dB/m

Values of 'α' from ISO 9613 Part 1[1] corresponding to a temperature of 10ºC and a relative humidity of 70%, the values specified in the Institute of Acoustics, Acoustics Bulletin agreement,, which give relatively low levels of atmospheric attenuation and correspondingly worst case noise predictions, as given below.

Table 4 - Frequency dependent atmospheric absorption coefficients

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.000122	0.000411	0.00104	0.00193	0.0037	0.00966	0.0328	0.117

A_{gr} - Ground Effect

A.7. Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and

[1] ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Method of calculation of the attenuation of sound by atmospheric absorption, International Organization for Standardization, 1992

receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete & any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The Institute of Acoustics, Acoustics Bulletin agreement states that use of G = 0.5 and a receptor height of 4m will generally result in realistic estimates of noise emission levels at receptor locations downwind of wind turbines where predictions are based on manufacturers warranted noise data and it is this approach which has been followed here. It should be noted that under worst case downwind noise propagation conditions noise levels may be up to 2dB higher.

A_{bar} - Barrier Attenuation

A.8. The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under down wind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU[2] concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site. It should be noted that no barrier attenuation has been used in any of the noise predictions carried out here since there is no significant shielding at this site.

A_{misc} – Miscellaneous Other Effects

A.9. ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

[2] ETSU W/13/00385/REP, A Critical Appraisal of Wind Farm Noise Propagation, DTI 2000

Wind Direction Effects

A.10. A supplementary term has been added to the ISO9613-2 methodology to allow for the effects of wind direction based on methodology taken from Wyle Research Report WR 88-19[3] . For any given wind direction, each nearby property is classified as being either downwind, crosswind, or upwind of each of the turbines. If the house is downwind (+/-75°) of the turbine no correction is required to the predicted turbine noise level. If it is crosswind (+/-15°) of the turbine a 2dB reduction is made to the predicted turbine noise level based on observations of reduced noise output under these conditions. If the property is upwind (+/-75°) of the turbine a reduction is made to the predicted turbine noise level due to wind shadow effects, which increase linearly from zero, at distances up to 5.25 x hub height, to 20 log (f) – 30, at a distance of 15.75 x hub height. Hayes McKenzie have modified the original Wyle methodology to include a term to scale the upwind attenuation according to the cosine of the difference between the wind direction angle and the angle corresponding to completely upwind propagation. Calculations have been carried out for wind directions in increments of 15° around the site. Once these corrections have been made, the overall noise level from all the turbines is calculated at each property for each wind direction.

[3] Wyle Research Report WR 88-19, Measurement and Evaluation of Environmental Noise from Wind Energy Conversion Systems in Alameda and Riverside Counties, October 1988

8 SHADOW FLICKER

8.1 INTRODUCTION

A shadow flicker assessment has been undertaken for the Phase 1 and Phase 2 only part of the development for Oweninny. The assessment also takes account of the planning refusal for the Cluddaun wind farm located to the north of the Oweninny site and turbines associated with that development have been excluded from the cumulative assessment process. The Corvoderry wind farm, which is located within the Oweninny site, is included in the shadow flicker cumulative assessment.

Wind turbines, as with trees or any other tall structure, can cast long shadows when the sun is shining and is low in the sky. A phenomenon, known as shadow flicker, which could be considered a nuisance even though the effect would be very short-lived, could occur under certain conditions. This is where the blades of a wind turbine cast a shadow over a window in a nearby house. The rotation of the blades might cause a shadow to be cast about once per second or two in the room whose window is affected.

The shadow flicker effect lasts for just a short period and depends for its occurrence on the following factors:

- The sun not being obscured and being at a low angle in the sky.
- The turbine(s) being directly between the sun and the affected property.
- There being enough wind for the turbine(s) to be in operation.

All three of the above factors must coincide for shadow flicker to occur. It is part of the nature of long shadows that they pass any particular point relatively quickly and, due to the movement of the sun across the sky, the effect, if present, lasts for only a short period of time. It is generally only observed in the period after dawn and before sunset as the sun is rising and setting. Potential occurrence of shadow flicker requires that the disc outlined by the rotating turbine blades be located in the path between the sun and a possible receptor. Each latitude on the globe has its own shadow signature. In the northern hemisphere the sun stays in the southern part of the sky and there is no potential shadow flicker occurrence at receptors located due south of a wind turbine because the arc of the sun's movement is such that sunshine from the north does not occur.

Concerns about shadow flicker have largely arisen in continental countries where wind turbines are located much closer to dwellings than is the practice in Ireland and where in summer months there is a high frequency of sunshine at dawn and before sunset.

8.2 RECEIVING ENVIRONMENT

The Department of Environment, Heritage and local Government (DoEHLG) Wind Farm Planning Guidelines (Section 5.12) note as follows:

"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low".

In order to ensure consistency, however, the same properties assessed as part of the EIS were assessed again, despite the fact that many are a far greater distance than ten rotor diameters from any turbine. The locations of all receptors included in the assessment are presented in Figure 8-1 and 8.2. It should be noted that the same house numbers used for the noise calculations were used for the shadow flicker calculations for ease of reference.

8.3 IMPACT OF THE DEVELOPMENT

Shadow flicker analysis was carried out for all 46 properties shown in Figures 8.1 & 8.2 using the computer software WindPRO (version 3.0). The software calculates times throughout the year when the disc outlined by a rotating turbine blade viewed from the window of a house is in line with the sun and, therefore, when a potential for shadow flicker occurrence exists. A zone of visual influence calculation, using a digital terrain model, is performed before the flicker calculation to ensure that all visible wind turbines contribute to calculated flicker values.

Shadow flicker calculations were conducted based on a notional window measuring 2 m wide x 1 m high and facing directly, in turn (“Greenhouse” effect), toward any turbine within a distance of ten rotor diameters. The bottom line height of each window was assumed to be 4 m above ground level (approximately equivalent to an upstairs window in a two-storey house). This parameter adds an additional level of conservatism since many of the houses are, in fact, only single storey houses and upstairs windows are more likely to be exposed to a view of the turbines and less likely to be screened by vegetation.

Further to the above the following was assumed in the analysis:

- All residences have windows that are not obscured by curtains or blinds.
- There is no intervening vegetation or objects between turbines and receptors.

8.3.1 Predicted Impact

The extent of shadow casting is determined principally by (a) the turbine’s hub height and (b) the size of the turbine’s rotor blade diameter. Two cases have been considered, both of which have a maximum tip height of 176 m, as follows:

a) The largest hub height proposed (i.e. 120 m), which would have a maximum rotor diameter of 112 m (and a maximum tip height of 176 m).
b) The largest size of rotor blade diameter proposed (i.e. 120 m), which would have a maximum hub height of 116 m (and a maximum tip height of 176 m).

The shadow flicker assessment results based on a rotor diameter of 112 m (and hub height of 120 m) are presented for all properties potentially affected by shadow flicker in Table 8.1. The shadow flicker assessment results based on a rotor diameter of 120 m (and hub height of 116 m) are presented for all properties potentially affected by shadow flicker in

Table 8.2. Copies of the results sheets from WindPRO showing the results for all 46 properties, for each turbine option, are included in Appendices 8A and 8B.

It should be noted that for a rotor diameter of 112 m, the majority of the 46 properties assessed are outside the ten rotor diameter distance limit (1,120 m) recommended in the Wind Farm Planning Guidelines and, therefore, would not be expected to be impacted by shadow flicker. Figure 8.1 shows the extent of the 1,120 m distance limit for this turbine option by way of a buffer line. Similarly for the rotor diameter of 120 m, the majority of the 46 properties assessed are outside the ten rotor diameter distance limit (1,200 m) and therefore, would not be expected to be impacted by shadow flicker. Figure 8.2 shows the extent of the 1,200 m distance limit for this turbine option by way of a buffer line.

The results presented in Tables 8.1 and 8.2 show the Worst Case Shadow Hours per Year, the Worst Case Shadow Hours per Day and the Expected Shadow Hours per Year. The worst case results per year are a theoretical maximum that will never actually occur since the sun will not be shining all year round from dawn to dusk, the wind will not always be blowing and the windows in the properties do not directly face each and every turbine. The expected results are a far more accurate representation of what will actually occur at the Oweninny site since it takes account of historical sunshine data and wind speed and directional data recorded on the site.

In Tables 8.1 and 8.2, the Expected Shadow Flicker Hours per Year have been automatically calculated by applying three factors to the theoretical, worst case, values, namely the rotor plane factor, the sunshine hours factor and the local wind regime factor.

- Rotor Plane: It would be highly unusual for the wind and, by extension, the plane of the turbine rotor, to track the sun (i.e. to remain continually facing the sun), thereby creating the conditions for a potentially greater level of shadow flicker. It is far more likely that, for the vast majority of the time, the plane of the rotor will not be facing the sun and so there will be a significant decrease in the potential for shadow flicker during these periods. In addition, there will be occasions when the rotor plane is parallel to the sun direction and no flicker will occur. The likely orientation of the rotor for each turbine has been factored into the shadow flicker calculations using wind measurements taken on site. (An alternative assumption of a random rotor position leads to a reduction of approximately 63% of the theoretical results.)
- Sunshine Hours: The sun will not be shining during all daylight hours. The long-term mean value is typically less than 30% of daylight hours, but evidently this varies from month to month. Records from the nearest meteorological station, for which such records are available (Belmullet), indicate average daily sunshine hours ranging from 0.89 hours in December to 5:79 hours in May.
- Local Wind Regime: Long-term wind speed records from a meteorological mast within the site boundary were applied to take account of the wind regime on the site, including factors such as the prevailing wind direction and periods when wind speed is below the turbine cut-in wind speed.

Further to the above, turbines will be unavailable for operation at certain times due, for instance, to routine and emergency maintenance, substation outages, etc. These factors also reduce potential shadow occurrence, but they are not reflected in the results.

WindPRO does not calculate the Expected Shadow Flicker Hours per Day because, while you can reduce the annual sunshine hours based on average data collected at meteorological stations, you could, in theory, get the majority of these sunshine hours on the same days which have the worst potential for shadow flicker impacts on a particular property. Hence, Table 8.1 and 8.2 only show the Worst Case results and not the Expected results for the shadow hours per day. It should be noted, however, that the Worst Case Shadow Hours per Day presented in Table 8.1 and 8.2 could only occur on a very small number of days each year (see 'Assessment' Section below for details).

Table 8.1: Potential Shadow Flicker Occurrence for turbines with Rotor Diameters of 112 m and Hub Heights of 120 m

House	Worst Case Shadow Hours per year	Worst Case Shadow Hours per Day	Expected Shadow Hours per year
H03	8:45	0:19	1:25
H07	10:21	0:24	2:12
H08	09:57	0:23	2:04
H09	12:39	0:26	2:36
H16	22:47	0:27	4:02
H18	36:35	0:26	7:05
H19	37:12	0:52	5:29
H20	10:45	0:26	1:49

Table 8.2: Potential Shadow Flicker Occurrence for Turbines with Rotor Diameters of 120 m and Hub Heights of 116 m

House	Worst Case Shadow Hours per year	Worst Case Shadow Hours per Day	Expected Shadow Hours per year
H01	15:22	0:25	2:29
H02	14:12	0:24	2:17
H03	10:12	0:20	1:37
H06	18:55	0:24	3:20
H07	11:55	0:27	2:27
H08	11:27	0:26	2:18
H09	14:24	0:28	2:52
H16	26:16	0:29	4:33
H17	25:48	0:26	4:55
H18	40:48	0:27	7:41
H19	43:01	0:54	6:05
H20	35:06	0:28	4:14

8.3.2 Assessment

The DoEHLG Wind Farm Planning Guidelines (Section 5.12) recommend that

“shadow flicker at neighbouring offices and dwellings within 500 m should not exceed 30 hours per year or 30 minutes per day “.

At Oweninny, there are no shadow sensitive locations (SSLs) within 500 m of any of the proposed turbines. The closest house (H20) is approximately 1,008 m from the nearest turbine (T45).

Option A: 112 m rotor diameters (56m blades) and hub heights of 120 m

For a rotor diameter of 112 m the results in Table 8.1 indicate that eight properties have the potential to be affected by shadow flicker, in accordance with the Wind Farm Planning Guidelines. However, the expected shadow flicker hours per year for all potentially affected houses, within ten rotor diameters of any turbine, are significantly below the recommended guideline limit of 30 hours annually.

The results in Table 8.1 show that the Worst Case Shadow Flicker Hours per Day exceed the recommended daily limit of 30 minutes at a single property (H19), although it must be noted that this limit of 30 minutes actually applies to properties within 500 m of a turbine; H19 is 1,044 m away from the closest turbine (T45). Detailed results for H19 for this turbine option are presented in Appendix 8E which show that the theoretical maximum of 52 minutes shadow flicker per day would only be possible on a single day of the year. In all, the limit of 30 minutes could potentially be exceeded on 33 days in any given year, although these days are all between 27th January - 11th February and 30th October – 15th November, times of the year at which the sun is statistically less likely to be shining.

Option B: 120 m rotor diameters (60m blades) and hub heights of 116 m

For a rotor diameter of 120 m the results in Table 8.2 indicate that 12 properties have the potential to be affected by shadow flicker, in accordance with the Wind Farm Planning Guidelines. However, the expected shadow flicker hours per year for all potentially affected houses, within ten rotor diameters of any turbine, are again significantly below the recommended guideline limit of 30 hours annually.

The results in Table 8.2 show that the Worst Case Shadow Flicker Hours per Day exceed the recommended daily limit of 30 minutes at a single property (H19), although, again, it must be noted that this limit of 30 minutes actually applies to properties within 500 m of a turbine. As stated, H19 is 1,044 m away from the closest turbine (T45). Detailed results for H19 for this turbine option are presented in Appendix 8F which show that the theoretical maximum of 54 minutes shadow flicker per day would only be possible on seven days of the year. In all, the limit of 30 minutes could potentially be exceeded on 36 days in any given year, although these days are all between 26th January - 12th February and 30th October – 16th November, times of the year at which the sun is statistically less likely to be shining.

The following factors, of which no account has been taken in the analysis, also arise:

- The rooms whose windows are potentially affected may not be in use at all times that shadow flicker could occur.

- Occupants in rooms that are potentially affected may not be awake at all times that shadow flicker could occur.
- The impact of internal light levels and the presence of blinds or curtains on the potentially affected windows may have a mitigating effect.
- The presence of natural features such as trees and hedges, which would reduce or eliminate shadow flicker occurrence, has not been taken into account.

Shadow flicker analysis is based on the potential for even faint, partial shadows to be cast by the blades of a turbine. However, because of the distance of all houses from the turbines, at most only some of the sun's light can ever be blocked out by the blades. A sharp shadow will never be cast on a residence by a blade.

The combined effect of many factors pertaining to the geometry of shadows and the dimensions and geometry of wind turbine blades is to greatly reduce the effect and impact of shadow flicker. It will actually be imperceptible for a significant amount of the time that blades are passing between the clear sun and a window of a residence.

The flickering frequency of any shadow occurring depends on the rate of rotation and the number of blades. It has been recommended that the critical flickering frequency should not be above 2.5 Hz, so as to avoid any possible potential to impact upon sufferers of a condition known as photosensitive epilepsy. (The UK National Society for Epilepsy identifies this threshold criterion as being 3 Hz). For a three-bladed wind turbine this is equivalent to a rotational speed of 50 revolutions per minute (rpm). The turbines are likely to operate at a maximum of circa 19 rpm. Therefore, the health impact of flicker frequency is not considered further in this assessment.

8.4 CUMULATIVE IMPACTS

Owing to the nature of shadow flicker occurrence, only additional wind farm projects have been included in the cumulative impact assessment. There are plans to construct a wind farm at Corvoderry, in close proximity to the proposed Oweninny Phase 1 and Phase 2 development and also a single win turbine at Dooleeg. Therefore, an assessment of the potential cumulative shadow flicker impacts from both wind farms was undertaken.

The following wind farms are located within the study area and have been included in the cumulative impact assessment:

- Dooleeg Wind Farm (1 permitted turbine) - adjacent to south-western site boundary, separated by the N59.
- Corvoderry Wind Farm (10 turbines) - located to the south-east of the proposed Phase 2 Oweninny turbines.

It should be noted that the proposed Tawnanasool Wind Farm (8 Turbines) is located over 10 km from the closest shadow receptor and was not included in the cumulative analysis.

Given the large distances between the Corvoderry turbines and all shadow receptors, these turbines do not contribute in any way to a cumulative impact.

The inclusion of the Dooleeg turbine in the shadow flicker analysis shows a potential impact on a number of shadow receptors within the cluster of houses numbered H21 to H33. It should be noted however that there is no potential for shadow flicker impacts at these houses resulting from the Oweninny turbines since the sun's path takes it south of these houses with no intervening Oweninny wind turbines. Therefore, any shadow flicker experienced by these houses will be exclusively as a result of the single Dooleeg turbine.

It can therefore be concluded that cumulative impacts with respect to shadow flicker will not be an issue at this site.

Potential future development of Oweninny Phase 3

Should Phase 3 of Oweninny be developed in accordance with the layout indicated in the original EIS then there would be a cumulative increase in the potential for shadow flicker to occur during the operational phase of all three phases working simultaneously.

The predicted shadow flicker impact for all three phases of the Oweninny development operating together would be as described in the original EIS Chapter 8, submitted to An Bord Pleanála in 2013. The cumulative impacts would not lead to shadow flicker predicted impact levels in excess of the existing Department of the Environment Guidelines of 2006.

8.5 MITIGATION

The principal means of reducing the potential for shadow flicker is by turbine siting and maintaining a suitable turbine exclusion zone around sensitive receptors. In the case of Oweninny the nearest dwelling to a wind turbine is located at a distance of 1,008 meters, limiting the potential for any shadow flicker to occur.

It is evident that, without operational constraints, the expected occurrence of shadow flicker at Oweninny will be low and will be well below the accepted limits of tolerance. However, out of an abundance of caution, a shadow detection and control system will be installed on turbines within ten rotor diameters of all existing dwellings, which have the potential to be impacted by shadow flicker, in order to prevent shadow flicker exceeding guidance levels at any property.

The technology is based on software that computes four risk factors, namely

- Angle and position of the sun relative to the property.
- Distance of the wind turbine to any potentially affected properties.
- Size of the turbine rotor.
- Height of the turbine hub from the ground.

Light levels are assessed using two light sensors placed on the east and west-facing aspects of a wind turbine's support tower. A shadow control unit, which is integrated into the turbine control system, measures the difference in intensity between the two sensor readings and calculates how pronounced a shadow is at any given moment. Once the risk of shadow flicker has been calculated, the control unit determines whether the turbine should be temporarily shut down. Shadow control units are uniquely configured for each turbine and are programmed with the locations of neighbouring properties and timetables indicating when shadow flicker may potentially occur.

In addition to the installation of a shadow detection and control system, the following additional mitigation measures will be put in place in light of recommendations made by the Health Service Executive (HSE) in response to the planning application:

- The applicant will contact the owner of property H19 (as shown in Figures 8.1 & 8.2) with a view to establishing the use of the rooms which have the potential to be impacted by shadow flicker. In any event, as stated above, a shadow detection and control system will be installed on the turbines which have the potential to cause shadow flicker at this property to ensure that shadow flicker guideline levels are not exceeded.
- It is proposed to implement the following procedure for recording, reporting and handling any complaints relating to shadow flicker during the operation of the Oweninny Wind Farm.
    - The developer, Oweninny Power Limited (OPL), will implement a procedure for the recording, investigating and reporting of public complaints for which the wind farm site operations manager will be responsible. This procedure will be subject to review by the OPL management. It will be a requirement that all complaints are investigated on receipt of complaint and that such complaints are immediately notified to the OPL management.
    - In the case of a shadow flicker complaint, an appropriately qualified person will investigate the potential for shadow flicker to have occurred by way of computer modelling and an analysis of meteorological data recorded by Met Eireann.
    - As set out above, a shadow detection and control system will be installed on all turbines within ten rotor diameters of any existing dwelling which has the potential to experience shadow flicker and will be implemented as required during the operational phase. If it is determined that the annual guidance limits could have been reached at a residence at any point during the lifetime of the wind farm, the developer will take immediate steps to shut down relevant turbines at further times when shadow flicker could potentially occur in the relevant 12 month period.

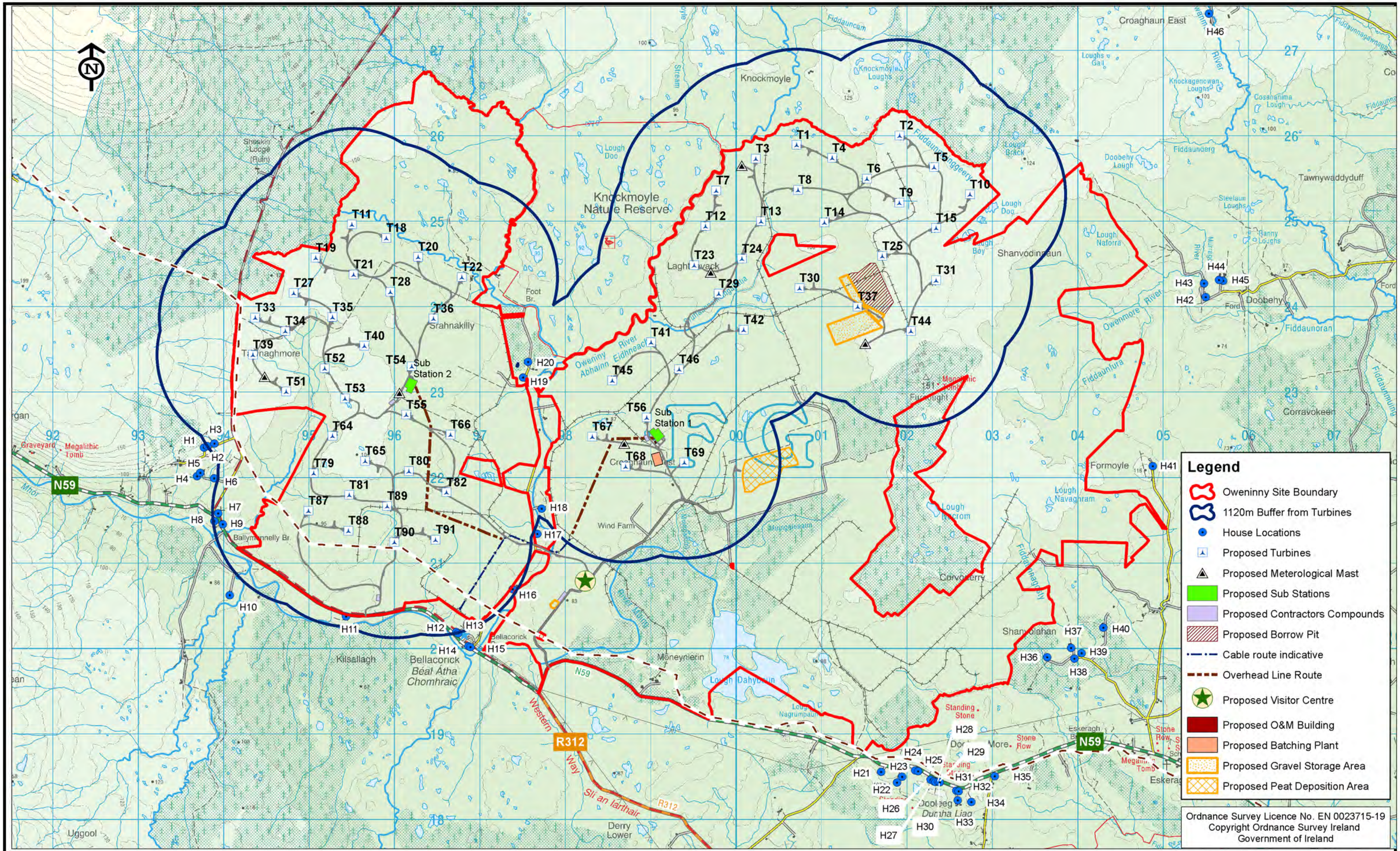
8.6 CONCLUSIONS

The Expected Shadow Flicker Hours per Year, which are the most accurate representation of what will actually occur on site, show that the annual limit of 30 hours, as recommended by the Wind Farm Planning Guidelines, is not exceeded at any of the properties.

The Worst Case Shadow Flicker Hours per Day, which are a theoretical maximum and not an accurate representation of what will occur at each property, exceed the daily limit of 30 minutes, recommended by the Wind farm Planning Guidelines, at a single property, H19, for both turbine options (112 m and 120 m rotor diameters). However, it must be noted that the 30 minute limit actually applies to properties within 500 m of the wind farm development. H19 is 1,044 m from the closest turbine, which greatly exceeds the 500 m limit but which is still within the ten rotor diameter limit of influence, also referred to in the Wind Farm Planning Guidelines. The detailed results in Appendices 8E and 8F show that daily shadow flicker at H19 could theoretically exceed 30 minutes on 33 days of the year for the 112 m rotor diameter turbine option and 36 days of the year for the 120 m rotor diameter option, although these are at times of the year when the sun is statistically far less likely to be shining. Thus, given the large distances between H19 and all turbines and the fact that the daily limit value of 30 minutes could only be exceeded on days of the year when the sun is statistically less likely to be shining, it is expected that the shadow flicker impacts experienced at this property will be minimal. (This is also excluding the fact that the windows of the residence do not face all of the proposed turbines, as assumed in the calculations, and that there may be intervening vegetation between the turbines and the property.)

Cumulative shadow flicker impact arising from Corvoderry will not occur. The shadow flicker from the Dooleeg turbine will potentially impact on a cluster of houses H21 to H33 but no cumulative impact on these locations from Oweninny Phase 1 and Phase 2 is possible.

.Overall, it is considered that significant impacts from shadow flicker will not arise as a result of the wind farm development at Oweninny. However, out of an abundance of caution, a shadow detection and control system will be installed on turbines within ten rotor diameters of all existing dwellings, which have the potential to be impacted by shadow flicker, in order to prevent shadow flicker exceeding guidance levels at any property.



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Shadow Flicker at Oweninny (Rotor diameter of 112m) - Phasing 1 & 2

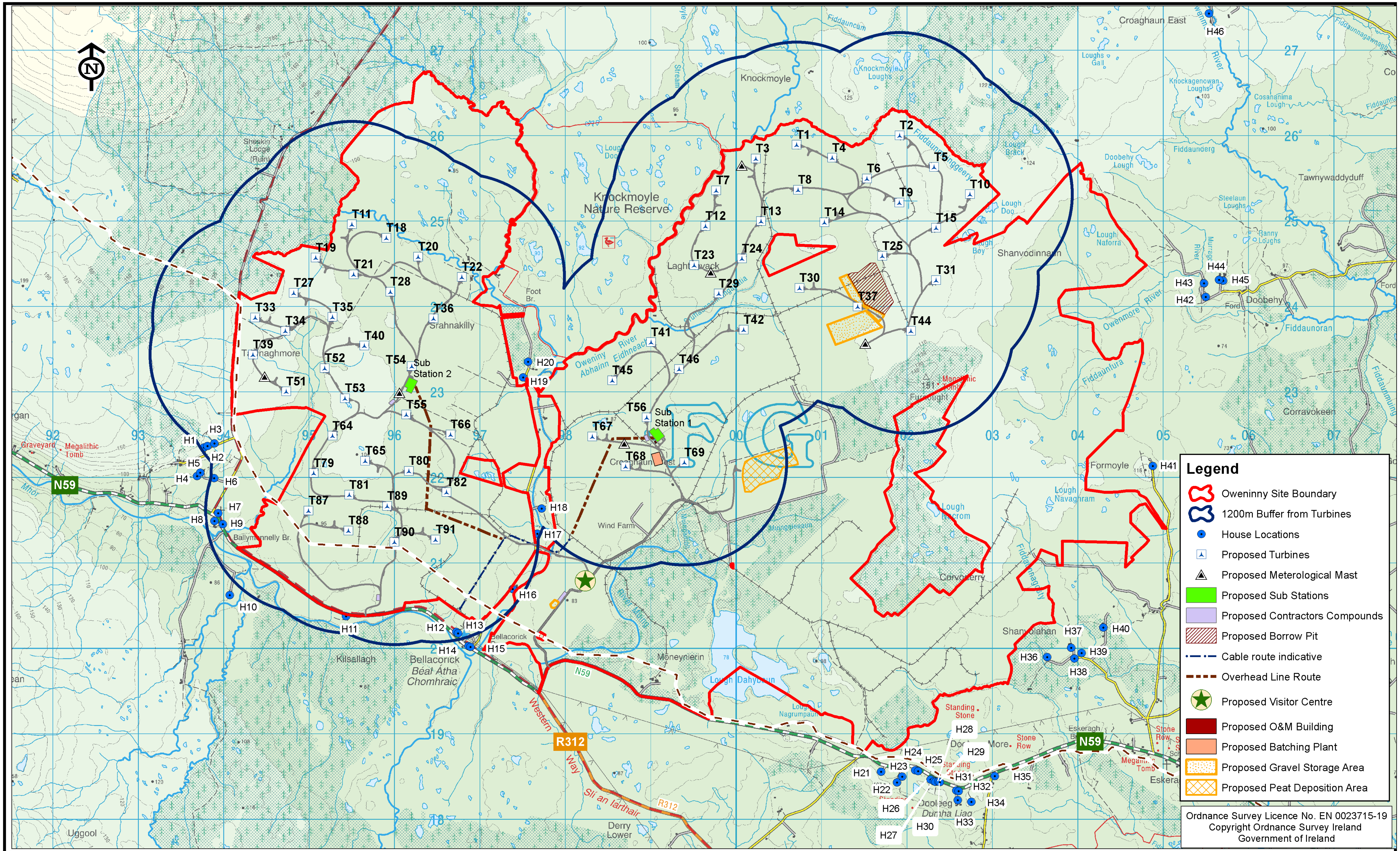
Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	23/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:40,000

MAP REFERENCE

Figure 8.1



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Shadow Flicker at Oweninny (Rotor diameter of 120m) - Phasing 1 & 2

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	23/09/2015

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00-00	1/1	A3	1:40,000

MAP REFERENCE

Figure 8.2

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Calculated:
03/09/2015 10:57/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015

Assumptions for shadow calculations

Maximum distance for influence	1,120 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational hours are calculated from WTGs in calculation and wind distribution:
Mast 0001 - Position Confirmed - Calibrated

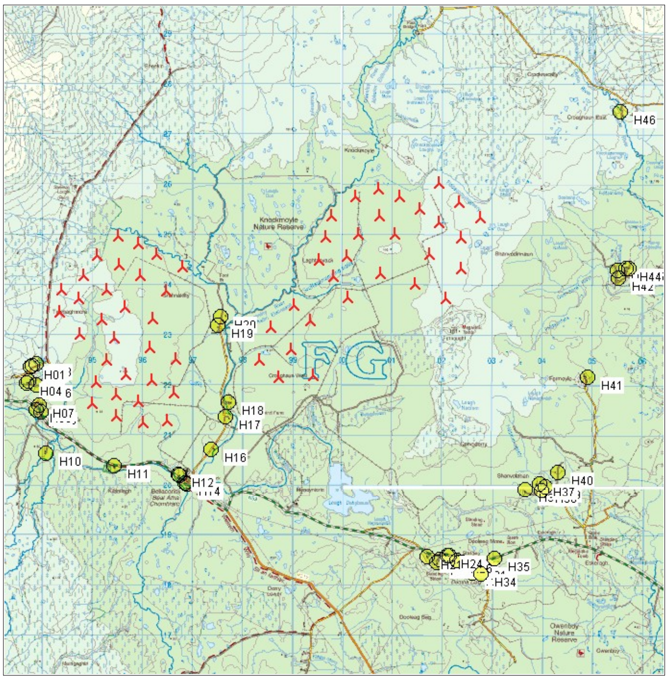
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
307	262	359	399	1,242	1,158	692	906	1,257	926	622	479	8,610

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: Oweninny Contours.wpo (0)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
ITM



Scale 1:150,000
New WTG   Shadow receptor

WTGs

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
T01	500,679	825,900	95.1	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T02	501,885	826,011	104.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T03	500,201	825,741	91.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T04	501,097	825,748	99.3	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T05	502,287	825,640	110.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T06	501,500	825,507	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T07	499,736	825,368	90.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T08	500,696	825,374	96.4	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T09	501,882	825,225	105.3	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T10	502,707	825,322	110.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T11	495,474	824,971	94.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T12	499,611	824,951	91.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T13	500,264	825,007	95.1	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T14	501,005	824,996	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T15	502,312	824,929	109.4	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T18	495,876	824,813	91.3	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T19	495,051	824,580	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T20	496,248	824,591	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T21	495,495	824,385	97.6	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T22	496,761	824,355	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T23	499,479	824,493	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T24	500,039	824,570	90.9	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T25	501,682	824,600	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T27	494,793	824,169	106.8	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T28	495,923	824,181	97.4	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T29	499,767	824,160	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T30	500,712	824,225	95.7	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T31	502,311	824,317	107.8	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T33	494,342	823,881	113.7	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T34	494,695	823,724	103.9	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T35	495,248	823,885	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T36	496,429	823,868	93.4	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8

To be continued on next page...

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Calculated:
03/09/2015 10:57/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015

...continued from previous page

	X(East)	Y(North)	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	RPM [RPM]
T37	501,394	824,010	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T39	494,314	823,446	110.1	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T40	495,619	823,550	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T41	498,975	823,591	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T42	500,061	823,736	95.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T44	502,016	823,723	106.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T45	498,521	823,145	88.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T46	499,305	823,276	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T51	494,705	823,015	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T52	495,156	823,287	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T53	495,392	822,935	100.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T54	496,176	823,310	96.3	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T55	496,111	822,744	97.6	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T56	498,926	822,711	89.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T64	495,246	822,497	98.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T65	495,630	822,204	102.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T66	496,627	822,512	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T67	498,288	822,487	87.1	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T68	498,678	822,140	89.1	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T69	499,365	822,186	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T79	495,028	822,060	96.7	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T80	496,141	822,085	95.2	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T81	495,443	821,807	95.7	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T82	496,582	821,837	88.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T87	494,965	821,622	92.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T88	495,432	821,388	92.5	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T89	495,886	821,677	92.4	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T90	495,971	821,255	90.0	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T91	496,454	821,284	88.3	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TO...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8

Shadow receptor-Input

No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H01	493,732	822,360	114.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H02	493,774	822,379	113.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H03	493,855	822,410	111.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H04	493,652	822,027	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H05	493,688	822,065	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H06	493,852	822,002	89.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H07	493,899	821,592	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H08	493,854	821,502	74.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H09	493,954	821,464	76.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H10	494,033	820,633	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H11	495,395	820,386	73.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H12	496,686	820,203	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H13	496,708	820,186	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H14	496,827	820,038	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H15	496,852	820,028	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H16	497,346	820,707	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H17	497,633	821,353	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H18	497,684	821,648	83.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H19	497,468	823,180	81.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H20	497,526	823,363	83.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H21	501,656	818,568	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H22	501,904	818,511	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H23	501,845	818,444	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H24	502,057	818,584	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H25	502,092	818,575	90.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H26	502,236	818,479	92.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H27	502,278	818,457	92.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H28	502,295	818,452	91.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015

...continued from previous page

No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H29	502,328	818,455	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H30	502,344	818,446	90.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H31	502,536	818,347	96.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H32	502,564	818,340	96.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H33	502,555	818,238	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H34	502,716	818,216	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H35	502,989	818,517	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H36	503,600	819,910	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H37	503,884	820,018	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H38	503,919	819,891	79.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H39	504,005	819,957	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H40	504,260	820,256	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H41	504,839	822,146	100.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H42	505,456	824,123	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H43	505,438	824,281	82.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H44	505,613	824,321	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H45	505,661	824,312	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H46	505,494	827,438	118.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
H01	0:00	0	0:00	0:00
H02	0:00	0	0:00	0:00
H03	8:45	37	0:19	1:25
H04	0:00	0	0:00	0:00
H05	0:00	0	0:00	0:00
H06	0:00	0	0:00	0:00
H07	10:21	32	0:24	2:12
H08	9:57	32	0:23	2:04
H09	12:39	37	0:26	2:36
H10	0:00	0	0:00	0:00
H11	0:00	0	0:00	0:00
H12	0:00	0	0:00	0:00
H13	0:00	0	0:00	0:00
H14	0:00	0	0:00	0:00
H15	0:00	0	0:00	0:00
H16	22:47	59	0:27	4:02
H17	0:00	0	0:00	0:00
H18	36:35	114	0:26	7:05
H19	37:12	76	0:52	5:29
H20	10:45	33	0:26	1:49
H21	0:00	0	0:00	0:00
H22	0:00	0	0:00	0:00
H23	0:00	0	0:00	0:00
H24	0:00	0	0:00	0:00
H25	0:00	0	0:00	0:00
H26	0:00	0	0:00	0:00
H27	0:00	0	0:00	0:00
H28	0:00	0	0:00	0:00
H29	0:00	0	0:00	0:00
H30	0:00	0	0:00	0:00
H31	0:00	0	0:00	0:00
H32	0:00	0	0:00	0:00
H33	0:00	0	0:00	0:00
H34	0:00	0	0:00	0:00
H35	0:00	0	0:00	0:00
H36	0:00	0	0:00	0:00
H37	0:00	0	0:00	0:00
H38	0:00	0	0:00	0:00

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Calculated:
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SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015

...continued from previous page

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H39	0:00	0	0:00	0:00
H40	0:00	0	0:00	0:00
H41	0:00	0	0:00	0:00
H42	0:00	0	0:00	0:00
H43	0:00	0	0:00	0:00
H44	0:00	0	0:00	0:00
H45	0:00	0	0:00	0:00
H46	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
T01	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1453)	0:00	0:00
T02	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1454)	0:00	0:00
T03	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1455)	0:00	0:00
T04	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1456)	0:00	0:00
T05	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1457)	0:00	0:00
T06	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1458)	0:00	0:00
T07	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1459)	0:00	0:00
T08	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1460)	0:00	0:00
T09	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1461)	0:00	0:00
T10	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1462)	0:00	0:00
T11	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1483)	0:00	0:00
T12	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1463)	0:00	0:00
T13	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1464)	0:00	0:00
T14	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1465)	0:00	0:00
T15	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1466)	0:00	0:00
T18	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1484)	0:00	0:00
T19	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1485)	0:00	0:00
T20	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1486)	0:00	0:00
T21	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1487)	0:00	0:00
T22	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1488)	0:00	0:00
T23	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1467)	0:00	0:00
T24	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1468)	0:00	0:00
T25	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1469)	0:00	0:00
T27	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1489)	0:00	0:00
T28	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1490)	0:00	0:00
T29	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1470)	0:00	0:00
T30	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1471)	0:00	0:00
T31	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1472)	0:00	0:00
T33	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1491)	0:00	0:00
T34	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1492)	0:00	0:00
T35	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1493)	0:00	0:00
T36	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1494)	0:00	0:00
T37	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1473)	0:00	0:00
T39	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1495)	0:00	0:00
T40	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1496)	0:00	0:00
T41	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1474)	0:00	0:00
T42	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1475)	0:00	0:00
T44	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1476)	0:00	0:00
T45	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1477)	21:09	3:54
T46	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1478)	0:00	0:00
T51	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1497)	8:45	1:25
T52	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1498)	0:00	0:00
T53	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1499)	0:00	0:00
T54	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1500)	0:00	0:00
T55	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1501)	0:00	0:00
T56	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1479)	0:00	0:00
T64	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1502)	0:00	0:00
T65	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1503)	0:00	0:00
T66	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1504)	13:31	1:43
T67	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1480)	13:17	1:42

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
T68	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1481)	26:27	4:59
T69	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1482)	0:00	0:00
T79	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1505)	0:00	0:00
T80	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1506)	0:00	0:00
T81	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1507)	0:00	0:00
T82	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1508)	10:08	2:06
T87	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1509)	26:40	5:35
T88	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1510)	0:00	0:00
T89	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1511)	0:00	0:00
T90	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1512)	0:00	0:00
T91	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1513)	22:47	4:02

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SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015

Assumptions for shadow calculations

Maximum distance for influence	1,200 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational hours are calculated from WTGs in calculation and wind distribution:
Mast 0001 - Position Confirmed - Calibrated

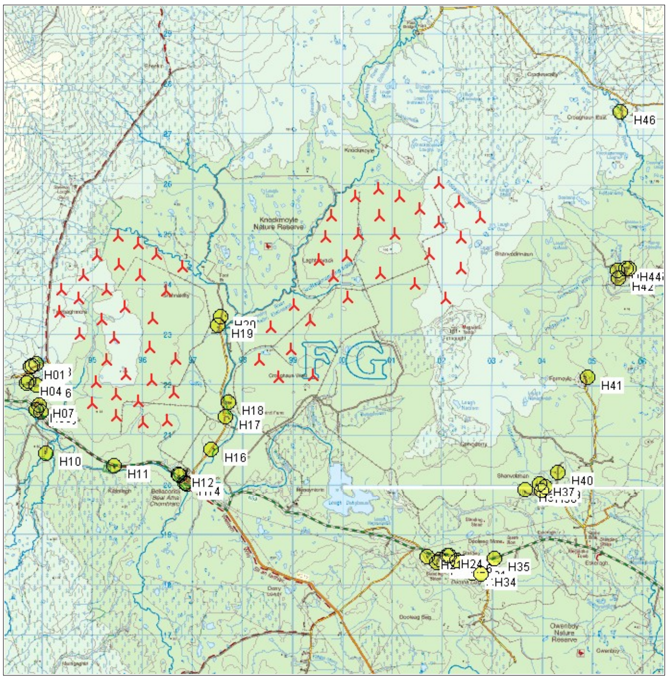
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
297	254	347	386	1,202	1,120	669	877	1,216	896	601	463	8,328

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: Oweninny Contours.wpo (0)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
ITM



Scale 1:150,000
New WTG
Shadow receptor

WTGs

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
T01	500,679	825,900	95.1	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T02	501,885	826,011	104.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T03	500,201	825,741	91.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T04	501,097	825,748	99.3	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T05	502,287	825,640	110.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T06	501,500	825,507	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T07	499,736	825,368	90.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T08	500,696	825,374	96.4	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T09	501,882	825,225	105.3	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T10	502,707	825,322	110.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T11	495,474	824,971	94.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T12	499,611	824,951	91.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T13	500,264	825,007	95.1	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T14	501,005	824,996	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T15	502,312	824,929	109.4	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T18	495,876	824,813	91.3	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T19	495,051	824,580	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T20	496,248	824,591	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T21	495,495	824,385	97.6	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T22	496,761	824,355	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T23	499,479	824,493	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T24	500,039	824,570	90.9	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T25	501,682	824,600	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T27	494,793	824,169	106.8	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T28	495,923	824,181	97.4	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T29	499,767	824,160	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T30	500,712	824,225	95.7	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T31	502,311	824,317	107.8	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T33	494,342	823,881	113.7	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T34	494,695	823,724	103.9	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T35	495,248	823,885	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T36	496,429	823,868	93.4	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015

...continued from previous page

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
T37	501,394	824,010	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T39	494,314	823,446	110.1	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T40	495,619	823,550	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T41	498,975	823,591	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T42	500,061	823,736	95.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T44	502,016	823,723	106.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T45	498,521	823,145	88.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T46	499,305	823,276	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T51	494,705	823,015	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T52	495,156	823,287	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T53	495,392	822,935	100.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T54	496,176	823,310	96.3	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T55	496,111	822,744	97.6	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T56	498,926	822,711	89.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T64	495,246	822,497	98.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T65	495,630	822,204	102.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T66	496,627	822,512	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T67	498,288	822,487	87.1	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T68	498,678	822,140	89.1	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T69	499,365	822,186	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T79	495,028	822,060	96.7	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T80	496,141	822,085	95.2	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T81	495,443	821,807	95.7	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T82	496,582	821,837	88.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T87	494,965	821,622	92.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T88	495,432	821,388	92.5	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T89	495,886	821,677	92.4	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T90	495,971	821,255	90.0	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T91	496,454	821,284	88.3	Siemens SWT-3.6-120 3600 120.0 !O! hub: ...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0

Shadow receptor-Input

No.	X(East)	Y(North)	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H01	493,732	822,360	114.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H02	493,774	822,379	113.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H03	493,855	822,410	111.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H04	493,652	822,027	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H05	493,688	822,065	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H06	493,852	822,002	89.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H07	493,899	821,592	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H08	493,854	821,502	74.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H09	493,954	821,464	76.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H10	494,033	820,633	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H11	495,395	820,386	73.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H12	496,686	820,203	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H13	496,708	820,186	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H14	496,827	820,038	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H15	496,852	820,028	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H16	497,346	820,707	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H17	497,633	821,353	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H18	497,684	821,648	83.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H19	497,468	823,180	81.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H20	497,526	823,363	83.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H21	501,656	818,568	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H22	501,904	818,511	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H23	501,845	818,444	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H24	502,057	818,584	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H25	502,092	818,575	90.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H26	502,236	818,479	92.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H27	502,278	818,457	92.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H28	502,295	818,452	91.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"

To be continued on next page...

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Calculated:
03/09/2015 15:03/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015

...continued from previous page

No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H29	502,328	818,455	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H30	502,344	818,446	90.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H31	502,536	818,347	96.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H32	502,564	818,340	96.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H33	502,555	818,238	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H34	502,716	818,216	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H35	502,989	818,517	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H36	503,600	819,910	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H37	503,884	820,018	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H38	503,919	819,891	79.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H39	504,005	819,957	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H40	504,260	820,256	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H41	504,839	822,146	100.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H42	505,456	824,123	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H43	505,438	824,281	82.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H44	505,613	824,321	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H45	505,661	824,312	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H46	505,494	827,438	118.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H01	15:22	53	0:25	2:29
H02	14:12	50	0:24	2:17
H03	10:12	42	0:20	1:37
H04	0:00	0	0:00	0:00
H05	0:00	0	0:00	0:00
H06	18:55	63	0:24	3:20
H07	11:55	34	0:27	2:27
H08	11:27	35	0:26	2:18
H09	14:24	40	0:28	2:52
H10	0:00	0	0:00	0:00
H11	0:00	0	0:00	0:00
H12	0:00	0	0:00	0:00
H13	0:00	0	0:00	0:00
H14	0:00	0	0:00	0:00
H15	0:00	0	0:00	0:00
H16	26:16	63	0:29	4:33
H17	25:48	81	0:26	4:55
H18	40:48	120	0:27	7:41
H19	43:01	80	0:54	6:05
H20	35:06	115	0:28	4:14
H21	0:00	0	0:00	0:00
H22	0:00	0	0:00	0:00
H23	0:00	0	0:00	0:00
H24	0:00	0	0:00	0:00
H25	0:00	0	0:00	0:00
H26	0:00	0	0:00	0:00
H27	0:00	0	0:00	0:00
H28	0:00	0	0:00	0:00
H29	0:00	0	0:00	0:00
H30	0:00	0	0:00	0:00
H31	0:00	0	0:00	0:00
H32	0:00	0	0:00	0:00
H33	0:00	0	0:00	0:00
H34	0:00	0	0:00	0:00
H35	0:00	0	0:00	0:00
H36	0:00	0	0:00	0:00
H37	0:00	0	0:00	0:00
H38	0:00	0	0:00	0:00

To be continued on next page...

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03/09/2015 15:03/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015

...continued from previous page

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H39	0:00	0	0:00	0:00
H40	0:00	0	0:00	0:00
H41	0:00	0	0:00	0:00
H42	0:00	0	0:00	0:00
H43	0:00	0	0:00	0:00
H44	0:00	0	0:00	0:00
H45	0:00	0	0:00	0:00
H46	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
T01	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1552)	0:00	0:00
T02	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1553)	0:00	0:00
T03	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1554)	0:00	0:00
T04	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1555)	0:00	0:00
T05	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1556)	0:00	0:00
T06	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1557)	0:00	0:00
T07	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1558)	0:00	0:00
T08	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1559)	0:00	0:00
T09	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1560)	0:00	0:00
T10	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1561)	0:00	0:00
T11	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1582)	0:00	0:00
T12	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1562)	0:00	0:00
T13	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1563)	0:00	0:00
T14	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1564)	0:00	0:00
T15	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1565)	0:00	0:00
T18	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1583)	0:00	0:00
T19	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1584)	0:00	0:00
T20	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1585)	0:00	0:00
T21	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1586)	0:00	0:00
T22	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1587)	0:00	0:00
T23	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1566)	0:00	0:00
T24	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1567)	0:00	0:00
T25	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1568)	0:00	0:00
T27	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1588)	0:00	0:00
T28	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1589)	0:00	0:00
T29	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1569)	0:00	0:00
T30	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1570)	0:00	0:00
T31	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1571)	0:00	0:00
T33	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1590)	0:00	0:00
T34	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1591)	0:00	0:00
T35	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1592)	0:00	0:00
T36	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1593)	0:00	0:00
T37	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1572)	0:00	0:00
T39	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1594)	0:00	0:00
T40	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1595)	0:00	0:00
T41	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1573)	0:00	0:00
T42	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1574)	0:00	0:00
T44	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1575)	0:00	0:00
T45	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1576)	24:16	4:18
T46	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1577)	0:00	0:00
T51	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1596)	15:23	2:29
T52	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1597)	0:00	0:00
T53	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1598)	0:00	0:00
T54	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1599)	0:00	0:00
T55	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1600)	0:00	0:00
T56	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1578)	0:00	0:00
T64	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1601)	0:00	0:00
T65	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1602)	0:00	0:00
T66	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1603)	15:33	1:54
T67	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1579)	38:18	4:11

To be continued on next page...

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Calculated:
03/09/2015 15:03/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
T68	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1580)	29:19	5:22
T69	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1581)	0:00	0:00
T79	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1604)	9:42	2:00
T80	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1605)	0:00	0:00
T81	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1606)	0:00	0:00
T82	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1607)	28:08	5:40
T87	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1608)	38:47	7:20
T88	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1609)	0:00	0:00
T89	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1610)	0:00	0:00
T90	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1611)	0:00	0:00
T91	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1612)	35:25	6:07

Project:
Oweninny Wind Farm

Hibernian Wind Power / Bord na Mona

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Calculated:
15/09/2015 16:06/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Vestas V112_120m Hubs_15th Sept 2015

Assumptions for shadow calculations

Maximum distance for influence	1,120 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational hours are calculated from WTGs in calculation and wind distribution:
Mast 0001 - Position Confirmed - Calibrated

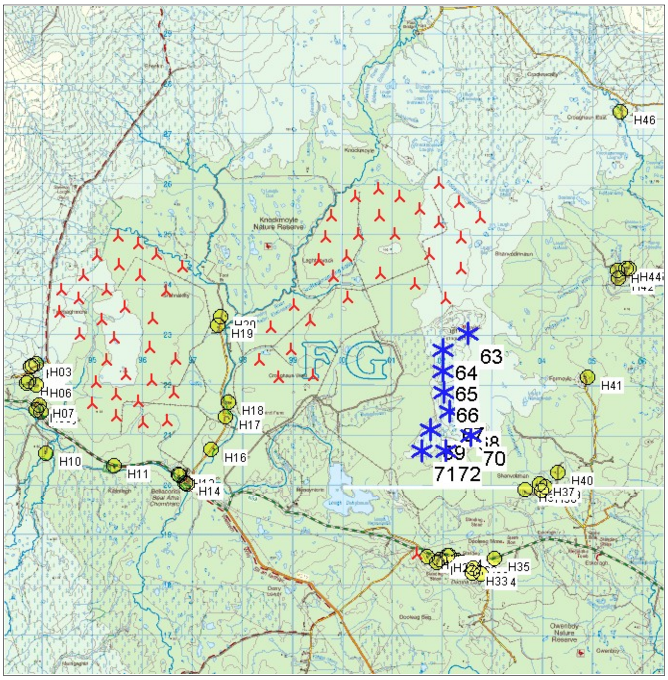
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
304	259	355	394	1,228	1,145	684	896	1,243	916	615	474	8,513

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: Oweninny Contours.wpo (0)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
ITM



Scale 1:150,000
New WTG
Existing WTG
Shadow receptor

WTGs

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
63	502,452	823,032	112.8	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
64	501,957	822,700	108.7	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
65	501,961	822,275	110.0	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
66	501,965	821,861	110.0	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
67	502,089	821,469	110.0	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
68	502,390	821,308	110.2	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
69	501,710	821,109	101.5	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
70	502,505	821,005	109.3	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
71	501,524	820,697	100.0	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
72	502,015	820,697	97.0	WINDTEC WT1500 1500 66.7 !O! h...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
Dooleeg Turbine	501,429	818,628	93.6	ENERCON E-82 2000 82.0 !O! hub: ...	No	ENERCON	E-82-2,000	2,000	82.0	82.0	19.5
T01	500,679	825,900	95.1	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T02	501,885	826,011	104.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T03	500,201	825,741	91.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T04	501,097	825,748	99.3	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T05	502,287	825,640	110.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T06	501,500	825,507	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T07	499,736	825,368	90.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T08	500,696	825,374	96.4	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T09	501,882	825,225	105.3	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T10	502,707	825,322	110.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T11	495,474	824,971	94.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T12	499,611	824,951	91.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T13	500,264	825,007	95.1	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T14	501,005	824,996	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T15	502,312	824,929	109.4	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T18	495,876	824,813	91.3	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T19	495,051	824,580	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T20	496,248	824,591	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T21	495,495	824,385	97.6	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T22	496,761	824,355	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T23	499,479	824,493	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Vestas V112_120m Hubs_15th Sept 2015

...continued from previous page

	X(East)	Y(North)	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	RPM [RPM]
T24	500,039	824,570	90.9	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T25	501,682	824,600	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T27	494,793	824,169	106.8	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T28	495,923	824,181	97.4	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T29	499,767	824,160	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T30	500,712	824,225	95.7	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T31	502,311	824,317	107.8	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T33	494,342	823,881	113.7	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T34	494,695	823,724	103.9	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T35	495,248	823,885	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T36	496,429	823,868	93.4	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T37	501,394	824,010	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T39	494,314	823,446	110.1	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T40	495,619	823,550	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T41	498,975	823,591	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T42	500,061	823,736	95.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T44	502,016	823,723	106.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T45	498,521	823,145	88.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T46	499,305	823,276	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T51	494,705	823,015	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T52	495,156	823,287	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T53	495,392	822,935	100.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T54	496,176	823,310	96.3	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T55	496,111	822,744	97.6	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T56	498,926	822,711	89.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T64	495,246	822,497	98.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T65	495,630	822,204	102.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T66	496,627	822,512	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T67	498,288	822,487	87.1	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T68	498,678	822,140	89.1	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T69	499,365	822,186	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T79	495,028	822,060	96.7	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T80	496,141	822,085	95.2	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T81	495,443	821,807	95.7	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T82	496,582	821,837	88.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T87	494,965	821,622	92.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T88	495,432	821,388	92.5	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T89	495,886	821,677	92.4	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T90	495,971	821,255	90.0	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8
T91	496,454	821,284	88.3	VESTAS V112 3000 112.0 !O! hub: ...	No	VESTAS	V112-3,000	3,000	112.0	120.0	12.8

Shadow receptor-Input

No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H01	493,732	822,360	114.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H02	493,774	822,379	113.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H03	493,855	822,410	111.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H04	493,652	822,027	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H05	493,688	822,065	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H06	493,852	822,002	89.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H07	493,899	821,592	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H08	493,854	821,502	74.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H09	493,954	821,464	76.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H10	494,033	820,633	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H11	495,395	820,386	73.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H12	496,686	820,203	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H13	496,708	820,186	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H14	496,827	820,038	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H15	496,852	820,028	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H16	497,346	820,707	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H17	497,633	821,353	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"

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Calculated:
15/09/2015 16:06/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Vestas V112_120m Hubs_15th Sept 2015

...continued from previous page

No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H18	497,684	821,648	83.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H19	497,468	823,180	81.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H20	497,526	823,363	83.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H21	501,656	818,568	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H22	501,904	818,511	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H23	501,845	818,444	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H24	502,057	818,584	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H25	502,092	818,575	90.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H26	502,236	818,479	92.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H27	502,278	818,457	92.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H28	502,295	818,452	91.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H29	502,328	818,455	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H30	502,344	818,446	90.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H31	502,536	818,347	96.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H32	502,564	818,340	96.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H33	502,555	818,238	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H34	502,716	818,216	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H35	502,989	818,517	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H36	503,600	819,910	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H37	503,884	820,018	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H38	503,919	819,891	79.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H39	504,005	819,957	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H40	504,260	820,256	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H41	504,839	822,146	100.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H42	505,456	824,123	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H43	505,438	824,281	82.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H44	505,613	824,321	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H45	505,661	824,312	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H46	505,494	827,438	118.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
H01	0:00	0	0:00	0:00
H02	0:00	0	0:00	0:00
H03	8:45	37	0:19	1:25
H04	0:00	0	0:00	0:00
H05	0:00	0	0:00	0:00
H06	0:00	0	0:00	0:00
H07	10:21	32	0:24	2:11
H08	9:57	32	0:23	2:03
H09	12:39	37	0:26	2:34
H10	0:00	0	0:00	0:00
H11	0:00	0	0:00	0:00
H12	0:00	0	0:00	0:00
H13	0:00	0	0:00	0:00
H14	0:00	0	0:00	0:00
H15	0:00	0	0:00	0:00
H16	22:47	59	0:27	4:00
H17	0:00	0	0:00	0:00
H18	36:35	114	0:26	7:01
H19	37:12	76	0:52	5:26
H20	10:45	33	0:26	1:47
H21	134:06	112	1:23	25:27
H22	34:11	66	0:40	6:59
H23	62:52	95	0:45	11:54
H24	16:24	41	0:31	3:26
H25	14:41	39	0:29	3:04
H26	9:46	32	0:24	2:00
H27	8:49	32	0:23	1:47

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Vestas V112_120m Hubs_15th Sept 2015

...continued from previous page

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H28	8:23	32	0:22	1:42
H29	7:39	30	0:21	1:33
H30	7:23	29	0:21	1:30
H31	0:00	0	0:00	0:00
H32	0:00	0	0:00	0:00
H33	0:00	0	0:00	0:00
H34	0:00	0	0:00	0:00
H35	0:00	0	0:00	0:00
H36	0:00	0	0:00	0:00
H37	0:00	0	0:00	0:00
H38	0:00	0	0:00	0:00
H39	0:00	0	0:00	0:00
H40	0:00	0	0:00	0:00
H41	0:00	0	0:00	0:00
H42	0:00	0	0:00	0:00
H43	0:00	0	0:00	0:00
H44	0:00	0	0:00	0:00
H45	0:00	0	0:00	0:00
H46	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
63	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (70)	0:00	0:00
64	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (71)	0:00	0:00
65	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (72)	0:00	0:00
66	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (73)	0:00	0:00
67	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (74)	0:00	0:00
68	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (75)	0:00	0:00
69	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (76)	0:00	0:00
70	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (77)	0:00	0:00
71	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (78)	0:00	0:00
72	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (79)	0:00	0:00
Dooleeg Turbine	ENERCON E-82 2000 82.0 !O! hub: 82.0 m (TOT: 123.0 m) (1614)	227:25	43:54
T01	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1453)	0:00	0:00
T02	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1454)	0:00	0:00
T03	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1455)	0:00	0:00
T04	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1456)	0:00	0:00
T05	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1457)	0:00	0:00
T06	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1458)	0:00	0:00
T07	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1459)	0:00	0:00
T08	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1460)	0:00	0:00
T09	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1461)	0:00	0:00
T10	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1462)	0:00	0:00
T11	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1483)	0:00	0:00
T12	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1463)	0:00	0:00
T13	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1464)	0:00	0:00
T14	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1465)	0:00	0:00
T15	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1466)	0:00	0:00
T18	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1484)	0:00	0:00
T19	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1485)	0:00	0:00
T20	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1486)	0:00	0:00
T21	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1487)	0:00	0:00
T22	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1488)	0:00	0:00
T23	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1467)	0:00	0:00
T24	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1468)	0:00	0:00
T25	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1469)	0:00	0:00
T27	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1489)	0:00	0:00
T28	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1490)	0:00	0:00
T29	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1470)	0:00	0:00
T30	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1471)	0:00	0:00
T31	VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1472)	0:00	0:00

To be continued on next page...

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SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Vestas V112_120m Hubs_15th Sept 2015

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
	T33 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1491)	0:00	0:00
	T34 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1492)	0:00	0:00
	T35 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1493)	0:00	0:00
	T36 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1494)	0:00	0:00
	T37 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1473)	0:00	0:00
	T39 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1495)	0:00	0:00
	T40 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1496)	0:00	0:00
	T41 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1474)	0:00	0:00
	T42 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1475)	0:00	0:00
	T44 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1476)	0:00	0:00
	T45 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1477)	21:09	3:52
	T46 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1478)	0:00	0:00
	T51 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1497)	8:45	1:25
	T52 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1498)	0:00	0:00
	T53 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1499)	0:00	0:00
	T54 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1500)	0:00	0:00
	T55 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1501)	0:00	0:00
	T56 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1479)	0:00	0:00
	T64 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1502)	0:00	0:00
	T65 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1503)	0:00	0:00
	T66 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1504)	13:31	1:42
	T67 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1480)	13:17	1:41
	T68 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1481)	26:27	4:56
	T69 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1482)	0:00	0:00
	T79 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1505)	0:00	0:00
	T80 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1506)	0:00	0:00
	T81 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1507)	0:00	0:00
	T82 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1508)	10:08	2:04
	T87 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1509)	26:40	5:31
	T88 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1510)	0:00	0:00
	T89 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1511)	0:00	0:00
	T90 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1512)	0:00	0:00
	T91 VESTAS V112 3000 112.0 !O! hub: 120.0 m (TOT: 176.0 m) (1513)	22:47	4:00

Project:
Oweninny Wind Farm

Hibernian Wind Power / Bord na Mona

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15/09/2015 16:12/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Siemens SWT3.6_116m Hubs_15th Sept 2015

Assumptions for shadow calculations

Maximum distance for influence	1,200 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational hours are calculated from WTGs in calculation and wind distribution:
Mast 0001 - Position Confirmed - Calibrated

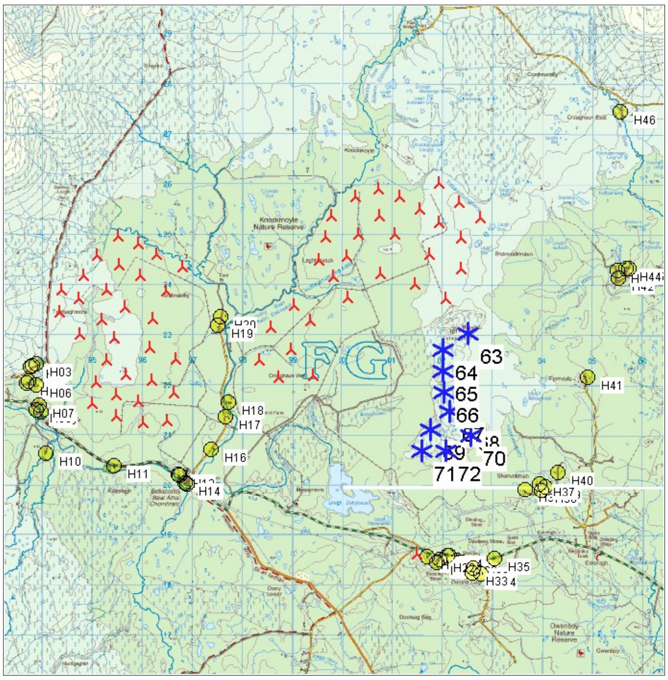
Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
295	252	345	383	1,194	1,113	665	871	1,208	890	597	460	8,274

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: Oweninny Contours.wpo (0)
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 10.0 m

All coordinates are in
ITM



Scale 1:150,000
New WTG
Existing WTG
Shadow receptor

WTGs

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
63	502,452	823,032	112.8	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
64	501,957	822,700	108.7	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
65	501,961	822,275	110.0	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
66	501,965	821,861	110.0	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
67	502,089	821,469	110.0	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
68	502,390	821,308	110.2	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
69	501,710	821,109	101.5	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
70	502,505	821,005	109.3	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
71	501,524	820,697	100.0	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
72	502,015	820,697	97.0	WINDTEC WT1500 1500 66.7 !...	No	WINDTEC	WT1500-1,500	1,500	66.7	64.5	24.0
Dooleeg Turbine	501,429	818,628	93.6	ENERCON E-82 2000 82.0 !O! h...	No	ENERCON	E-82-2,000	2,000	82.0	82.0	19.5
T01	500,679	825,900	95.1	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T02	501,885	826,011	104.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T03	500,201	825,741	91.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T04	501,097	825,748	99.3	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T05	502,287	825,640	110.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T06	501,500	825,507	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T07	499,736	825,368	90.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T08	500,696	825,374	96.4	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T09	501,882	825,225	105.3	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T10	502,707	825,322	110.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T11	495,474	824,971	94.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T12	499,611	824,951	91.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T13	500,264	825,007	95.1	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T14	501,005	824,996	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T15	502,312	824,929	109.4	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T18	495,876	824,813	91.3	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T19	495,051	824,580	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T20	496,248	824,591	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T21	495,495	824,385	97.6	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T22	496,761	824,355	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T23	499,479	824,493	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T24	500,039	824,570	90.9	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0

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SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Siemens SWT3.6_116m Hubs_15th Sept 2015

...continued from previous page

	X(East)	Y(North)	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM
			[m]					[kW]	[m]	[m]	[RPM]
T25	501,682	824,600	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T27	494,793	824,169	106.8	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T28	495,923	824,181	97.4	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T29	499,767	824,160	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T30	500,712	824,225	95.7	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T31	502,311	824,317	107.8	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T33	494,342	823,881	113.7	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T34	494,695	823,724	103.9	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T35	495,248	823,885	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T36	496,429	823,868	93.4	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T37	501,394	824,010	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T39	494,314	823,446	110.1	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T40	495,619	823,550	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T41	498,975	823,591	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T42	500,061	823,736	95.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T44	502,016	823,723	106.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T45	498,521	823,145	88.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T46	499,305	823,276	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T51	494,705	823,015	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T52	495,156	823,287	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T53	495,392	822,935	100.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T54	496,176	823,310	96.3	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T55	496,111	822,744	97.6	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T56	498,926	822,711	89.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T64	495,246	822,497	98.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T65	495,630	822,204	102.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T66	496,627	822,512	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T67	498,288	822,487	87.1	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T68	498,678	822,140	89.1	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T69	499,365	822,186	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T79	495,028	822,060	96.7	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T80	496,141	822,085	95.2	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T81	495,443	821,807	95.7	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T82	496,582	821,837	88.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T87	494,965	821,622	92.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T88	495,432	821,388	92.5	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T89	495,886	821,677	92.4	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T90	495,971	821,255	90.0	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0
T91	496,454	821,284	88.3	Siemens SWT-3.6-120 3600 120...	Yes	Siemens	SWT-3.6-120-3,600	3,600	120.0	116.0	14.0

Shadow receptor-Input

No.	X(East)	Y(North)	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H01	493,732	822,360	114.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H02	493,774	822,379	113.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H03	493,855	822,410	111.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H04	493,652	822,027	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H05	493,688	822,065	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H06	493,852	822,002	89.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H07	493,899	821,592	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H08	493,854	821,502	74.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H09	493,954	821,464	76.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H10	494,033	820,633	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H11	495,395	820,386	73.8	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H12	496,686	820,203	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H13	496,708	820,186	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H14	496,827	820,038	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H15	496,852	820,028	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H16	497,346	820,707	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H17	497,633	821,353	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H18	497,684	821,648	83.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H19	497,468	823,180	81.9	2.0	1.0	4.0	0.0	90.0	"Green house mode"

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Siemens SWT3.6_116m Hubs_15th Sept 2015

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No.	X(East)	Y(North)	Z [m]	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
H20	497,526	823,363	83.6	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H21	501,656	818,568	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H22	501,904	818,511	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H23	501,845	818,444	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H24	502,057	818,584	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H25	502,092	818,575	90.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H26	502,236	818,479	92.4	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H27	502,278	818,457	92.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H28	502,295	818,452	91.7	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H29	502,328	818,455	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H30	502,344	818,446	90.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H31	502,536	818,347	96.1	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H32	502,564	818,340	96.5	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H33	502,555	818,238	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H34	502,716	818,216	100.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H35	502,989	818,517	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H36	503,600	819,910	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H37	503,884	820,018	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H38	503,919	819,891	79.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H39	504,005	819,957	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H40	504,260	820,256	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H41	504,839	822,146	100.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H42	505,456	824,123	80.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H43	505,438	824,281	82.3	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H44	505,613	824,321	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H45	505,661	824,312	90.0	2.0	1.0	4.0	0.0	90.0	"Green house mode"
H46	505,494	827,438	118.2	2.0	1.0	4.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H01	15:22	53	0:25	2:28
H02	14:12	50	0:24	2:16
H03	10:12	42	0:20	1:36
H04	0:00	0	0:00	0:00
H05	0:00	0	0:00	0:00
H06	18:55	63	0:24	3:19
H07	11:55	34	0:27	2:26
H08	11:27	35	0:26	2:18
H09	14:24	40	0:28	2:51
H10	0:00	0	0:00	0:00
H11	0:00	0	0:00	0:00
H12	0:00	0	0:00	0:00
H13	0:00	0	0:00	0:00
H14	0:00	0	0:00	0:00
H15	0:00	0	0:00	0:00
H16	26:16	63	0:29	4:31
H17	25:48	81	0:26	4:53
H18	40:48	120	0:27	7:38
H19	43:01	80	0:54	6:03
H20	35:06	115	0:28	4:12
H21	134:06	112	1:23	24:44
H22	34:11	66	0:40	6:47
H23	62:52	95	0:45	11:34
H24	16:24	41	0:31	3:20
H25	14:41	39	0:29	2:59
H26	9:46	32	0:24	1:56
H27	8:49	32	0:23	1:44
H28	8:23	32	0:22	1:39
H29	7:39	30	0:21	1:31

To be continued on next page...

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Siemens SWT3.6_116m Hubs_15th Sept 2015

...continued from previous page

No.	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
H30	7:23	29	0:21	1:27
H31	3:47	22	0:16	0:44
H32	3:34	22	0:16	0:41
H33	3:20	22	0:15	0:39
H34	0:00	0	0:00	0:00
H35	0:00	0	0:00	0:00
H36	0:00	0	0:00	0:00
H37	0:00	0	0:00	0:00
H38	0:00	0	0:00	0:00
H39	0:00	0	0:00	0:00
H40	0:00	0	0:00	0:00
H41	0:00	0	0:00	0:00
H42	0:00	0	0:00	0:00
H43	0:00	0	0:00	0:00
H44	0:00	0	0:00	0:00
H45	0:00	0	0:00	0:00
H46	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
63	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (70)	0:00	0:00
64	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (71)	0:00	0:00
65	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (72)	0:00	0:00
66	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (73)	0:00	0:00
67	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (74)	0:00	0:00
68	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (75)	0:00	0:00
69	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (76)	0:00	0:00
70	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (77)	0:00	0:00
71	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (78)	0:00	0:00
72	WINDTEC WT1500 1500 66.7 !O! hub: 64.5 m (TOT: 97.8 m) (79)	0:00	0:00
Dooleeg Turbine	ENERCON E-82 2000 82.0 !O! hub: 82.0 m (TOT: 123.0 m) (1614)	232:22	43:38
T01	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1552)	0:00	0:00
T02	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1553)	0:00	0:00
T03	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1554)	0:00	0:00
T04	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1555)	0:00	0:00
T05	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1556)	0:00	0:00
T06	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1557)	0:00	0:00
T07	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1558)	0:00	0:00
T08	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1559)	0:00	0:00
T09	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1560)	0:00	0:00
T10	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1561)	0:00	0:00
T11	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1582)	0:00	0:00
T12	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1562)	0:00	0:00
T13	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1563)	0:00	0:00
T14	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1564)	0:00	0:00
T15	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1565)	0:00	0:00
T18	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1583)	0:00	0:00
T19	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1584)	0:00	0:00
T20	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1585)	0:00	0:00
T21	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1586)	0:00	0:00
T22	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1587)	0:00	0:00
T23	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1566)	0:00	0:00
T24	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1567)	0:00	0:00
T25	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1568)	0:00	0:00
T27	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1588)	0:00	0:00
T28	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1589)	0:00	0:00
T29	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1569)	0:00	0:00
T30	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1570)	0:00	0:00
T31	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1571)	0:00	0:00
T33	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1590)	0:00	0:00
T34	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1591)	0:00	0:00

To be continued on next page...

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Calculated:
15/09/2015 16:12/3.0.629

SHADOW - Main Result

Calculation: Oweninny Shadow Calc_Cumulative Impacts_Corvoderry & Dooleeg_Phase 1 & 2_61 x Siemens SWT3.6_116m Hubs_15th Sept 2015

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
T35	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1592)	0:00	0:00
T36	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1593)	0:00	0:00
T37	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1572)	0:00	0:00
T39	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1594)	0:00	0:00
T40	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1595)	0:00	0:00
T41	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1573)	0:00	0:00
T42	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1574)	0:00	0:00
T44	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1575)	0:00	0:00
T45	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1576)	24:16	4:16
T46	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1577)	0:00	0:00
T51	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1596)	15:23	2:28
T52	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1597)	0:00	0:00
T53	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1598)	0:00	0:00
T54	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1599)	0:00	0:00
T55	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1600)	0:00	0:00
T56	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1578)	0:00	0:00
T64	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1601)	0:00	0:00
T65	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1602)	0:00	0:00
T66	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1603)	15:33	1:53
T67	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1579)	38:18	4:09
T68	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1580)	29:19	5:20
T69	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1581)	0:00	0:00
T79	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1604)	9:42	1:59
T80	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1605)	0:00	0:00
T81	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1606)	0:00	0:00
T82	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1607)	28:08	5:38
T87	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1608)	38:47	7:17
T88	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1609)	0:00	0:00
T89	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1610)	0:00	0:00
T90	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1611)	0:00	0:00
T91	Siemens SWT-3.6-120 3600 120.0 !O! hub: 116.0 m (TOT: 176.0 m) (1612)	35:25	6:05

SHADOW - Calendar

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015 Shadow receptor: H19 - Shadow Receptor: 2.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (98)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
307	262	359	399	1,242	1,158	692	906	1,257	926	622	479	8,610

Idle start wind speed: Cut in wind speed from power curve

Day	January	Jan min.	Jan flicker	February	Feb min.	Feb flicker	March	Mar min.	Mar flicker	April	Apr min.	Apr flicker	May	June
1	08:59			08:28		09:05 (T67)	07:30			07:14		07:48 (T45)	06:04	05:13
	16:26			17:18	47	16:34 (T66)	18:14			20:13	24	08:12 (T45)	21:10	22:00
2	08:59			08:26		09:05 (T67)	07:27			07:11		07:47 (T45)	06:02	05:13
	16:27			17:20	49	16:34 (T66)	18:16			20:15	25	08:12 (T45)	21:11	22:02
3	08:58			08:24		09:04 (T67)	07:25			07:09		07:47 (T45)	06:00	05:12
	16:28			17:22	50	16:34 (T66)	18:18			20:17	25	08:12 (T45)	21:13	22:03
4	08:58			08:23		09:04 (T67)	07:23			07:06		07:46 (T45)	05:58	05:11
	16:29			17:24	51	16:35 (T66)	18:20			20:19	24	08:10 (T45)	21:15	22:04
5	08:58			08:21		09:04 (T67)	07:20			07:04		07:47 (T45)	05:55	05:10
	16:30			17:26	52	16:35 (T66)	18:22			20:21	23	08:10 (T45)	21:17	22:05
6	08:57			08:19		09:05 (T67)	07:18			07:01		07:47 (T45)	05:53	05:09
	16:32			17:28	49	16:34 (T66)	18:24			20:23	21	08:08 (T45)	21:19	22:06
7	08:57			08:17		09:05 (T67)	07:15			06:59		07:48 (T45)	05:52	05:09
	16:33			17:30	49	16:34 (T66)	18:26			20:25	19	08:07 (T45)	21:21	22:07
8	08:56			08:15		09:06 (T67)	07:13			06:57		07:49 (T45)	05:50	05:08
	16:35			17:32	46	16:34 (T66)	18:28			20:26	17	08:06 (T45)	21:22	22:08
9	08:56			08:13		09:06 (T67)	07:10			06:54		07:50 (T45)	05:48	05:07
	16:36			17:34	44	16:33 (T66)	18:30			20:28	13	08:03 (T45)	21:24	22:09
10	08:55			08:11		09:07 (T67)	07:08			06:52		07:54 (T45)	05:46	05:07
	16:38			17:36	41	16:33 (T66)	18:32			20:30	6	08:00 (T45)	21:26	22:10
11	08:54			08:09		09:08 (T67)	07:06			06:49			05:44	05:06
	16:39			17:38	36	16:32 (T66)	18:34			20:32			21:28	22:11
12	08:54			08:07		09:10 (T67)	07:03			06:47			05:42	05:06
	16:41			17:40	29	16:30 (T66)	18:35			20:34			21:29	22:11
13	08:53			08:05		09:12 (T67)	07:01			06:44			05:40	05:06
	16:42			17:42	19	16:27 (T66)	18:37			20:36			21:31	22:12
14	08:52			08:03		09:15 (T67)	06:58			06:42			05:39	05:05
	16:44			17:44	5	09:20 (T67)	18:39			20:38			21:33	22:13
15	08:51			08:01			06:56			06:40			05:37	05:05
	16:46			17:46			18:41			20:40			21:35	22:13
16	08:50			07:59			06:53			06:37			05:35	05:05
	16:47			17:48			18:43			20:41			21:36	22:14
17	08:49			07:57			06:51			06:35			05:33	05:05
	16:49			17:50			18:45			20:43			21:38	22:14
18	08:48			07:54			06:48			06:33			05:32	05:05
	16:51			17:52			18:47			20:45			21:40	22:15
19	08:47			07:52			06:46			06:30			05:30	05:05
	16:53			17:54			18:49			20:47			21:41	22:15
20	08:46			07:50			06:43			06:28			05:29	05:05
	16:54			17:56			18:51			20:49			21:43	22:16
21	08:44			07:48			06:41			06:26			05:27	05:05
	16:56			17:58			18:53			20:51			21:45	22:16
22	08:43			07:46			06:39			06:23			05:26	05:05
	16:58			18:00			18:55			20:53			21:46	22:16
23	08:42			07:43			06:36			06:21			05:24	05:05
	17:00			18:02			18:56			20:55			21:48	22:16
24	08:40		16:18 (T66)	07:41			06:34			06:19			05:23	05:06
	17:02	3	16:21 (T66)	18:04			18:58			20:56			21:49	22:16
25	08:39		09:15 (T67)	07:39			06:31			06:17			05:22	05:06
	17:04	12	16:26 (T66)	18:06			19:00			20:58			21:51	22:16
26	08:37		09:11 (T67)	07:37			06:29		06:56 (T45)	06:14			05:20	05:06
	17:06	24	16:28 (T66)	18:08			19:02	10	07:06 (T45)	21:00			21:52	22:16
27	08:36		09:09 (T67)	07:34			06:26		06:54 (T45)	06:12			05:19	05:07
	17:08	31	16:29 (T66)	18:10			19:04	15	07:09 (T45)	21:02			21:54	22:16
28	08:34		09:07 (T67)	07:32			06:24		06:51 (T45)	06:10			05:18	05:07
	17:10	36	16:30 (T66)	18:12			19:06	19	07:10 (T45)	21:04			21:55	22:16
29	08:33		09:07 (T67)				07:21		07:50 (T45)	06:08			05:17	05:08
	17:12	40	16:32 (T66)				20:08	21	08:11 (T45)	21:06			21:56	22:16
30	08:31		09:06 (T67)				07:19		07:50 (T45)	06:06			05:16	05:09
	17:14	44	16:33 (T66)				20:10	22	08:12 (T45)	21:08			21:58	22:16
31	08:30		09:06 (T67)				07:16		07:48 (T45)				05:14	
	17:16	45	16:33 (T66)				20:11	24	08:12 (T45)				21:59	
Potential sun hours	248			272			367			421			496	512
Total, worst case		235			567			111			197			
Sun reduction		0.17			0.22			0.22			0.34			
Oper. time red.		0.98			0.98			0.98			0.98			
Wind dir. red.		0.64			0.64			0.69			0.69			
Total reduction		0.11			0.14			0.15			0.23			
Total, real		25			78			17			46			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Oweninny Wind Farm

Hibernian Wind Power / Bord na Mona

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Calculated:
03/09/2015 10:57/3.0.629

SHADOW - Calendar

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Vestas V112_120m Hubs_3rd Sept 2015 Shadow receptor: H19 - Shadow Receptor: 2.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (98)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
307	262	359	399	1,242	1,158	692	906	1,257	926	622	479	8,610

Idle start wind speed: Cut in wind speed from power curve

Day	July	August	September			October			November			December
1	05:09	05:50	06:45			07:39			07:38		08:37 (T67)	08:34
	22:15	21:39	20:32			19:17			17:06	41	16:02 (T66)	16:21
2	05:10	05:52	06:47		07:52 (T45)	07:41			07:40		08:36 (T67)	08:35
	22:15	21:37	20:29	6	07:58 (T45)	19:15			17:04	45	16:03 (T66)	16:20
3	05:11	05:53	06:49		07:48 (T45)	07:43			07:42		08:35 (T67)	08:37
	22:14	21:36	20:27	13	08:01 (T45)	19:12			17:02	47	16:04 (T66)	16:19
4	05:12	05:55	06:50		07:46 (T45)	07:45			07:44		08:35 (T67)	08:38
	22:14	21:34	20:24	17	08:03 (T45)	19:10			17:00	48	16:04 (T66)	16:19
5	05:13	05:57	06:52		07:44 (T45)	07:46			07:46		08:34 (T67)	08:40
	22:13	21:32	20:22	20	08:04 (T45)	19:07			16:58	50	16:04 (T66)	16:18
6	05:14	05:59	06:54		07:43 (T45)	07:48			07:48		08:35 (T67)	08:41
	22:13	21:30	20:20	21	08:04 (T45)	19:05			16:56	50	16:05 (T66)	16:18
7	05:15	06:00	06:56		07:42 (T45)	07:50			07:50		08:35 (T67)	08:43
	22:12	21:28	20:17	23	08:05 (T45)	19:03			16:54	50	16:05 (T66)	16:17
8	05:16	06:02	06:58		07:42 (T45)	07:52			07:52		08:35 (T67)	08:44
	22:11	21:26	20:15	24	08:06 (T45)	19:00			16:52	50	16:05 (T66)	16:17
9	05:17	06:04	06:59		07:40 (T45)	07:54			07:54		08:35 (T67)	08:45
	22:10	21:24	20:12	25	08:05 (T45)	18:58			16:51	50	16:05 (T66)	16:16
10	05:18	06:06	07:01		07:40 (T45)	07:56			07:56		08:36 (T67)	08:46
	22:10	21:22	20:10	25	08:05 (T45)	18:55			16:49	48	16:05 (T66)	16:16
11	05:19	06:07	07:03		07:40 (T45)	07:58			07:58		08:36 (T67)	08:48
	22:09	21:20	20:07	25	08:05 (T45)	18:53			16:47	46	16:04 (T66)	16:16
12	05:20	06:09	07:05		07:40 (T45)	08:00			08:00		08:37 (T67)	08:49
	22:08	21:18	20:05	24	08:04 (T45)	18:50			16:45	43	16:03 (T66)	16:16
13	05:21	06:11	07:07		07:40 (T45)	08:01			08:02		08:39 (T67)	08:50
	22:07	21:15	20:02	23	08:03 (T45)	18:48			16:44	40	16:04 (T66)	16:15
14	05:23	06:13	07:08		07:40 (T45)	08:03			08:04		08:40 (T67)	08:51
	22:06	21:13	20:00	22	08:02 (T45)	18:46			16:42	36	16:03 (T66)	16:15
15	05:24	06:14	07:10		07:41 (T45)	08:05			08:06		08:42 (T67)	08:52
	22:05	21:11	19:57	20	08:01 (T45)	18:43			16:40	31	16:02 (T66)	16:15
16	05:25	06:16	07:12		07:43 (T45)	08:07			08:07		08:44 (T67)	08:53
	22:03	21:09	19:55	16	07:59 (T45)	18:41			16:39	23	16:00 (T66)	16:15
17	05:27	06:18	07:14		07:44 (T45)	08:09			08:09		15:49 (T66)	08:53
	22:02	21:07	19:52	12	07:56 (T45)	18:39			16:37	10	15:59 (T66)	16:16
18	05:28	06:20	07:16			08:11			08:11		15:53 (T66)	08:54
	22:01	21:04	19:50			18:36			16:36	2	15:55 (T66)	16:16
19	05:29	06:22	07:17			08:13			08:13			08:55
	22:00	21:02	19:47			18:34			16:34			16:16
20	05:31	06:23	07:19			08:15			08:15			08:56
	21:58	21:00	19:45			18:32			16:33			16:16
21	05:32	06:25	07:21			08:17			08:17			08:56
	21:57	20:58	19:42			18:30			16:32			16:17
22	05:34	06:27	07:23			08:19			08:19			08:57
	21:56	20:55	19:40			18:27			16:30			16:17
23	05:35	06:29	07:25			08:21			08:20			08:57
	21:54	20:53	19:37			18:25			16:29			16:18
24	05:37	06:31	07:26			08:22			08:22			08:58
	21:53	20:51	19:35			18:23			16:28			16:18
25	05:38	06:32	07:28			07:24			08:24			08:58
	21:51	20:48	19:32			17:21			16:27			16:19
26	05:40	06:34	07:30			07:26			08:26			08:58
	21:49	20:46	19:30			17:18			16:26			16:20
27	05:42	06:36	07:32			07:28			08:27			08:59
	21:48	20:44	19:27			17:16			16:25			16:21
28	05:43	06:38	07:34			07:30		08:43 (T67)	08:29			08:59
	21:46	20:41	19:25			17:14	7	08:50 (T67)	16:24			16:21
29	05:45	06:40	07:35			07:32		08:40 (T67)	08:31			08:59
	21:44	20:39	19:22			17:12	22	15:57 (T66)	16:23			16:22
30	05:47	06:41	07:37			07:34		08:39 (T67)	08:32			08:59
	21:43	20:37	19:20			17:10	31	16:00 (T66)	16:22			16:23
31	05:48	06:43				07:36		08:38 (T67)				08:59
	21:41	20:34				17:08	36	16:01 (T66)				16:24
Potential sun hours	514	461	382			328			258			231
Total, worst case				316			96			710		
Sun reduction				0.29			0.23			0.20		
Oper. time red.				0.98			0.98			0.98		
Wind dir. red.				0.69			0.64			0.64		
Total reduction				0.20			0.15			0.12		
Total, real				62			14			88		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Oweninny Wind Farm

Hibernian Wind Power / Bord na Mona

Licensed user:
ESBI Engineering & Facility Management LTD
Stephen Court 18/21, Stephen's Green
IE-DUBLIN 2
+353 1 703 7013
David Murphy / david.murphy@esbi.ie
Calculated:
03/09/2015 15:03/3.0.629

SHADOW - Calendar

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015Shadow receptor: H19 - Shadow Receptor: 2.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (98)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
297	254	347	386	1,202	1,120	669	877	1,216	896	601	463	8,328

Idle start wind speed: Cut in wind speed from power curve

	January			February			March			April			May	June
1	08:59			08:28		09:03 (T67)	07:30			07:14		07:46 (T45)	06:04	05:13
	16:26			17:18	52	16:35 (T66)	18:14			20:13	27	08:13 (T45)	21:10	22:00
2	08:59			08:26		09:03 (T67)	07:27			07:11		07:45 (T45)	06:02	05:13
	16:27			17:20	54	16:36 (T66)	18:16			20:15	27	08:12 (T45)	21:11	22:02
3	08:58			08:24		09:03 (T67)	07:25			07:09		07:46 (T45)	06:00	05:12
	16:28			17:22	54	16:36 (T66)	18:18			20:17	26	08:12 (T45)	21:13	22:03
4	08:58			08:23		09:03 (T67)	07:23			07:06		07:45 (T45)	05:58	05:11
	16:29			17:24	54	16:36 (T66)	18:20			20:19	26	08:11 (T45)	21:15	22:04
5	08:58			08:21		09:03 (T67)	07:20			07:04		07:46 (T45)	05:55	05:10
	16:30			17:26	54	16:36 (T66)	18:22			20:21	24	08:10 (T45)	21:17	22:05
6	08:57			08:19		09:03 (T67)	07:18			07:01		07:46 (T45)	05:53	05:09
	16:32			17:28	53	16:36 (T66)	18:24			20:23	23	08:09 (T45)	21:19	22:06
7	08:57			08:17		09:04 (T67)	07:15			06:59		07:47 (T45)	05:52	05:09
	16:33			17:30	51	16:35 (T66)	18:26			20:25	21	08:08 (T45)	21:21	22:07
8	08:56			08:15		09:04 (T67)	07:13			06:57		07:48 (T45)	05:50	05:08
	16:35			17:32	50	16:35 (T66)	18:28			20:26	18	08:06 (T45)	21:22	22:08
9	08:56			08:13		09:05 (T67)	07:10			06:54		07:49 (T45)	05:48	05:07
	16:36			17:34	46	16:34 (T66)	18:30			20:28	14	08:03 (T45)	21:24	22:09
10	08:55			08:11		09:06 (T67)	07:08			06:52		07:53 (T45)	05:46	05:07
	16:38			17:36	43	16:34 (T66)	18:32			20:30	7	08:00 (T45)	21:26	22:10
11	08:54			08:09		09:07 (T67)	07:06			06:49			05:44	05:06
	16:39			17:38	38	16:33 (T66)	18:34			20:32			21:28	22:11
12	08:54			08:07		09:09 (T67)	07:03			06:47			05:42	05:06
	16:41			17:40	31	16:31 (T66)	18:35			20:34			21:29	22:11
13	08:53			08:05		09:11 (T67)	07:01			06:44			05:40	05:06
	16:42			17:42	21	16:28 (T66)	18:37			20:36			21:31	22:12
14	08:52			08:03		09:14 (T67)	06:58			06:42			05:39	05:05
	16:44			17:44	6	09:20 (T67)	18:39			20:38			21:33	22:13
15	08:51			08:01			06:56			06:40			05:37	05:05
	16:46			17:46			18:41			20:40			21:35	22:13
16	08:50			07:59			06:53			06:37			05:35	05:05
	16:47			17:48			18:43			20:41			21:36	22:14
17	08:49			07:57			06:51			06:35			05:33	05:05
	16:49			17:50			18:45			20:43			21:38	22:14
18	08:48			07:54			06:48			06:33			05:32	05:05
	16:51			17:52			18:47			20:45			21:40	22:15
19	08:47			07:52			06:46			06:30			05:30	05:05
	16:53			17:54			18:49			20:47			21:41	22:15
20	08:46			07:50			06:43			06:28			05:29	05:05
	16:54			17:56			18:51			20:49			21:43	22:16
21	08:44			07:48			06:41			06:26			05:27	05:05
	16:56			17:58			18:53			20:51			21:45	22:16
22	08:43			07:46			06:39			06:23			05:26	05:05
	16:58			18:00			18:55			20:53			21:46	22:16
23	08:42		16:16 (T66)	07:43			06:36			06:21			05:24	05:05
	17:00	9	16:25 (T66)	18:02			18:56			20:55			21:48	22:16
24	08:40		09:10 (T67)	07:41			06:34			06:19			05:23	05:06
	17:02	22	16:27 (T66)	18:04			18:58			20:56			21:49	22:16
25	08:39		09:09 (T67)	07:39			06:31		06:56 (T45)	06:17			05:22	05:06
	17:04	29	16:29 (T66)	18:06			19:00	11	07:07 (T45)	20:58			21:51	22:16
26	08:37		09:07 (T67)	07:37			06:29		06:53 (T45)	06:14			05:20	05:06
	17:06	35	16:30 (T66)	18:08			19:02	16	07:09 (T45)	21:00			21:52	22:16
27	08:36		09:06 (T67)	07:34			06:26		06:51 (T45)	06:12			05:19	05:07
	17:08	39	16:31 (T66)	18:10			19:04	20	07:11 (T45)	21:02			21:54	22:16
28	08:34		09:05 (T67)	07:32			06:24		06:49 (T45)	06:10			05:18	05:07
	17:10	43	16:32 (T66)	18:12			19:06	22	07:11 (T45)	21:04			21:55	22:16
29	08:33		09:05 (T67)				07:21		07:48 (T45)	06:08			05:17	05:08
	17:12	46	16:34 (T66)				20:08	24	08:12 (T45)	21:06			21:56	22:16
30	08:31		09:04 (T67)				07:19		07:48 (T45)	06:06			05:16	05:09
	17:14	48	16:34 (T66)				20:10	25	08:13 (T45)	21:08			21:58	22:16
31	08:30		09:04 (T67)				07:16		07:46 (T45)				05:14	
	17:16	51	16:35 (T66)				20:11	26	08:12 (T45)				21:59	
Potential sun hours	248			272			367			421			496	512
Total, worst case		322			607			144			213			
Sun reduction		0.17			0.22			0.22			0.34			
Oper. time red.		0.95			0.95			0.95			0.95			
Wind dir. red.		0.64			0.64			0.69			0.69			
Total reduction		0.10			0.13			0.15			0.22			
Total, real		33			81			21			48			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Oweninny Wind Farm

Hibernian Wind Power / Bord na Mona

Licensed user:
ESBI Engineering & Facility Management LTD
Stephen Court 18/21, Stephen's Green
IE-DUBLIN 2
+353 1 703 7013
David Murphy / david.murphy@esbi.ie
Calculated:
03/09/2015 15:03/3.0.629

SHADOW - Calendar

Calculation: Oweninny Shadow Calc_Phases 1 & 2_61 x Siemens SWT3.6_116m Hubs_3rd Sept 2015Shadow receptor: H19 - Shadow Receptor: 2.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (98)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [BELMULLET]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	2.16	2.65	4.82	5.79	4.41	4.42	4.07	3.73	2.48	1.71	0.89

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
297	254	347	386	1,202	1,120	669	877	1,216	896	601	463	8,328

Idle start wind speed: Cut in wind speed from power curve

	July	August	September			October			November			December
1	05:09	05:50	06:45			07:39			07:38		08:36 (T67)	08:34
	22:15	21:39	20:32			19:17			17:06	43	16:03 (T66)	16:21
2	05:10	05:52	06:47		07:50 (T45)	07:41			07:40		08:35 (T67)	08:35
	22:15	21:37	20:29	8	07:58 (T45)	19:15			17:04	47	16:04 (T66)	16:20
3	05:11	05:53	06:49		07:47 (T45)	07:43			07:42		08:34 (T67)	08:37
	22:14	21:36	20:27	14	08:01 (T45)	19:12			17:02	50	16:05 (T66)	16:19
4	05:12	05:55	06:50		07:45 (T45)	07:45			07:44		08:33 (T67)	08:38
	22:14	21:34	20:24	18	08:03 (T45)	19:10			17:00	52	16:05 (T66)	16:19
5	05:13	05:57	06:52		07:43 (T45)	07:46			07:46		08:33 (T67)	08:40
	22:13	21:32	20:22	21	08:04 (T45)	19:07			16:58	53	16:05 (T66)	16:18
6	05:14	05:59	06:54		07:42 (T45)	07:48			07:48		08:34 (T67)	08:41
	22:13	21:30	20:20	23	08:05 (T45)	19:05			16:56	54	16:07 (T66)	16:18
7	05:15	06:00	06:56		07:41 (T45)	07:50			07:50		08:34 (T67)	08:43
	22:12	21:28	20:17	24	08:05 (T45)	19:03			16:54	54	16:07 (T66)	16:17
8	05:16	06:02	06:58		07:40 (T45)	07:52			07:52		08:34 (T67)	08:44
	22:11	21:26	20:15	26	08:06 (T45)	19:00			16:52	54	16:06 (T66)	16:17
9	05:17	06:04	06:59		07:39 (T45)	07:54			07:54		08:34 (T67)	08:45
	22:10	21:24	20:12	26	08:05 (T45)	18:58			16:51	52	16:06 (T66)	16:16
10	05:18	06:06	07:01		07:39 (T45)	07:56			07:56		08:34 (T67)	08:46
	22:10	21:22	20:10	26	08:05 (T45)	18:55			16:49	52	16:06 (T66)	16:16
11	05:19	06:07	07:03		07:39 (T45)	07:58			07:58		08:35 (T67)	08:48
	22:09	21:20	20:07	26	08:05 (T45)	18:53			16:47	51	16:06 (T66)	16:16
12	05:20	06:09	07:05		07:39 (T45)	08:00			08:00		08:35 (T67)	08:49
	22:08	21:18	20:05	26	08:05 (T45)	18:50			16:45	49	16:05 (T66)	16:16
13	05:21	06:11	07:07		07:38 (T45)	08:01			08:02		08:37 (T67)	08:50
	22:07	21:15	20:02	25	08:03 (T45)	18:48			16:44	46	16:06 (T66)	16:15
14	05:23	06:13	07:08		07:39 (T45)	08:03			08:04		08:38 (T67)	08:51
	22:06	21:13	20:00	24	08:03 (T45)	18:46			16:42	43	16:05 (T66)	16:15
15	05:24	06:14	07:10		07:39 (T45)	08:05			08:06		08:39 (T67)	08:52
	22:05	21:11	19:57	23	08:02 (T45)	18:43			16:40	39	16:04 (T66)	16:15
16	05:25	06:16	07:12		07:40 (T45)	08:07			08:07		08:40 (T67)	08:53
	22:03	21:09	19:55	20	08:00 (T45)	18:41			16:39	34	16:03 (T66)	16:15
17	05:27	06:18	07:14		07:41 (T45)	08:09			08:09		08:42 (T67)	08:53
	22:02	21:07	19:52	17	07:58 (T45)	18:39			16:37	29	16:02 (T66)	16:16
18	05:28	06:20	07:16		07:43 (T45)	08:11			08:11		08:44 (T67)	08:54
	22:01	21:04	19:50	12	07:55 (T45)	18:36			16:36	22	16:01 (T66)	16:16
19	05:29	06:22	07:17			08:13			08:13		15:50 (T66)	08:55
	22:00	21:02	19:47			18:34			16:34	9	15:59 (T66)	16:16
20	05:31	06:23	07:19			08:15			08:15			08:56
	21:58	21:00	19:45			18:32			16:33			16:16
21	05:32	06:25	07:21			08:17			08:17			08:56
	21:57	20:58	19:42			18:30			16:32			16:17
22	05:34	06:27	07:23			08:19			08:19			08:57
	21:56	20:55	19:40			18:27			16:30			16:17
23	05:35	06:29	07:25			08:21			08:20			08:57
	21:54	20:53	19:37			18:25			16:29			16:18
24	05:37	06:31	07:26			08:22			08:22			08:58
	21:53	20:51	19:35			18:23			16:28			16:18
25	05:38	06:32	07:28			07:24			08:24			08:58
	21:51	20:48	19:32			17:21			16:27			16:19
26	05:40	06:34	07:30			07:26			08:26			08:58
	21:49	20:46	19:30			17:18			16:26			16:20
27	05:42	06:36	07:32			07:28			08:27			08:59
	21:48	20:44	19:27			17:16			16:25			16:21
28	05:43	06:38	07:34			07:30		08:42 (T67)	08:29			08:59
	21:46	20:41	19:25			17:14	8	08:50 (T67)	16:24			16:21
29	05:45	06:40	07:35			07:32		08:39 (T67)	08:31			08:59
	21:44	20:39	19:22			17:12	24	15:58 (T66)	16:23			16:22
30	05:47	06:41	07:37			07:34		08:38 (T67)	08:32			08:59
	21:43	20:37	19:20			17:10	33	16:01 (T66)	16:22			16:23
31	05:48	06:43				07:36		08:37 (T67)				08:59
	21:41	20:34				17:08	38	16:02 (T66)				16:24
Potential sun hours	514	461	382			328			258			231
Total, worst case				359			103			833		
Sun reduction				0.29			0.23			0.20		
Oper. time red.				0.95			0.95			0.95		
Wind dir. red.				0.69			0.64			0.64		
Total reduction				0.19			0.14			0.12		
Total, real				68			15			100		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

9 TERRESTRIAL ECOLOGY

9.1 INTRODUCTION

In this flora and fauna component of the EIS emphasis is placed on identification of natural and/or semi-natural habitats and assessment of their quality. Emphasis is placed on identification and assessment of habitats of conservation value, as well as breeding and wintering bird species. The study included specific surveys for otters and bats.

This report was carried out by Biosphere Environmental Services and is based on work carried out in the period 2010 to 2013. It is noted that an ecological assessment had previously been carried out in 2002 on the same site for the permitted wind farm (planning ref. PL 16.131260).

9.1.1 Locational and General Information

The Oweninny cutaway bog site is located at Bellacorick in north-west Mayo. This part of County Mayo is dominated by Atlantic blanket bog – whilst large areas of bog have been cut for peat extraction, planted with coniferous forests or improved for agriculture, substantial tracts of intact or largely intact bogs remain and these are of high conservation importance in both an Irish and European context.

The Oweninny site is centred at Bellacorick and extends over a large area (c.5,000 ha) to the north of the N59 National Primary Road. A third class road leading northwards from the N59 to Sheskin Lodge and beyond skirts part of the western boundary. To the east a local road runs northwards from the N59 to the townlands of Shanvolahan and Formoyle. The site is contiguous with the Bellacorick Bog Complex SAC (which includes the Knockmoyle Nature Reserve) along parts of its western and northern boundaries and along much of the eastern boundary (see following section for a summary of sites of conservation importance in area). Coillte forest plantations occur to the north-west and north-east of the site, while there are small areas of marginal farmland to the south-west and south-east.

The site is irregular in outline and extends in an east to west direction for some 11km and in a north south direction some 7.4km. It comprises two distinct areas divided almost entirely by a narrow strip of private land holdings but is linked by an internal bridge over the Oweninny River. Bord na Móna was involved in industrial scale peat production operations at the site for half a century to supply the ESB Bellacorick peat burning power station. Peat production commenced in the 1950s and harvesting operations ceased in 2003 followed by the closure of the power station in 2005 and subsequent decommissioning. Internally, the site is traversed by the former Bord na Móna rail network, which is now a network of drivable roads. A wind farm, comprising 21 turbines, has been operating within the site since 1992. The site includes some 352 hectares of Coillte forest plantation comprising mainly Sitka Spruce and Lodgepole pine. This is located mainly around and to the northwest of Lough Dahybaun. The site also encompasses 192 hectares of private forest plantation land at Corvoderry.

The Oweninny River, which gives the site its name, forms part of the northern boundary of the site. This is joined by the Sheskin, Knockmoyle, Sruffaunnamuingabatia and

Fiddaunnamuingeery streams before flowing south through the central area of the site being joined by the Muing and then joining the Altnabrocky just south of Bellacorick Bridge to form the Owenmore River which flows westwards to the sea. The north eastern part of the site is drained by a river also known as the Owenmore, which rises in Shanvolahan before flowing eastwards becoming the Clonaghmore before entering the sea. To the south east the Fiddauntooghaun forms part of the southern boundary of the site and together with the Fiddaunagosty joins the Shanvolahan River before entering the Deel River. Lough Dahybaun, a medium sized oligotrophic lake, is located in the southern part of the site and drains via the Muing River westwards to the Oweninny just before it joins the Owenmore flowing west.

The site lands are owned by Bord na Móna and comprise largely cutover and cutaway bog land. Peat harvesting operated under an Integrated Pollution Control License (IPC License Number 505) issued by the Environmental Protection Agency (EPA). In accordance with the licence for the site a bog rehabilitation programme has been developed and implemented (between 2001 and 2012) to enhance recovery of parts of the site. As restoration of the former Atlantic blanket bog that existed at the site was not considered possible, the priority of the rehabilitation work was to stabilise the peat and encourage peat-forming vegetation on site. The rehabilitation work was undertaken largely by blocking drains and sculpting the peat surface to re-wet the peatland area. The greater part of the work was completed between 2003 and 2005.

As expected, the site is largely flat, with altitude mostly between 80 and 100 m above sea level. A higher ridge of ground occurs at Furnought, rising to 151 m (where there is a Megalithic tomb).

9.2 SURVEY METHODS AND DATA COLLATION

No limitations are associated with the habitat and bird surveys as these were carried out during the optimum periods for such surveys.

9.2.1 Habitats and Vegetation

Between July and September 2012 the composition and distribution of habitats and vegetation occurring within the Oweninny site was surveyed. Although areas which lie within the development footprint of the wind farm were prioritised for survey, areas elsewhere within the site were also visited and surveyed.

A walkover survey was conducted over ten days and the composition/distribution of habitats and vegetation types occurring were recorded. During the walkover survey copies of recent vertical aerial photographs (photographed in 2005) were used to identify and map important habitat features such as areas of bare peat, vegetated cutover bog, bog remnants, open water etc. The availability of detailed aerial photography proved to be an important aid in the interpretation of habitat/vegetation cover. A habitat distribution map for the site was subsequently compiled (see Figure 9-1), which was supported by reference to a detailed vegetation map of the Oweninny site compiled by Bord na Móna ecological staff during 2011.

At the proposed turbine locations the dominant habitats/vegetation occurring within a 50 metre radius of the turbine centre were recorded and the results/observations are presented in Appendix 9A. Whilst accurate habitat/vegetation surveying within areas of coniferous forestry was not feasible due to difficulties with access, it is noted that such areas are of low ecological interest in terms of vegetation composition.

A walkover survey of the principal remnant bog areas was conducted in October 2012 to assess their ecological quality and condition (see Figure 9-2 and Appendix 9B).

In February 2013 the proposed locations of the structures carrying power lines from Substation 1 and Substation 2 were surveyed.

Habitats occurring within the site are classified according to the scheme outlined in "A Guide to Habitats in Ireland" (Fossitt 2000)[45]. During the site survey particular attention was paid to the possible occurrence of plant species listed in either the 1999 Flora Protection Order or the Irish Red Data Book (Curtis and McGough 1988[46]). Vascular plant species nomenclature in this report follows Stace (1997[47]) whilst that of mosses follows Smith (2004[48]).

9.2.2 Bird Surveys

9.2.2.1 Summer bird surveys

The site was surveyed for breeding birds in the 2010, 2011 and 2012 seasons.

From a desk review of the 2002 survey information from the site and an initial site visit in May 2010, it was decided that a combination of survey methods would be needed to ensure adequate coverage of the potential range of bird species associated with the site. The following three-pronged approach was followed over the three seasons:

1) Transect survey
2) Vantage point watches
3) Focused surveys of specific areas of potential interest not covered by above two methods

[45] Fossitt, J. (2000) *A Guide to Habitats in Ireland*. The Heritage Council, Kilkenny.

[46] Curtis, T.G.F. & McGough, H.N. (1988) The Irish Red Data Book. 1 Vascular Plants. Stationary Office, Dublin.

[47] Stace, C. (1997). *New Flora of the British Isles* (2nd edition). Cambridge University Press, Cambridge.

[48] Smith, A.J.E. (2004). *The Moss Flora of Britain and Ireland*. 2nd edition. University Press, Cambridge.

In addition, sections of forest boundary within the site were walked for signs of Merlin[49] presence in 2011 and 2012.

Surveys were carried out in the periods indicated in Table 9.1.

Table 9.1: Summer bird survey periods

2010	2011	2012
4-5 May	15 April	12 April
24-27 May	29 April-2 May	30 April-3 May
20-23 June	1-4 June	27-29 May
	27-28 June	19-20 June
	25-26 July	24-26 June
		2-3 July
		14-15 July

Transect survey

The use of transects to record birds within sites is a well established survey method (Bibby et al. 2000[50]). The method is particularly useful for open habitats such as peatlands. The value of the method is that it is repeatable over time, which is particularly relevant to the Oweninny site where habitat conditions are somewhat transient and bird communities can be expected to change over time. At Oweninny, survey limitations exist due to the sheer scale of the site and also because of the physical ground conditions which can be difficult in places (e.g. drains, soft ground etc.).

In 2009, a transect survey for breeding birds had been carried out on the site by BirdWatch Ireland (see Copland 2010[51], 2011[52]). The transect route traversed the entire

[49] Scientific names of bird species are given in Appendix 9H

[50] Bibby et al (2000). *Bird Census Techniques*. Second Edition. Academic Press, London.

[51] Copland, A. (2010) *Birds on Oweninny Cutaway Peatlands, Co. Mayo*. BirdWatch Ireland Project Report 2009-10.

site from west to east and passed through all the main habitats within the site. After considering some options, such as numerous short transects scattered through the site, it was decided to adopt the 2009 survey route especially as it is fairly easily identifiable and is mostly along roads and tracks (hence ease of repeatability). Further, data for 2009 already exist and thus strengthen the baseline being established.

The transect is divided into 26 sections, based upon physical features such as road junctions or bends. As a result, each transect is of differing length (from 200 m to 1,578 m). The total length of the route is 17,874 m. The route of the transect is shown in Figure 9-3 and a detailed description of the transect route is given in Appendix 9C.

Two transect surveys, equating to early season and late season nesting periods were carried out in each survey year. Visits were made during suitable weather conditions (i.e. winds < Force 4, dry or mostly dry). The entire transect took approximately 13-14 hours to walk in stages over a two day period.

All birds seen or heard to either side of the transect were recorded. Most of the registrations were within a 200 m distance from the transect line though large or obvious birds, such as gulls or cuckoo, could be recorded at distances further. Birds were recorded by sight (with aid of binoculars) and sound. Evidence of breeding behaviour for each species followed the standard classification into 'confirmed', 'probable' and 'possible' categories as used in the Bird Atlas 2007-2011 project (BTO 2009[53]).

Vantage point surveys

Vantage point surveys were carried out in general accordance with the recommended methodology published by Scottish Natural Heritage (SNH 2005[54]). The purpose of these surveys was mainly to detect birds of prey, especially species such as Hen Harrier (*Circus cyaneus*) and Merlin (*Falco columbarius*), though all birds observed during watches were recorded.

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[52] Copland, A., Farrell, C.A. & McCorry, M.J. 2011. Breeding bird populations on the Oweninny cutaway peatlands, County Mayo. *Irish Birds* 9: 197-208.

[53] BTO (2009) *Bird Atlas 2007-2011: Breeding Status Codes.* Downloaded at: http://www.bto.org/birdatlas/taking_part/breedingcodes.pdf

[54] Scottish Natural Heritage (November 2005). Survey Methods for Use in Assessing the Impacts of Onshore Wind Farms on Bird Communities

As the site is not within a known breeding area for Hen Harriers (see Barton et al. 2006[55], Ruddock et al. 2012[56]), and considering that large areas of the site comprise bare or sparsely vegetated cut bog, it was considered that achieving 36 hours of coverage from vantage points over all areas of the site (as recommended for hen harrier surveys in areas of known occurrence) was not merited. Rather, the aim of the VP surveys over the three seasons was to provide systematic baseline data for target bird species and to add to the overall information on birds being collated for the site. However, intensive coverage for Hen Harrier presence was achieved in summer 2012 over the heather dominated ridge to the east of Lough Dahybaun (where harriers roost in winter), which is the only area of the site that has realistic potential for nesting harriers.

Information recorded for target species included time spent on site, behaviour, habitat(s) being used and gender (where determinable).

A series of 12 vantage points were identified across the site where timed watches of up to 3 hours duration were carried out. These were in strategic positions giving views over large areas of the site. The locations of the VPs are shown in Figure 9-4. The locations and general viewable areas of the vantage points are shown in

Table 9.2.

[55] Barton, C., Pollack, C., Norriss, D.W., Nagle, T.A., Oliver, G.A. & Newton, S. (2006) The second national survey of breeding Hen Harriers *Circus cyaneus* in Ireland 2005. *Irish Birds* 8: 1-20

[56] Ruddock, M, Dunlop, B.J., O'Toole, L., Mee, A., & Nagle, T. (2012*) Republic of Ireland National Hen Harrier Survey 2010.* Irish Wildlife Manual No. 59. NPWS, Dublin.

Table 9.2: Vantage point locations

Vantage point	Easting	Northing	Description
VP1	00972	18922	From N59 – view over Lough Dahybaun, forest to west of lake, ridge used by wintering hen harriers & east to bogs of Dooleeg More.
VP2	00972	18922:	From HH ridge - view over Corvoderry forest, bog to east to Muingaieeaun forest & bog to east-north-east to Formoyle.
VP3	00385	2185	From 110 m peak above Lough Navaghram - view looking west towards eastern side of Corvoderry forest & all bog northwards to north boundary of site.
VP4	00385	2185	From 110 m peak above Lough Navaghram - view looking east over much of eastern boundary and bog beyond.
VP5	98404	21054	VP just off wind farm road looking over existing windfarm and bog with ridges to north and west.
VP6	99254	22400	VP at Croaghaun West – view northwards over extensive bog of Knockmoyle and areas of bog within site, also Oweninny river valley and farm complex. Eastwards towards wind farm sheds.
VP7	00745	23270	VP along track looking east over extensive bog area and north towards iron flush. Also Furnough forest to SE
VP8	00418	24858	VP on track just north of iron flush. Looking north over open bog, Knockmoyle to west, Fiddaunnamuingeery to east and extensive forest to north east.
VP9	97628	21381	VP on road just beyond farm – view west over bog towards 104 m ridge and to south boundary of site
VP10	96089	24308	From track looking north over O'Boyle's Bog and extensive forests to north and east (Sheskin)
VP 11	96089	24308	From track looking south over bog towards 104 m ridge.
VP12	94592	23638	From west end of track looking west over extreme

Vantage point	Easting	Northing	Description
			western margin of site and over Sheskin forest and Tawnaghmore bog to west of site.

Focused habitat surveys

During each survey session, time was given to specific search for breeding birds of conservation importance, especially waders and wildfowl and birds of prey, in areas of the site where suitable habitats exist. Such areas included the scattered remnants of intact blanket bog, the large complex of blanket bog in the north-west (known as O'Boyle's Bog), the many small ponds especially in the south-east sector, and the large ponds associated with the old power station.

Merlin survey

As well as the use of vantage points, survey for Merlin was carried out by sign searching (Lusby et al. 2011[57] based on Hardy et al. 2009[58]). Prominent features (posts, pine stumps, hummocks etc.) along selected forest edges which could be used as perches by Merlin were checked for signs of activity (prey remains, pellets, feathers etc.). Strips of approximately 200 m width were walked when searching for evidence. The searches were carried out along the forests extending from Furnought southwards towards Lough Dahybaun.

9.2.2.2 Winter bird surveys

The site was surveyed for wintering birds in winters 2011/12 and 2012/13. In addition, a site visit in February 2011 was focused specifically on search for Greenland White-fronted Geese on site and in the wider area. Surveys were carried in the periods indicated in Table 9.3.

Table 9.3: Winter bird survey periods

2011	2012	2013

[57] Lusby, J., Fernandez-Bellon, Norriss, D. & Lauder, A. (2011) Assessing the effectiveness of monitoring methods for Merlin in Ireland: the Pilot Merlin Survey 2010. *Irish Birds* 9: 143-154.

[58] Hardy, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. (2009) *Raptors: a field guide for surveys and monitoring.* Stationery Office, Edinburgh.

1-3 February 2011	12-14 January 2012	23-25 January 2013
14-16 November 2011	6-8 February 2012	20-22 February 2013
	28 February – 1 March 2012	13-15 March 2013
	11-12 November 2012	
	17-19 December 2012	

The winter surveys were focused on the potential presence of the following groups of birds or species:

- Wildfowl, including geese and swans
- Waders, especially Golden Plover
- Hen Harriers, Merlin and other birds of prey

In addition, all other winter birds using the site were recorded during the various surveys. The following methods were employed during the winter site visits:

Hen Harrier roost watches

A known roost site in the vicinity of Lough Dahybaun was surveyed using the methodology for roost search of the Irish Hen Harrier Winter Roost Survey (coordinated by Dr Barry O'Donoghue, NPWS). Two observers positioned themselves at two of the vantage points selected for the summer surveys - VP1 (on road to south of roost area) and VP2 (on track close to roost with observations made mostly from within a vehicle to avoid disturbance).

Observers were in place between 90 and 120 minutes before sunset and as near to sunrise as possible (morning watches were often hampered by fog). Observers kept in contact by mobile phone. Particular attention was given to establishing the arrival and departure routes of the birds.

During these evening and morning watches, attention was also given to the possibility of passing geese and swans.

Vantage point watches

Watches of up to 3 hours were made from a selection of the vantage points used in the summer surveys (mainly VPs 3, 6, 8, 10). All birds observed during the watches were recorded with full details noted for target species.

Transect survey

A section of the transect used to record breeding birds was used for the winter survey. This comprised sections 1-11 in the western part of the site and amounted to a distance of 7.3 km. Methodology was similar to that used in summer.

Focused surveys

During each winter session, a general visit was made to ponds and flooded areas throughout the site for waterbirds.

9.2.2.3 Autumn bird surveys

Site surveys were carried out in October 2011 and from August to October 2012, as per Table 9.4.

Table 9.4: Autumn bird survey periods

2011	2012
13-14 October, 2011	20-21 August, 2012
	18-19 September, 2012
	17-18 October, 2012

The main purpose of these surveys was to assess whether there are movements of migratory birds, such as waders, wildfowl or passerines, within or across the site.

The approach used was to achieve ground coverage of the site with focus on ponds which might support waterbirds on passage.

Selected vantage point watches were carried out on each survey, with evening watches (to 1 hour past sunset) in October 2011 and October 2012 for passing geese and swans.

9.2.3 Bat Survey

A bat assessment for the site was carried out by Mr Conor Kelleher. This comprised a desk study into previous records of bat species (from *Bat Conservation Ireland's* National Bat Distribution Database) in the area of the proposed development and that of site visits on 21st October 2011 and 8th August 2012 during which the on-site habitats (the nature of which are indicative of the bat species likely to be present) were assessed during daylight hours for their favourability for bats. Also, a bat activity survey was carried out at dusk and through the night using a *Batbox Duet* heterodyne/frequency division detector.

The first survey was undertaken within the autumn season while bats were still active due to unseasonably mild weather with temperatures of 12℃ in daylight hours and 9℃ after dark. Winds were light and rainfall was light and intermittent. The second survey was undertaken within the late summer season when adult as well as juvenile bats were on the wing and in temperatures of 19℃ in daylight hours and 13℃ at night. During survey in August, wind conditions were calm and there was no rainfall. These weather conditions provided optimum conditions for flying bats.

9.2.4 Otter Survey

An otter survey was carried out by Dr Derek McLoughlin, assisted by ecologist Mr Conor Ryan. Site specific information for otters on site was provided by Bord na Móna ecologist Mr David Fallon, whilst doing habitat surveys in 2011 & 2012. These records are also presented in this report.

The methods for this study broadly follow the National Roads Authorities' Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes (National Roads Authority 2006 & 2007).

The banks of all the primary river channels and the larger tributaries on the Oweninny site were searched for Otter signs including spraints, footprints, slides, resting areas and holts. Prominent physical features, e.g. stream/river junctions, large rocks, ledges under bridges were checked for Otter signs where they occurred within approximately 20 metres of the main channels. Where any signs were found along tributaries, these streams were searched for further signs and holts. Two surveyors worked in tandem on either bank side to cover a given stretch of river channel simultaneously.

Particular attention was given to river bank areas with undercut trees, as the root system of some species of large tree can provide ledges and caverns in which holts are often located. Although the primary target of this study was Otters, where practical, signs of other mammals were recorded throughout the course of the survey.

9.2.4.1 Survey route distance & survey timing

Approximately 41 km of river channel was surveyed for Otters over four days by two surveyors between 15th June and 18th July 2012. An approximate break-down is given in Table 9.5 below. In addition, some smaller tributaries were also surveyed. The survey route is illustrated in.

Table 9.5: Approximate length of survey route for otter.

River channel/tributaries	Length (km)
Oweninny	25
Muing	5.5
Ballymonnelly	3
Deel Catchment stream (east of site)	7.5
Total	41

9.2.5 Other Mammals, Amphibians and Reptiles

During the otter, bat, bird and habitat surveys, observations were made for other mammal species, amphibians and reptiles. Presence of mammals is indicated principally by their signs, such as dwellings, feeding signs or droppings - though direct observations are also occasionally made. The nature and type of habitats present are also indicative of the species likely to be present.

9.2.6 Criteria for Evaluation of Ecological Resources and Impact Assessment

The evaluation of ecological interests and assessment of impacts is assisted by the relevant guidance documents, namely the NRA Guidelines for Assessment of Ecological Impacts of National Road Schemes (NRA, 2009[59]) and the EPA Guidelines on the Information to be Contained in Environmental Impact Statements (EPA, 2002[60]). Whilst the NRA guidelines were devised specifically for road schemes, they can be applied to general environmental impact assessment. Reference is also made to guidance in the IEEM Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM 2006[61]). The evaluation of ecological resources used in this report is in line with the NRA system, using the following five-point scale:

- International Importance
- National Importance
- County Importance
- Local Importance (higher value)
- Local Importance (lower value)

The prediction of impacts considers such factors as the magnitude, extent, duration and the timing and frequency of the predicted impact. The likelihood of the impact occurring is also considered where possible. From these criteria the significance of the impact is determined on the basis of the factors which characterise the ecological receptor (receptor being habitat and/or species) and take into account the effects on the conservation status or integrity of the receptor resulting from the proposed development. The integrity of a receptor can be regarded as the coherence of ecological structure and function, across the entirety of a receptor, which enables it to sustain all of the ecological resources for which it has been valued. The impact significance criteria (EPA, 2002) as set out in Table 9.6 are used where applicable.

Table 9.6: Impact significance criteria

Significance of Impact	Significance Criteria

[59] National Roads Authority [2009] Guidelines for Assessment of Ecological Impacts of National Road Schemes. NRA, Dublin. (Revision, 21st June 2009)

[60] Environmental Protection Agency (2002) Guidelines on the information to be contained in Environmental Impacts Statements. EPA, Co Wexford.

[61] Guidelines for Ecological Impact Assessment In the United Kingdom, IEEM 2006

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

9.3 RECEIVING ENVIRONMENT

9.3.1 Sites Designated for Nature Conservation

North Mayo is of particular significance for the large number of sites of nature conservation importance. These include European sites (SACs, SPAs) and sites designated under the Wildlife Acts (NHAs, Nature Reserves). There are also a large number of proposed NHAs though these generally correspond with the European sites.

The following sites of nature conservation importance occur within a 15 km radius of the Oweninny wind farm (see Figure 9-6).

9.3.1.1 Special Areas of Conservation (SAC)

SACs are designated under Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

Bellacorick Iron Flush candidate Special Area of Conservation (code 0466)

This small site is entirely surrounded by the Oweninny wind farm site. It is a small minerotrophic fen with an associated area of blanket bog pools/dystrophic lake developed on glacial till overlying calcareous sandstone. The site supports several rare and protected plant species, including marsh saxifrage. Part of the SAC is owned by An Taisce and is managed for nature conservation.

Lough Dahybaun candidate Special Area of Conservation (code 02177)

This lake, which is partly within the Oweninny wind farm site, is a good example of an oligotrophic lake surrounded by blanket bog. It supports the rare and protected plant species Slender Naiad (*Najas flexilis*).

Bellacorick Bog Complex candidate Special Area of Conservation (code 01922)

This is a large blanket bog site with some of the best examples of lowland blanket bog in the country and particularly well developed pool systems. A small portion of O'Boyle's Bog (which is part of Oweninny wind farm site) is included within the SAC site. The site includes the Knockmoyle Sheskin Nature Reserve and the Owenboy Nature Reserve.

Owenduff/Nephin Complex candidate Special Area of Conservation (code 0534)

This very large site extends from south-east of Bellacorick (and the Oweninny wind farm) to include the entire Nephin Beg range. It is an excellent example of a peatland landscape, with extensive blanket bog and wet heath.

River Moy candidate Special Area of Conservation (code 02298)

This very large site comprises almost the entire freshwater element of the Moy and its tributaries and includes both Loughs Conn and Cullen. Includes the Deel River to the west of Crossmolina.

Carrowmore Lake candidate Special Area of Conservation (code 0476)

Carrowmore Lake is a large, shallow oligotrophic/mesotrophic lake. The SAC includes the entire lake system and an adjoining tract of blanket bog (Largan More Bog).

Broadhaven Bay candidate Special Area of Conservation (code 0472)

This large coastal site, which includes Sruwaddacon Bay, is of importance for an excellent range of coastal and estuarine/marine habitats. The site is also a proposed Natural Heritage Area.

Slieve Fyagh Bog candidate Special Area of Conservation (code 0542)

This site supports a large area of mountain blanket bog, a habitat that is uncommon in the region.

Glenamoy Bog Complex candidate Special Area of Conservation (code 0500)

This very large site supports one of the largest areas of undisturbed blanket bog in the country, as well as a range of related habitats.

9.3.1.2 Special Protection Areas (SPA)

SPAs are designated under Council Directive 79/409/EEC on the conservation of wild birds.

Owenduff/Nephin Complex SPA (code 004098)

This very large site, which is coincident with the SAC, supports a range of typical peatland bird species. It is selected specifically for populations of Greenland White-fronted Geese, Merlin, Peregrine and Golden Plover.

Lough Conn and Lough Cullin SPA (code 004228)

These lakes are of particular ornithological importance for wintering Greenland White-fronted Geese and Tufted Duck and for nesting Common Scoter and Common Gull.

Carrowmore Lake SPA (code 004052)

The Carrowmore Lake SPA supports an important breeding colony of Common Gulls and has supported Sandwich Terns in the past. During winter, the lake is used Greenland White-fronted Geese and various wildfowl species. The lake is also a Wildfowl

Sanctuary.

Blacksod Bay/Broadhaven SPA (code 004037)

This large site comprises all of the inner part of Broadhaven Bay, including Sruwaddacon Bay, and the various sheltered bays and inlets in Blacksod Bay. The site is of high ornithological importance for its excellent diversity of wintering waterfowl which includes nationally important populations of five species.

9.3.1.3 Natural Heritage Areas (NHA)

NHAs are designated under the Wildlife Amendment Act 2000.

Forrew Bog NHA (code 002432)

This lowland blanket bog is located approximately 6 km north-west of Crossmolina. It includes areas of intact bog with interconnecting pool systems and areas of re-vegetated cutover and flushes.

Ummerantarry Bog NHA (code 001570)

This area of upland blanket bog is located approximately 20 km north-west of Crossmolina, near Crocknacaly. Breeding Golden Plover occur on the site.

Inagh Bog NHA (code 002391)

This upland blanket bog is located approximately 4 km south-south-east of Belderg in north Mayo. It includes an extensive area of undisturbed blanket bog, which supports Red Grouse and breeding Golden Plover.

9.3.1.4 Proposed Natural Heritage Areas (pNHA)

pNHAs do not receive legal protection though the ecological value of pNHAs is recognised by Planning and Licensing Authorities.

- Bellacorick Iron Flush pNHA (code 0466)
- Bellacorick Bog Complex pNHA (code 01922)
- Owenduff/Nephin Complex pNHA (code 0534)
- River Moy pNHA (code 02298)
- Carrowmore Lake pNHA (code 0476)
- Broadhaven Bay pNHA (code 0472)
- Slieve Fyagh Bog pNHA (code 0542)
- Glenamoy Bog Complex pNHA (code 0500)

9.3.1.5 Statutory Nature Reserves

Knockmoyle Sheskin Nature Reserve

This site comprises an extensive area of lowland blanket bog densely pool-studded and with interesting flushes. Established in 1986, this state owned site adjoins the Oweninny wind farm site. The nature reserve is also a Ramsar site and a Council of Europe Biogenetic Reserve.

Owenboy Nature Reserve

This site comprises an extensive bog of intermediate type lying in a broad basin. It contains a number of low domes resembling raised bogs and has numerous flushes.

Established in 1986, this state owned site occurs just south of the N59 and at the closest is approximately 1.5 km from the south-east boundary of the Oweninny wind farm site. The nature reserve is also a Ramsar site and a Council of Europe Biogenetic Reserve.

9.3.1.6 National Parks

The **Ballycroy National Park** was established in 1998 and covers approximately 11,000 ha of Atlantic blanket bog and mountainous terrain. It is a vast uninhabited area dominated by the Nephin Beg range. The park is managed by the Department of Arts, Heritage and the Gaeltacht according to the criteria and standards for National Parks as set by the International Union for the Conservation of Nature (IUCN). The northern end of the park lies within 5 km of the Oweninny wind farm site.

9.3.2 Habitats, Vegetation and Flora

A general description of the habitats and vegetation types within the entire Oweninny site is presented. This is followed by descriptions for the turbine locations and the various associated infrastructure. Detailed descriptions of the remnant bog areas (no. 46) which are scattered throughout the site are presented in Appendix 9B.

9.3.2.1 Description of habitats on site

In general the Oweninny site is dominated by cutover blanket bog which was harvested commercially between the 1950s and the early 2000s. In addition to the cutover bog there are a large number (no. 46) of remnant bog areas which lie scattered throughout the site. Although these remnant areas are dominated by lowland blanket bog they also contain areas of dry heath and wet heath and patches of rich fen and flush. Various lakes and ponds, some of recent origin, occur scattered through the site. In the south-eastern portion of the site there are a number of areas dominated by commercial conifer plantation on peat. There follows a description of the principal habitats which occur on the site, with a summary in Table 9.7, where applicable, the corresponding Annex I habitat category of the EU Habitats Directive is given.

Table 9.7:. Summary of habitat types found on site. Classification is after Fossitt (2000). Where relevant, the corresponding Annex 1 habitat of the EU Habitats Directive is given.

Habitat Type (Fossitt)	EU Habitats Directive
Dystrophic lakes (FL1)	Natural dystrophic lakes and ponds (3160).
Acid oligotrophic lakes (FL2)	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* (3130)
Artificial lakes (FL8)	-
Eroding/upland rivers (FW1)	-
Drainage ditches (FW4)	-
Calcareous springs (FP1)	*Petrifying springs with tufa formation (*Cratoneurio*n) (7220)

Habitat Type (Fossitt)	EU Habitats Directive
Reed and large sedge swamps (FS1)	-
Improved grassland (GA1)	-
Dry meadows and grassy verges (GS2)	-
Dry-humid acid grassland (GS3)	-
Wet grassland (GS4)	-
Dry siliceous heath (HH1)	European dry heaths (4030)
Wet heath (HH3)	Northern Atlantic wet heaths with *Erica tetralix* (4010)
Lowland blanket bog (PB3)	Blanket bogs (* if active bog) (7130)
Cutover blanket bog (PB4)	-
Rich fen and flush (PF1)	Alkaline fen (7230)
Poor fen and flush (PF2)	-
Conifer plantation (WD4)	-
Scrub (WS1)	-
Exposed sand, gravel or till (ED1)	-
Buildings and artificial surfaces (BL3)	-

** indicates Annex I habitat with priority status*

Dystrophic lakes (FL1)

Dystrophic lakes, which usually have a sharply defined, peaty, lake edge, occur within some of the bog remnant areas on site. There is generally little associated vegetation in these lakes apart from some sparse common bog-cotton (*Eriophorum angustifolium*) and the bog moss *Sphagnum cuspidatum* along the margins. The aquatic species American pipewort (*Eriocaulon aquaticum*), which has a very restricted distribution in Europe (western Ireland and Scotland), occasionally grows along the margins of a small number of dystrophic lakes.

Most of the best examples of dystrophic lakes within the survey area are found near the wettest central areas of the larger bog remnants. It is often difficult to separate this lake type from acid oligotrophic lakes, which generally have a stony lake shore.

These lakes correspond to the Annex I habitat “natural dystrophic lakes and ponds (3160)”.

Plate 9-1: View of a dystrophic lake within a bog remnant area with bog islands.

Acid oligotrophic lakes (FL2)

A number of small, lowland oligotrophic lakes occur throughout the site. These generally lie within the blanket bog remnant areas. Although it can be difficult to distinguish the lake type from dystrophic lakes, the fringing vegetation is usually better developed. Fringing vegetation is generally still sparse and is largely confined to narrow bands of bottle sedge (*Carex rostrata*) swamp with occasional stunted willows. Additional swamp species which grow along the shallow water of the margins include water horsetail (*Equisetum fluviatile*), bog bean (*Menyanthes trifoliate*) and common reed (*Phragmites australis*), though extensive areas of swamp dominated by these species is rare.

Lough Dahybaun Special Area of Conservation is an excellent example of an acid, oligotrophic lake and contains a population of the legally protected (Flora Protection Order) and Annex II listed plant species slender Naiad (*Najas flexilis*). This rare aquatic plant was recorded at the site in 1987 and 1995. Slender Naiad occurs in association with a range of other aquatic and emergent species, including Common Club-rush (*Scirpus lacustris),* Bristle Club-rush *(S. setaceus),* Bulbous Rush *(Juncus bulbous),* Horned Pondweed *(Zannichellia palustris),* Bottle Sedge *(Carex rostrata),* Bulrush *(Typha latifolia),* Yellow Water-lily *(Nuphar lutea)*, Curled Pondweed (*Potamogeton crispus),* Water Horsetail *(Equisetum fluviatile)* and species of Stonewort *(Chara* sp*.).*

These lakes correspond to the Annex I habitat "oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* (3130)".

Artificial lakes (FL8)

In the cutover bog areas of the site there are a number of substantial open water areas which have developed in low-lying depressions with poor drainage or have been developed from long term siltation areas developed under the site rehabilitation programme post peat production.

These lakes are a by-product of peat harvesting and they are not considered to be examples of natural dystrophic pools. The water levels within these “lakes” fluctuate markedly throughout the year and often there is little or no associated swamp/wetland vegetation along the lake margins.

Plate 9-2: An artificial lake in cutover bog west of the existing windfarm. Note the absence of fringing wetland vegetation.

Eroding/upland rivers (FW1)

Most of the river channels within the site are narrow, i.e. <5 metres wide, and are best described as eroding/upland rivers. In many areas these rivers have been widened and substantially deepened in the past in order to facilitate better drainage of the adjoining cutover bog areas. In general there is little growing within the river channels apart from small patches of bulbous rush (*Juncus bulbosus*) and various pondweeds (*Potamogeton* sp.). Along the river margins which are liable to flood the vegetation is mostly characterised by wet grassland vegetation in which soft rush (*Juncus effusus*) dominates, with purple moor grass (*Molinia caerulea*) dominant in more peatier areas. Occasional shrubs of willow (*Salix aurita*) and gorse (*Ulex europaeus*) also occur.

Plate 9-3: River Muing in the south of the site with fringing acid grassland and conifer forest plantation.

Drainage ditches (FW4)

Drainage ditches are a frequent feature of the Oweninny cutover. The ditches were excavated as part of peat extraction and are now generally less than 1 metre in depth. Throughout the site most of these have been blocked with peat dams within the last ten years as part of a bog rehabilitation programme. In areas where peat harvesting continued up until 2003 there is little or no associated ditch vegetation. In more vegetated areas of cutover bog however most drains are colonized by species such as soft rush (*Juncus effusus*), common bog-cotton (*Eriophorum angustifolium*), bog pondweed (*Potamogeton polygonifolius*), jointed rush (*Juncus articulatus*), bulbous rush (*Juncus bulbosus*) and the mosses *Sphagnum cuspidatum* and *Polytrichum commune*.

Calcareous springs (FP1)

One small area of calcareous spring habitat with tufa formation occurs beside an old railway bed in cutaway bog in the south-eastern corner of the site. The spring vegetation at this location is dominated by mounds of the moss *Philonotis calcarea* with frequent marsh horsetail (*Equisetum palustre*), colt's foot (*Tussilago farafara*) and common reed (*Phragmites australis*). Many of the other frequent associated plant species are indicator species of alkaline fen habitat. The habitat merges with bottle sedge (*Carex rostrata*) swamp to the south.

This area of habitat corresponds to the priority Annex I habitat "petrifying springs with tufa formation (Cratoneurion) (7220)

Plate 9-4: A view of calcareous spring vegetation with calcium carbonate visible on the surface.

Reed and large sedge swamps (FS1)

Small areas of tall reedswamp vegetation occur along the margins of lakes within the site. The main species growing include common reed (*Phragmites australis*) and reedmace (*Schoenoplectus lacustris*). Bulrush (*Typha latifolia*) is also a component of reedswamp vegetation though it is localised in distribution. Occasional stands of common reed may also be found occurring in drainage ditches and in areas of calcareous fen vegetation, however areas such as these are very limited in their occurrence.

Improved grassland (GA1)

Agriculturally improved grassland comprises a very small area of the overall site. A small area of the habitat lies to the north of the site of the old power generating station. The vegetation is generally dominated by agricultural grasses such as Yorkshire fog (*Holcus lanatus*), bent grasses (*Agrostis* sp.), sweet vernal grass (*Anthoxanthum odoratum*), *Poa* sp. (meadow grasses) and forbs such as white clover (*Trifolium repens*) and ribwort plantain (*Plantago lanceolata*).

Dry meadows and grassy verges (GS2)

Throughout the Oweninny site there is an extensive network of disused railway tracks. These railway track embankments were constructed with stone and over time relatively species-rich grassy vegetation has developed along the track margins. The most frequent and conspicuous species occurring are glaucous sedge (*Carex flacca*), common bent (*Agrostis capillaris*), ribwort plantain (*Plantago lanceolata*), annual meadow-grass (*Poa annua*) and colts foot (*Tussilago farafara*). Table 9.8 outlines the typical range of species present.

Table 9.8: Typical species list for grassland on old railway tracks.

Scientific name	English name	Scientific name	English name
Agrostis capillaris	Common bent	*Leucanthemum vulgare*	Ox eye daisy
Anthoxanthum odoratum	Sweet vernal grass	*Linum catharticum*	Fairy flax
Bellis perennis	Daisy	*Lotus corniculatus*	Birds foot trefoil
Carex flacca	Glaucous sedge	*Molinia caerulea*	Purple moor-grass
Carex nigra	Common sedge	*Pilosella officinarium*	Mouse-eared hawkweed
Carex viridula oedocarpa	Short-stalked yellow sedge	*Plantago lanceolata*	Ribwort plantain
Centaurea nigra	Knapweed	*Poa annua*	Annual meadow grass
Centaurium erythraea	Common centaury	*Polygala serpyllifolia*	Heath milkwort
Cerastium fontanum	Common mouse-ear	*Potentilla anserina*	Silverweed
Cirsium arvense	Creeping thistle	*Potentilla erecta*	Tormentil
Daucus carota	Wild carrot	*Prunella vulgaris*	Self heal
Equisetum arvense	Field horsetail	*Sagina nodosa*	Knotted pearlwort
Erica cinerea	Bell heather	*Succisa pratensis*	Devils bit scabious
Euphrasia sp.	Eyebright species	*Taraxacum officinale*	Dandelion
Festuca ovina	Sheeps fescue	*Trifolium dubium*	Lesser Trefoil
Festuca rubra	Red fescue	*Trifolium pratense*	Red clover
Gentianella campestris	Field gentian	*Tussilago farfara*	Colts foot
Holcus lanatus	Yorkshire fog	*Viola riviniana*	Dog violet
Juncus articulatus	Jointed rush		

Dry-humid acid grassland (GS3)

Small areas of dry-humid acid grassland occur scattered throughout the site. The habitat is usually associated with freely-draining soil occurring on glacial till and many of these areas have small, disused quarries associated with them. The vegetation of this grassland type is dominated by common bent (*Agrostis capillaris*), mat grass (*Nardus stricta*), sheep's fescue (*Festuca ovina*), tormentil (*Potentilla erecta*) and the mosses *Rhytidiadelphus squarrosus* and *Hylocomium splendens*.

Wet grassland (GS4)

Much of the wet grassland vegetation within the site is dominated by tall shoots of soft rush (*Juncus effusus*), with creeping buttercup (*Ranunculus repens*), lesser spearwort (*Ranunculus flammula*) and the moss *Calliergonella cuspidata* frequent. The habitat/vegetation is found in a variety of ecological settings ranging from river margins to areas of reclaimed blanket bog in the south of the site.

Dry siliceous heath (HH1)

Species-poor dry heath, dominated by ling heather (*Calluna vulgaris*), is found on a number of low hills, mainly in the south-eastern sector of the site. Other frequent species in the vegetation include purple moor grass (*Molinia caerulea*), bell heather (*Erica cinerea*) and the mosses *Hypnum jutlandicum* and *Plagiothecium undulatum*. Areas of dry heath generally have developed on shallow peat soils (<50cm deep) on the sloping sides of low hills and usually occur in mosaic with blanket bog which dominates the adjoining areas with deeper peat. Small areas of developing dry heath dominated by *Calluna vulgaris* are also found in drier areas of cutover bog and on dry banks along the margins of blanket bog remnants.

The relatively rare montane plant species bearberry (*Arctostaphylos uva-ursi*) has been recorded from an area of dry heath within one of the bog remnants recorded central to the site.

The dry heath present on site corresponds to the Annex I habitat European dry heaths (4030). Typical dry heath species are listed in Table 9.9.

Table 9.9: Typical species list for dry heath habitat.

Scientific name	English name
Agrostis sp.	Bent grass species
Anthoxanthum odoratum	Sweet
Blechnum spicant	Hard fern
Calluna vulgaris	Ling heather
Cladonia portentosa	Lichen species
Erica cinerea	Bell heather
Hylocomium splendens	Moss species
Hypnum jutlandicum	A moss

Scientific name	English name
Molinia caerulea	Purple moor-grass
Pedicularis sylvatica	Lousewort
Plagiothecium undulatum	Moss species
Pleurozium schreberi	Moss species
Potentilla erecta	Tormentil
Scleropodium purum	A moss
Sphagnum capillifolium	Sphagnum moss species
Sphagnum palustre	Sphagnum moss species
Sphagnum tenellum	Sphagnum moss species
Tricophorum cespitosum	Deer grass

Plate 9-5: Dry heath vegetation dominated by *Calluna vulgaris* is frequent on the low hills in the south-east of the site.

Wet heath (HH3)

In terms of overall floristic composition wet heath is quite similar to dry heath. In wet heath vegetation, however, purple moor grass (*Molinia caerulea*) tends to dominate with cross-leaved heath (*Erica tetralix*), deer grass (*Trichophorum cespitosum*) and various Sphagnum mosses also conspicuous. Wet heath is often found in close proximity to dry heath and there is often a degree of ecological overlap between the two habitats. In common with dry heaths, areas of wet heath habitat occur in areas of relatively shallow peat cover or along the margins of bog remnants where there has been recent drainage.

The wet heath areas present corresponds to the Annex I habitat Northern Atlantic wet heaths with *Erica tetralix* (4010).

Lowland blanket bog (PB3)

Throughout the site there are blanket bog remnants which were not subject to peat extraction in the past. A total of 46 remnants have been identified and these are described in detail in Appendix 9B and their distribution shown in Figure 9-2. Some of these remnants remained untouched by Bord na Móna as they were unsuitable for development under the peat extraction method of the time.

Others are intact but had been ditched and drained in preparation for peat exploitation (which never occurred). Some of these had the surface vegetation removed but good recovery has since occurred. As part of the site rehabilitation programme, most of the drainage networks on these bogs have been blocked in order to restore the hydrology of the remnant. Most of the remnants are relatively small in size (< 20 ha) but there are several larger ones between 20 and 50 ha and four of substantial size, see Table 9.10:

Table 9.10: Substantial bog remnants

Bog Remnant Number	Area
1 (O'Boyle's Bog)	317
26	50
29	112
34	77

The calculated total area of the bog remnants (equating to lowland blanket bog) on site is 1,043 ha.

The peat depth within the bog remnants is generally between 1 and 4 m and they are now mostly surrounded by cutover bog – this gives many of them a 'perched' appearance.

Typically, the dominant plant species in the vegetation are purple moor-grass (*Molinia caerulea*) and ling heather (*Calluna vulgaris*), with cross-leaved heath (*Erica tetralix*), black bog-rush (*Schoenus nigricans*), bog asphodel (*Narthecium ossifragum*) and deer-grass (*Trichophorum cespitosum*) conspicuous in the more intact areas. The main bryophyte species are generally *Sphagnum capillifolium, Sphagnum papillosum, Hypnum jutlandicum* and *Racomitrium lanuginosum,* with the lichen species *Cladonia portentosa* and *Cladonia uncialis* also locally frequent. The central areas of the larger remnants are more hydrologically intact and here bog pools and small dystrophic lakes are often present. These typically contain a sparse emergent flora which includes bog bean (*Menyanthes trifoliata*), common bog-cotton (*Eriophorum angustifolium*) and the aquatic moss *Sphagnum cuspidatum*. Whilst central areas of the undrained blanket bog remnants are usually wet and have a high cover of Sphagnum mosses, the marginal areas of blanket bog remnants are often quite dry and modified, as a result of drainage effects from the surrounding cutover bog.

Blanket bog remnants with a relatively intact hydrology correspond to the Annex I habitat blanket bogs (* if active bog) (7130). Typical species listed in Table 9.11.

Table 9.11: Typical species list for lowland blanket bog habitat.

Scientific name	English name	Scientific name	English name
Agrostis sp.	Bent grass species	*Odontoschisma sphagni*	Liverwort species
Aulocomium palustris	Moss species	*Molinia caerulea*	Purple moor-grass
Calluna vulgaris	Ling heather	*Myrica gale*	Bog myrtle
Campylopus atrovirens	Moss species	*Pedicularis sylvatica*	Lousewort
Campylopus introflexus	Moss species	*Polygala serpyllifolia*	Heath milkwort
Carex panacea	Carnation sedge	*Potentilla erecta*	Tormentil
Cladonia portentosa	Lichen species	*Racomitrium lanuginosum*	A moss
Cladonia uncialis	Lichen species	*Rhynchospora alba*	White-beaked sedge
Drosera intermedia	Oblong-leaved sundew	*Schoenus nigricans*	Black bog rush
Drosera rotundifolia	Round-leaved sundew	*Sphagnum auriculatum*	Sphagnum moss species
*Eleocharis multicaulis**	Many-stalked spike-rush	*Sphagnum capillifolium*	Sphagnum moss species
Erica tetralix	Cross-leaved heath	*Sphagnum cuspidatum*	Sphagnum moss species
*Eriocaulon aquaticum**	Pipewort	*Sphagnum fuscum*	Sphagnum moss species
Eriophorum angustifolium	Common bog cotton	*Sphagnum magellanicum*	Sphagnum moss species
Eriophorum vaginatum	Hares tail bog cotton	*Sphagnum papillosum*	Sphagnum moss species
Hypnum jutlandicum	A moss	*Sphagnum tenellum*	Sphagnum moss species
*Menyanthes trifoliata**	Bog bean	*Tricophorum cespitosum*	Deer grass
Narthecium ossifragum	Bog asphodel		

* = species largely confined to bog pools

Plate 9-6: A view of intact lowland blanket bog within a bog remnant in the south-east of the site.

Many of the bog remnant areas contain substantial drains which have lowered the water table. Most of these drains have been blocked with peat dams in recent years.

Plate 9-7: Drains through bog remnants

Cutover blanket bog (PB4)

The Oweninny site is now dominated by cutover blanket bog which is the result of industrial-scale peat extraction since the 1950's. This extensive peat extraction has resulted in the presence of a variable peat cover within the site which, in turn, has resulted in a varying patchwork of plant recolonization. A full list of plant species recorded from cutover areas is presented in the following table. The main recolonizing vascular plant species are soft rush (*Juncus effusus*), common bog cotton (*Eriophorum angustifolium*) and bulbous rush (*Juncus bulbosus*). The most common moss species are *Polytrichum commune* and *Campylopus introflexus,* with *Hypnum jutlandicum* and *Sphagnum capillifolium* also locally common in areas where revegetation of cutover is more advanced. Areas of cutover which remain wet for much of the year often have a high cover of *Juncus effusus* and *Sphagnum cuspidatum*.

Past peat extraction has resulted in the presence of undulating peat surfaces which are separated by wide drains. The degree of plant recolonization evident depends to a large extent on the length of time since peat extraction. Over large areas bare peat surface dominates with occasional clumps of *Juncus effusus* and *Eriophorum angustifolium* scattered throughout, while in other areas where peat extraction ceased at an earlier time the vegetation cover comes close to 100% with *Juncus effusus* and *Polytrichum commune* the typical dominant species. This vegetation type is difficult to accurately classify however the closest fit would appear to be 'Poor fen and flush (PF2)'(Farrell 2001[62]).

In many of the low knoll areas within the site the peat layer has been excavated down to the till/subsoil and varying mixtures of *Juncus effusus* and *Polytrichum commune* have colonized growing in association with extensive areas of bare peat and gravel. Where substantial areas of bare gravels occur, these can be assigned to the habitat 'Exposed sand, gravel or till (ED1)'.

As outlined previously there are areas in which pioneer dry heath vegetation dominated by ling heather (*Calluna vulgaris*) is conspicuous. Another characteristic seen in some of the older cutover areas is the high frequency of low, naturally seeded Lodgepole pine (*Pinus contorta*) trees. If left to develop these areas would quickly develop into a scrub pine woodland.

[62] Farrell, C.A. 2001. *An ecological study of intact and industrial cutaway Atlantic blanket bog at Bellacorick, Northwest Mayo.* Ph.D. thesis, University College Dublin.

Throughout Oweninny most of the drains within areas of cutover blanket bog have been blocked with large peat dams in order to slow drainage within the site and to encourage the regeneration of wetland vegetation.

Table 9.12: Typical species list for cutover bog habitat.

Scientific name	English name	Scientific name	English name
Agrostis sp.	*Bent grass species*	*Eriophorum vaginatum*	*Hares tail bog cotton*
Anthoxanthum odoratum	*Sweet vernal grass*	*Holcus lanatus*	*Yorkshire fog*
Aulocomium palustris	*Moss species*	*Hypnum jutlandicum*	*A moss*
Blechnum spicant	*Hard fern*	*Juncus bulbosus*	*Bulbous rush*
*Calliergonella cuspidata**	*Moss species*	*Juncus effusus*	*Soft rush*
Calluna vulgaris	*Ling heather*	*Juncus squarrosus*	*Heath rush*
Campylopus atrovirens	*Moss species*	*Molinia caerulea*	*Purple moor-grass*
Campylopus introflexus	*Moss species*	*Narthecium ossifragum*	*Bog asphodel*
Carex panicea	*Carnation sedge*	*Phragmites australis**	*Common reed*
*Carex rostrata**	*Bottle sedge*	*Picea sitchensis*	*Sitka spruce*
Carex viridula subsp. oedocarpa	*Short-stalked yellow sedge*	*Pinus contorta*	*Lodgepole pine*
Cirsium palustre	*Marsh thistle*	*Polytrichum commune*	*Moss species*
Cladonia portentosa	*A lichen*	*Polytrichum juniperinum*	*Moss species*
Drosera rotundifolia	*Round-leaved sundew*	*Potentilla erecta*	*Tormentil*
Dryopteris dilatata	*Broad-buckler fern*	*Racomitrium lanuginosum*	*A moss*
Empetrum nigrum	*Crowberry*	*Rhododendron ponticum seedlings*	*Rhododendron*
Erica cinerea	*Bell heather*	*Rhytidiadelphus squarrosus*	*Moss species*
Erica tetralix	*Cross-leaved heath*	*Rubus fruticosus*	*Bramble*

Scientific name	English name	Scientific name	English name
Eriophorum angustifolium	*Common bog cotton*	*Salix aurita*	*Eared willow*
Sphagnum auriculatum	*Sphagnum moss species*	*Sphagnum papillosum*	*Sphagnum moss species*
Sphagnum capillifolium	*Sphagnum moss species*	*Sphagnum tenellum*	*Sphagnum moss species*
*Sphagnum cuspidatum**	*Sphagnum moss species*	*Tricophorum cespitosum*	*Deer grass*
*Sphagnum fallax**	*Sphagnum moss species*	*Triglochin palustris**	*Arrow-grass*
Sphagnum palustre	*Sphagnum moss species*	*Typha latifolia**	*Bulrush*

** = species largely confined to wet areas of cutover.*

Plate 9-8: Soft rush and common bog-cotton dominate large areas of re-vegetating cutover bog.

Bare peat surface with a very sparse vegetation cover accounts for some of the areas that were still in peat production up until 2003, particularly where relatively deeper depths of peat remain at Oweninny.

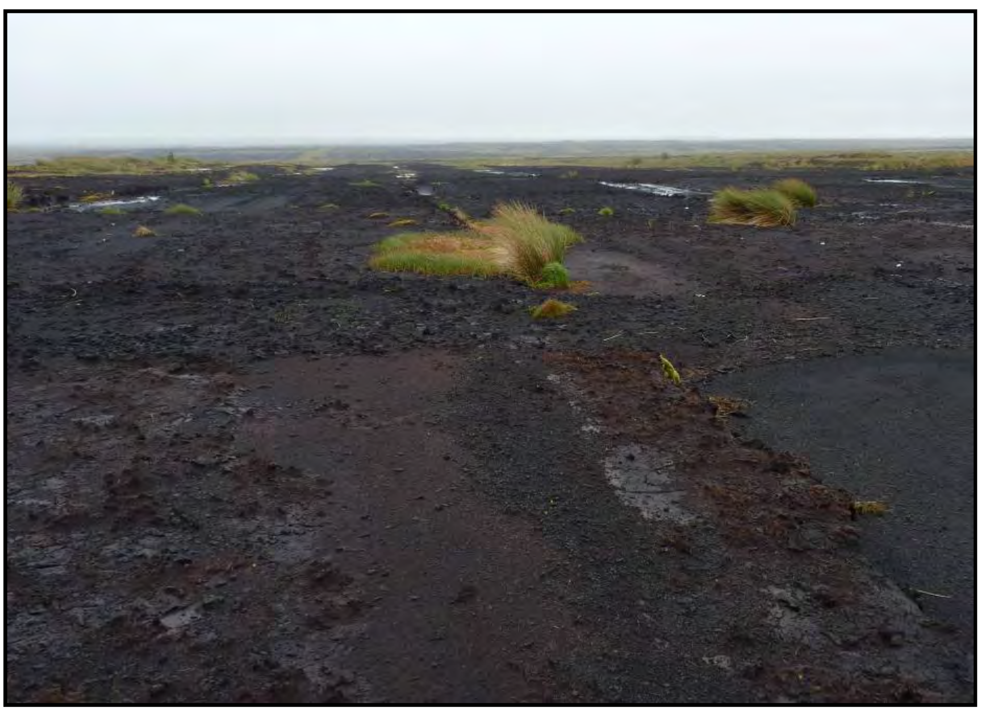

Plate 9-9: Bare peat surface

Rich fen and flush (PF1)

Rich fen and flush is an uncommon habitat within the survey area. The largest area of the habitat occurs at Bellacorick Iron Flush SAC with smaller areas of the habitat found in wet cutaway channels in the south of the site where there is some influence of upwelling base-rich water. Characteristic species of rich fen habitat include black bog rush (*Schoenus nigricans*), long-stalked yellow sedge (*Carex viridula* subsp. *brachyrhyncha*), and mosses such as *Campylium stellatum, Drepanocladus revolvens* and *Bryum pseudotriquetrum*. In most of the areas of rich fen plant species typical of more base poor waters such as bog pondweed (*Potamogeton polygonifolius*) and marsh bedstraw (*Galium palustre*) also occur.

The legally protected and Annex II listed plant species marsh saxifrage (*Saxifraga hirculus*) grows in fen habitat within the Bellacorick Iron Flush SAC and the rare moss species *Tomentypnum nitens* also occurs.

Areas of rich fen correspond to the Annex I habitat "alkaline fen" (7230), see species list in Table 9.13.

Table 9.13: Typical species list for rich fen habitat.

Scientific name	English name
Agrostis stolonifera	Creeping bent grass
Anagallis tenella	Bog pimpernel
Angelica sylvestris	Angelica
Bryum pseudotriquetrum	Moss species
Caltha plaustris	Marsh marigold
Campylium stellatum	Moss species
Cardamine pratensis	Cuckoo flower
Carex diandra	Lesser tussock sedge
Carex flacca	Glaucous sedge
Carex nigra	Common sedge
Carex panacea	Carnation sedge
Carex paniculata	Greater tussock sedge
Carex rostrata	Bottle sedge
Cirsium dissectum	Meadow thistle
Drepanocladus revolvens	Moss species
Equisetum fluviatile	Water horsetail
Eriophorum angustifolium	Common bog cotton
Fissidens adianthoides	Moss species
Juncus subnodulosus	Blunt-flowered rush

Scientific name	English name
Menyanthes trifoliata	Bog bean
Molinia caerulea	Purple moor-grass
Philonotis calcarea	Moss species
Philonotis Fontana	Moss species
Phragmites australis	Common reed
Potamogeton polygonifolius	Bog pondweed
Ranunculus flammula	Lesser spearwort
Sagina nodosa	Knotted pearlwort
Saxifraga hirculus	Marsh saxifrage
Schoenus nigricans	Black bog rush
Sphagnum subnitens	Sphagnum moss species
Tomentypnum nitens	Moss species
Triglochin palustris	Arrow-grass
Vaccinium oxycoccus	Cranberry

Poor fen and flush (PF2)

Apart from the extensive areas of cutover bog which are dominated by the poor flush species soft rush (*Juncus effusus*), common bog-cotton (*Eriophorum angustifolium*) and *Polytrichum commune* there are also occasional flushed areas within cutover with a high cover of bottle sedge (*Carex rostrata*). Other frequent species growing in these flushed areas include common bog-cotton (*Eriophorum angustifolium*), jointed rush (*Juncus articulatus*), soft rush (*Juncus effusus*), bulbous rush (*Juncus bulbosus*) and bog pondweed (*Potamogeton polygonifolius*).

Conifer plantation (WD4)

Coniferous plantations occur mainly in the south-eastern section of the site. These were planted mainly in the 1980s and are now closed canopy. The main tree species are Sitka spruce (*Picea sitchensis*) and Lodgepole pine (*Pinus contorta*). In most areas of forest there is little or no ground flora present due to shading and needle litter deposition. In areas where the trees have not grown well or where there are gaps a modified blanket bog/wet heath ground flora may still occur, with *Molinia caerulea* and *Calluna vulgaris* the main species present.

Scrub WS1

Scrub occurs scattered across the cutover bog though is not particularly dominant in any area. Willows (*Salix aurita* and *Salix cinerea*) are the principal species though gorse (*Ulex europaeus*) and brambles (*Rubus fruticosus*) also occur. As already noted, self-seeded lodgepole pine (*Pinus contorta*) saplings are contributing to a scrub canopy in some areas of the cutover bog.

Exposed sand, gravel or till (ED1)

Where peat remains on a slope (a common feature of the cutaway at Oweninny due to the undulating sub-surface contours), there is little or no vegetation establishment. The exposed gravel hills present a compacted, exposed and nutrient-poor habitat for colonising plants.

Buildings and artificial surfaces (BL3)

As a result of the past use of the site for peat production tracks and buildings are scattered throughout the site. These generally hold little or no interest from an ecology point of view however the presence of relatively species-rich grassland vegetation (GS2) on old railway embankments has been noted previously.

9.3.3 Vegetation descriptions at construction areas

9.3.3.1 Turbines and tracks

The habitats and the main plant species which occur within a 50 metre radius of each of the turbine locations within Phase 1 and Phase 2 of the Oweninny project are outlined in Appendix 9A. All of the proposed turbines and associated tracks lie within areas of cutover blanket bog which are of relatively low ecological value (see habitat/vegetation map in Figure 9-1). These affected areas are dominated either by bare peat/exposed gravels, with a sparse associated vegetation, or re-vegetating cutover bog areas which are mostly dominated by varying amounts of *Juncus effusus* and *Eriophorum angustifolium*. Other frequent vascular plant species in these re-vegetating cutaway bog areas include *Molinia caerulea, Calluna vulgaris, Juncus bulbosus* and *Agrostis* species. The main moss species occurring are generally *Polytricum commune* and *Campylopus introflexus,* with *Sphagnum cuspidatum, Sphagnum capillifolium, Aulocomium palustris* and *Hypnum jutlandicum* prominent in wetter areas.

Turbines 64, 65 and 79 are located along the margins of bog remnant No. 9 (see Figure 9-2) and the construction of these turbines and associated hard standings will result in the direct loss of a small area of modified blanket bog habitat (estimated as 0.5 hectares).

The construction areas of five turbines come close to various bog remnants but will not actually encroach upon them (care will be taken during construction to ensure that there is no overlap – see mitigation section). These are listed in Table 9.14, with the calculated distances to the bog remnants given.

Table 9.14: Distance from nearest bog remnants to construction area

Turbine	Bog remnant	Distance (metres)
T1	41	29
T19	4	0
T42	22	15
T52	8	6
T89	11	16

9.3.3.2 Sub-stations

The electrical sub-stations are all located in cutover bog areas where there is a high cover of surface gravels and bare peat (see Appendix 9A).

9.3.3.3 Borrow pit and gravel storage area

The proposed borrow pit and associated gravel/rock storage area covers an area of 30.2 ha. This is dominated by cutover bog with a variable cover of vegetation. Within most of the area the vegetation cover is more than 50% however in the middle of the area there is a zone of approximately 12 hectares in which bare peat surface is dominant. In common with most of the cutover areas at Oweninny the two dominant plant species in the cutover vegetation are soft rush (*Juncus effusus*) and common bog-cotton (*Eriophorum angustifolium*). Other vascular plant species have a rather patchy distribution with the most frequent being bulbous rush (*Juncus bulbosus*), purple moor-grass (*Molinia caerulea*) and bent grass species (*Agrostis* species). The cover of mosses is generally very patchy with *Polytrichum commune* and *Campylopus introflexus* the main species colonizing the drier cutover areas. Towards the north-western edge of the borrow pit area there is some pooling of shallow surface waters during wet periods of the year and in this area *Juncus effusus* and *Eriophorum angustifolium* are accompanied by floating rafts of *Sphagnum cuspidatum*.

9.3.3.4 Peat deposition area

The proposed peat deposition area covers an area of approximately 37 ha and this is also dominated by cutover bog. The majority of the area is reasonably well vegetated however there are occasional small patches of bare peat surface scattered throughout. There is also an area in the north where an iron pan has been exposed and this is largely devoid of vegetation. The bulk of the vegetation cover in the proposed peat deposition area is provided by soft rush (*Juncus effusus*) and common bog-cotton (*Eriophorum angustifolium*). Other vascular plant species have a rather patchy distribution with the most frequent being bulbous rush (*Juncus bulbosus*), purple moor-grass (*Molinia caerulea*), ling heather (*Calluna vulgaris*) and bent grass species (*Agrostis* spp.). The most common moss species are *Polytrichum commune* and *Campylopus introflexus* with *Calliergonella cuspidata* occasional in wet drains. In the south there is an area which supports shallow open water, partially colonized by *Juncus effusus* and *Eriophorum angustifolium*, for most of the year.

9.3.3.5 Powerline routes

It is proposed to construct overhead powerlines leading away from substation No. 1 and substation No. 2. The corridors followed by the two lines are over areas of cutover blanket bog which have been re-vegetated to varying degrees and which are considered to be of relatively low ecological value.

Table 9.15 outlines the percentage bare peat cover and the dominant species in the vegetation associated with the proposed locations of the powerline polesets leading from substation no. 1. The cutover bog areas along the route of this line show a variable cover of vegetation. *Juncus effusus* and *Eriophorum angustifolium* provide the bulk of the vegetation cover with other vascular plant species and mosses of limited occurrence. Structure No. 6 is located in an area with a high cover of *Juncus effusus* and *Sphagnum* *cuspidatum* in shallow standing water (<20cm). Between structures 8 and 9 there is a narrow area of dry remnant bog habitat.

Table 9.15: Details of bare peat cover and vegetation associated with powerline structures leading away from Substation No. 1.

Overhead 110 kV line Leading From Substation No. 1		
Structure No.	**% Bare peat cover**	**Main plant species in vegetation**
1	50	Eriophorum angustifolium and Juncus effusus
2	90	Sparse Juncus effusus and Eriophorum angustifolium
3	80	Sparse Eriophorum angustifolium
4	80	Sparse Juncus effusus and Eriophorum angustifolium
5	70	Sparse Eriophorum angustifolium and Juncus effusus
6	<5	Juncus effusus and Sphagnum cuspidatum
7	30	Juncus effusus and Polytrichum commune
8	90	Sparse Eriophorum angustifolium and Juncus effusus
9	80	Sparse Eriophorum angustifolium and Juncus effusus
10	0	Dominant Juncus effusus with Eriophorum angustifolium
11	5	Dominant Juncus effusus with Eriophorum angustifolium
12	75	Sparse Juncus effusus and Campylopus introflexus

Table 9.16 outlines the percentage bare peat cover and the dominant species in the vegetation associated with the proposed locations of the powerline polesets leading from substation No. 2. Structures 11, 12, 15 and 16 are located in wet cutover areas where there is standing water for much of the year.

Table 9.16: Details of bare peat cover and vegetation associated with powerline structures leading away from Substation No. 2.

Overhead 110 kV line Leading From Substation No. 2		
Structure No.	**% bare peat cover**	**Main plant species in vegetation**
1	50	*Eriophorum angustifolium* and *Campylopus introflexus*
2	40	*Juncus effusus* and *Polytrichum commune*
3	50	*Juncus effusus* and *Eriophorum angustifolium*
4	20	*Juncus effusus* and *Polytrichum commune*
5	20	*Juncus effusus* and *Polytrichum commune*
6	30	*Juncus effusus* and *Polytrichum commune*
7	15	*Juncus effusus* and *Eriophorum angustifolium*
8	60	*Juncus effusus* and *Eriophorum angustifolium*
9	40	*Juncus effusus* and *Eriophorum angustifolium*
10	0	*Juncus effusus* and *Polytrichum commune*
11	10	*Juncus effusus* and *Calliergonella cuspidata*
12	5	*Juncus effusus* and *Juncus bulbosus*
13	20	*Juncus effusus* and *Campylopus introflexus*
14	25	*Juncus effusus* and *Eriophorum angustifolium*
15	50	*Juncus effusus* and *Polytrichum commune*
16	0	*Juncus effusus* and *Sphagnum fallax*

9.4 Otters and Other Terrestrial Mammals

9.4.1.1 Otters

Otter (*Lutra lutra)* signs were observed at four locations during the course of this study. Two of these locations were within the site boundary (Figure 9-5) situated in the northwest of the site at Srahnakilly. The other two records from this survey were along channels that run from the site at Ballymonnelly Bridge in the southwest, and Doobehy in the north east. No evidence of Otter activity was found along the main Oweninny Channel or on the River Muing.

During a 2011 and 2012 habitat survey, Otter signs were recorded at five locations on the Oweninny site by David Fallon, Bord na Móna ecologist. One of these locations occurred in the northwest corner, at a similar site to that recorded in the present survey, two were observed on minor tributaries of the Oweninny, and two were recorded along the River Muing.

It is unclear why no signs were present on the River Muing or Oweninny channels at the time of this survey, despite both having previous incidental records of Otters (D. McLoughlin personal observation and Catherine Farrell personal communication). It is possible that some signs may have been washed away during heavy rain episodes preceding the surveys.

From the evidence of this study, along with previous incidental records from 2011/2012, it appears that Otters tend to occur throughout the main river channels on the site, with some use of the larger tributaries (see Plate 9.10).

Plate 9-10: Tributary of Oweninny River on which Otters were previously recorded.

9.4.1.2 Badger

Badgers (*Meles meles*) were recorded at three locations – a sighting of an animal crossing the track just north of the existing wind farm (grid ref. G007 234) at c. 20.00 hrs on 2nd May 2012 and another sighting in same general area on 19th June 2012; a sighting along the forest edge at Muingamolt (grid ref F996 217); a print along the eastern margin of O'Boyle's Bog on 15th June 2012. Bord na Móna staff have confirmed presence of Badger (by tracks & latrines) at a few locations throughout the site.

It is considered that badger is sparsely distributed throughout the site, with the main focus in the vicinity of conifer plantations.

9.4.1.3 Pine Marten

Pine Martens (*Martes martes*) have a presence on site, with some animals trapped and relocated in the early 2000s (C. Farrell personal communication). As with Badger, Pine Martens avail of the conifer plantations for cover though will feed out on open bog and especially along the rail tracks.

9.4.1.4 Irish Hare

The Irish Hare (*Lepus timidus hibernicus*) is widely distributed throughout the entire site.

9.4.1.5 Deer

Deer, probably Red Deer (*Cervus elaphus*), are known to have been released within the site in the 1990s. Small herds of up to ten animals may be seen anywhere on the site.

9.4.1.6 Fox

Foxes (*Vulpes vulpes*) are widespread within the site with several sightings and numerous signs.

9.4.1.7 Others

Other ubiquitous mammal species such as pygmy shrew (*Sorex minutus*), long-tailed field mouse (*Apodemus sylvaticus*) and hedgehog (*Erinaceus europaeus*) would be certain to occur.

9.4.2 Bats

9.4.2.1 Desk study results

Of the ten recorded bat species in Ireland, six have been recorded within a 10 km radius of the study site including; common (*Pipistrellus pipistrellus)* and soprano (*P. pygmaeus)* pipistrelle, brown long-eared (*Plecotus auritus)*, Leisler's *Nyctalus leisleri*, Daubenton's (*Myotis daubentonii)* and Natterer's (*M. nattereri)* bats and others may be expected to occur occasionally. A record of an unidentified roosting bat - possibly Daubenton's - (1st May 2006, C. Shiel, pers. comm.) within a bridge on the N59 road over the Owenmore River (near the Bellacorick Post Office), which is on the south western boundary of the study area, is the only known bat roost within a ten kilometre radius of the planned development area.

9.4.2.2 Bat field survey results

Sunset on the October evening in 2011 was at 18:30 hrs and soprano pipistrelles were observed on the wing soon after at 18:51 hrs. Four bat species were subsequently detected on-site with the most common being the soprano pipistrelle. The soprano pipistrelle's sibling, the common pipistrelle, was also present. Both pipistrelle species confined their foraging activities to the on-site wooded and scrub areas as well as vegetated areas of the on-site rivers. A single Leisler's bat was detected flying high over the area and a single Daubenton's bat was detected over the Oweninny/Muing Rivers at Bellacorick Bridge. Bat activity on-site during the initial detector survey was low with few individual bats being observed however it was late in the year after summer roosts had dispersed.

Sunset on the August evening in 2012 was at 21:10 hrs and common pipistrelle was the first bat species flying with the first detected at 21:33 hrs. On this occasion, five bat species were detected on-site. The common pipistrelle was widespread across the study area throughout the night, foraging along sheltered forest edges and tree-lined track areas. The soprano pipistrelle was equally ubiquitous but was more active over on-site water bodies and along riparian vegetation. Leisler's bat hunted over the area for 90 minutes after dusk and was then detected intermittently throughout the night. More than one specimen of this species was present. Daubenton's bat was active over the on-site lakes and rivers throughout the night and Natterer's bat was detected commuting along a track near a small lake at Moneynierin.

No bat roosting sites were found on-site. Table 9.17 outlines the adjudged local status of each bat species and its presence within the study site.

Table 9.17: Adjudged local status of Irish bat species at Oweninny site.

Common name	Scientific name	Occurrence on-site	Known roosts	Source
Common pipistrelle	Pipistrellus pipistrellus	Present	No	BCIreland
Soprano pipistrelle	Pipistrellus pygmaeus	Present	No	BCIreland
Nathusius' pipistrelle	Pipistrellus nathusii	Potential – rare	No	BCIreland
Leisler's bat	Nyctalus leisleri	Present	No	BCIreland
Brown long-eared bat	Plecotus auritus	Potential	No	BCIreland
Lesser horseshoe bat	Rhinolophus hipposideros	Absent	No	BCIreland
Daubenton's bat	Myotis daubentonii	Present	Possible roost, Bellacorick bridge	BCIreland
Natterer's bat	Myotis nattereri	Present	No	Pers. Obs.
Whiskered bat	Myotis mystacinus	Potential	No	BCIreland
Brandt's bat	Myotis brandtii	Potential – rare	No	BCIreland

9.4.3 Amphibians and Reptiles

The common frog (*Rana temporaria)* is widespread throughout the site, occurring on wet bog, ponded areas and within drains along tracks.

The common lizard (*Zootoca vivipara)*, a species often found on peatlands and open areas, has been recorded on bog behind the Bord na Móna workshop and offices (D. Fallon personal communication) and is likely to be widespread throughout the site.

9.4.4 Birds

Separate descriptions of the breeding/summering birds, winter birds and autumn birds are given, followed by detailed species accounts for the birds of conservation importance that were recorded during the study.

9.4.4.1 Breeding and summering birds

Details of the transect and vantage point surveys are presented in Appendices 9D and 9E. A summary table of all species recorded from these surveys, as well as from the focused surveys, is presented in Table 9.18. This considers the results from the three seasons (2010-2012), with adjudged breeding status given using the BTO Breeding Bird Atlas 2007-2011 criteria.

A total of 51 species was recorded within the site during the breeding surveys over the three seasons. Forty-six of these were considered to be in one of the three breeding categories (possible, probable, confirmed), with five species (grey heron, hen harrier, dunlin, snowy owl, raven) considered to be merely using the site but perhaps breeding elsewhere.

Breeding birds of bog and wetland habitats

Skylark and Meadow Pipit were by far the most widely distributed species throughout the site. These are classic species of open bog habitats occurring both on intact and cutover surfaces and even in regenerating areas with sparse vegetation. Other widespread passerine species found in the open bog habitats were Wren and Reed Bunting. Stonechat had been widely recorded in the 2009 survey (Copland 2010[51]) but numbers declined dramatically after the severe 2009/10 and 2010/11 winters, with some recovery by the 2012 season. Wheatear is found occasionally and may breed. However, in early May 2012 large numbers (hundreds) of migrant Wheatears were on site though practically all had moved on by the next survey in late May. Grasshopper Warbler was recorded in areas dominated by rushes while Sedge Warbler occurs widely in wetland vegetation along the margins of ponds and rivers. Several Cuckoos occur annually and undoubtedly breed on site. Sand Martins breed in peat banks on site.

Red Grouse, a species confined to bog and heath habitats, occurs where suitable remnants of uncut bog occur though also occurs in re-vegetating areas where there is a good cover of heather (though would not be expected in areas of the site where there is less than 25% heather cover).

Two species of duck, Teal and Mallard, breed sparsely in the bog habitats. Both are usually found in proximity to bog pools, ponds and drains. A few Moorhens breed on site and one Water Rail (a very secretive species) was heard and assumed to be breeding. Little Grebes breed on the larger water bodies on site.

Six species of wader were recorded during the breeding surveys. Ringed Plover is well distributed, breeding on bare or sparsely vegetated areas of bog usually close to ponds and especially where stones and gravel are exposed. Snipe occurs throughout the site where suitable wet bog occurs. Common Sandpiper is confined to the margins of the larger ponds and along the main river courses. One pair of Golden Plover bred annually on intact bog in the north-west sector of the site. A breeding event by Greenshank was recorded during the 2012 season (possible/probable category). A single Dunlin in July 2012 was considered a passing bird though the site holds some potential for breeding by this rare breeding species.

Common Gull breeds in small numbers at several locations throughout the site.

Breeding birds of scrub and woodland

The majority of the passerine species found on site are associated with the scrub and conifer forest habitats. These are mainly ubiquitous species of the countryside, including Woodpigeon, Robin, Blackbird, Song Thrush, Willow Warbler, Goldcrest, Blue Tit, Chaffinch and Bullfinch. Several pairs of Blackcaps breed in areas of conifer forest and scrub. Two species, Siskin and Crossbill, are specialist species of conifer forests. Several of the species which breed in scrub or forest feed on the open bog habitats at times – these include Linnet, Lesser Redpoll and Hooded Crow. While no evidence of breeding by Merlin was found, there is some possibility that this secretive species may breed on site. In Ireland, Merlin normally nests in conifer forest but hunts over open bog.

Breeding birds of buildings

Four species which occur on site breed in buildings within or around the site – these are Kestrel, Swallow, Pied Wagtail and Starling.

Table 9.18: Breeding status of species recorded within Oweninny wind farm during 2010, 2011 and 2012 breeding seasons. Red and Amber listed species (after Lynas et al. 2007[63]) & Annex I species of the EU Birds Directive are highlighted.

Species	Breeding Status	Conservation Status
Little Grebe	**Probable**	**Amber**
Grey Heron	Non-breeder	Green
Teal	**Confirmed**	**Amber**
Mallard	Confirmed	Green
Hen Harrier	**Non-breeder**	**Amber, Annex 1**
Kestrel	**Confirmed**	**Amber**
Merlin	**Possible**	**Amber, Annex 1**
Red Grouse	**Confirmed**	**Red**
Pheasant	Probable	Green

[63] Lynas, P., Newton, S. & Robinson, J.A. (2007) The status of birds in Ireland: an analysis of conservation concern 2008-2013. *Irish Birds* 8 (2): 149-166.

Species	Breeding Status	Conservation Status
Water Rail	**Possible (1 bird heard)**	**Amber**
Moorhen	Confirmed	Green
Ringed Plover	**Confirmed**	**Amber**
Golden Plover	**Confirmed - 1 pair**	**Red, Annex 1**
Dunlin	**Non-breeder (1 bird)**	**Amber**
Snipe	**Probable (birds drumming)**	**Amber**
Greenshank	**Probable**	**Amber**
Common Sandpiper	**Confirmed**	**Amber**
Common Gull	**Confirmed**	**Amber**
Woodpigeon	Probable	Green
Snowy Owl	**Non-breeder**	**Amber, Annex 1**
Cuckoo	Probable	Green
Skylark	**Confirmed**	**Amber**
Sand Martin	**Confirmed (nest holes in peat bank)**	**Amber**
Swallow	**Confirmed (nest in buildings)**	**Amber**
Meadow Pipit	Confirmed	Green
Pied Wagtail	Possible	Green
Wren	Probable	Green
Robin	Probable	Green
Wheatear	**Possible**	**Amber**
Blackbird	Probable	Green
Song Thrush	Probable	Green
Mistle Thrush	Possible	Green
Grasshopper Warbler	**Probable**	**Amber**
Sedge Warbler	Confirmed	Green
Blackcap	Probable	Green
Willow Warbler	Confirmed	Green
Blue Tit	Confirmed	Green
Coal Tit	Confirmed	Green
Magpie	Probable	Green

Species	Breeding Status	Conservation Status
Hooded Crow	Probable	Green
Raven	Non-breeder	Green
Starling	**Confirmed**	**Amber**
Chaffinch	Confirmed	Green
Goldfinch	Possible	Green
Siskin	Confirmed	Green
Linnet	**Probable**	**Amber**
Lesser Redpoll	Confirmed	Green
Crossbill	Confirmed	Green
Bullfinch	Possible	Green
Reed Bunting	Confirmed	Green
Total Species	**50**	
Not Breeding	**5**	
Possible Breeding	**7**	
Probable Breeding	**15**	
Confirmed Breeding	**23**	

9.4.4.2 Wintering birds

A summary table of the species recorded along the transect section (7.3 km) is given in Table 9.19. Details of the vantage point surveys are presented in Appendix 9F.

Detailed accounts for the species of conservation importance are given in the species section. Briefly, four principal target species were recorded during the various winter surveys: Whooper Swan, Hen Harrier, Merlin and Golden Plover. Of these, only Hen Harrier occurs on site in significant numbers.

The general winter bird community is characterised by a relatively low number of species which are sparsely distributed. A total of 32 species were recorded on the transect survey during the two winter periods. Species such as Skylark and to a lesser extent Meadow Pipit abandon the bog habitats during the main winter period for more hospitable areas elsewhere. A flock of up to 50 pipits recorded on the transect walk on 23rd January 2013 was on adjoining pasture land. The principal small passerine species present in the cutaway bogs during winter are Reed Bunting, Lesser Redpoll, Wren and the occasional Stonechat. The scrub and woodland habitats support Robin, Goldcrest, Coal Tit, Chaffinch and Crossbill (latter a specialised bird of conifer forests). Magpies, Hooded Crows and at times Ravens are found on the open bog habitats throughout the winter. An unexpected species recorded on the site in November 2011 was Twite, with a flock of seven along the transect route in the westernmost part of the site. This very localised species is rarely found inland during the winter period.

Mallard and Teal occur scattered in small numbers on Lough Dahybaun and the various small lakes and ponds throughout the site. Small numbers of Tufted Ducks are found on Lough Dahybaun, along with the occasional Cormorant (latter also occurs on the Oweninny River).

Snipe is the only wader species that is regular on site during winter. It is widely distributed throughout the entire site including sparsely vegetated areas. A single Greenshank was recorded on ponds close to Lough Dahybaun in December 2012 and March 2012, Note this was not recorded on the transect surveys and as such is not included in Table 9.19 . Grey Heron occurs regularly, usually single birds or occasionally two together.

Table 9.19: Winter occurrences of species recorded on Transect sections 1-11 (7.3 km) within Oweninny wind farm during winters 2011/12 and 2012/13. Red and Amber listed species are highlighted (after Lynas et al. 2007).

Species	14-11-11	12-1-12	6-2-12	28-2-12	17-12-12	23-1-13	20-2-13	13-3-13
Grey Heron	-	-	-	1	-	-	2	-
Teal	12	2	-	-	2	-	2	-
Mallard	8	3	10	1	4	-	4	2
Sparrowhawk	-	-	-	-	-	-	-	1
Merlin	-	-	1	-	-	-	-	-
Red Grouse	-	-	-	-	-	-	3	-
Ringed Plover	-	-	-	3	-	-	-	1
Golden Plover	-	-	1	-	-	-	-	-
Snipe	4	2	1	7	2	3	3	1
Skylark	-	-	-	9	-	-	-	3
Meadow Pipit	12	-	1	21	6	*(50)	9	29
Pied Wagtail	-	-	-	-	-	1	-	-
Wren	4	1	3	2	4	5	1	3
Robin	3	1	1	1	2	5	4	2
Stonechat	1	-	-	-	1	-	-	1
Blackbird	-	-	-	-	1	7	2	1
Song Thrush	-	-	-	-	-	1	-	-
Mistle Thrush	-	-	-	-	-	2	-	-
Goldcrest	-	-	1	-	-	1	-	-

Species	14-11-11	12-1-12	6-2-12	28-2-12	17-12-12	23-1-13	20-2-13	13-3-13
Blue Tit	-	-	8	-	2	2	-	-
Great Tit	1	-	-	-	-	-	-	-
Coal Tit	-	-	2	2	-	1	1	-
Long-tailed Tit	-	-	-	-	9	-	-	-
Magpie	-	2	5	2	2	-	-	1
Hooded Crow	3	3	5	-	3	-	1	2
Raven	1	-	2	-	2	2	-	-
Chaffinch	-	-	-	1		-	2	-
Twite	**7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Goldfinch	-	-	-	-	-	-	-	-
Lesser Redpoll	5	3	-	1	25	3	5	7
Crossbill	3	-	2	1		-	-	-
Reed Bunting	1	2	1	1	2	-	2	2
Total Species	**14**	**9**	**15**	**14**	**15**	**13**	**14**	**14**

* These meadow pipits were in a loose flock on adjoining pasture land.

9.4.4.3 Autumn birds

A summary table of the species recorded along the transect section (7.3 km) is given in Table 9.20. Details of the vantage point surveys are presented in Appendix 9G.

The diversity of birds present on site in autumn is generally similar to that during summer. Meadow Pipit and Lesser Redpoll were the most widely distributed species, with Skylark noticeably scarce and completely absent by October. In August 2012, post-breeding flocks each involving 20-30 pipits were recorded throughout the site.

Two Snow Buntings in October 2011 would have been recent arrivals and may have wintered elsewhere in Co. Mayo. Small numbers of Wheatears were also considered as migrants. A flock of Swallows and four Swifts on 20th August 2012 were probably of local origin though the date is fairly late for Swift.

In October 2011 a small flock of 14 Lapwing was recorded flying over the Lough Dahybaun area of the site.

A flock of Greylag Geese was reported from Lough Dahybaun in September/October 2012 (Denis Strong personal communication). A feral population of Greylag Geese occurs on the Mullet Peninsula and the geese at Oweninny are likely to have been from that population.

Table 9.20: Autumn occurrences of species recorded on Transect sections 1-11 (7.3 km) within Oweninny wind farm during October 2011 and August to October 2012. Red and Amber listed species are highlighted (after Lynas et al. 2007[63]).

Species	13-10-11	20-8-12	18-9-12	17-10-12
Teal	**-**	**2**	**3**	**1**
Mallard	4	3	2	6
Kestrel	**1**	**2**	**1**	**1**
Snipe	**3**	**1**	**4**	**2**
Swift	**-**	**4**	**-**	**-**
Skylark	**-**	**3**	**4**	**-**
Swallow	**-**	**32**	**6**	**-**
Meadow Pipit	13	22	18	9
Pied Wagtail	2	1	-	-
Wren	4	6	5	4
Robin	2	3	1	1
Stonechat	1	2	1	1
Wheatear	**2**	**1**	**1**	**-**
Blackbird	2	3	2	-
Song Thrush	-	1	2	1
Goldcrest	-	4	5	1
Coal Tit	5	7	4	4
Sedge Warbler	-	3	-	-
Willow Warbler	-	12	1	-
Magpie	1	2	1	2
Hooded Crow	4	5	2	2
Raven	1	2	4	1
Chaffinch	-	2	-	1
Linnet	**-**	**5**	**2**	**-**
Lesser Redpoll	17	22	9	14
Snow Bunting	2	-	2	1
Reed Bunting	3	3	1	4
Total Species	**17**	**26**	**23**	**18**

9.4.4.4 Birds of conservation importance

Species are classified as of conservation importance on the basis of the following criteria:

- EU Birds Directive, Annex I
- Birds of Conservation Concern Red List (High conservation concern) or Amber List (Medium conservation concern), after Lynas et al. (2007)

A summary of the species of conservation importance recorded on site is given in Table 9.21.

Table 9.21: Bird species of conservation importance recorded on site, 2010-2013

Species	EU Birds Directive Annex 1	Birds of Conservation Concern in Ireland: Red List	Birds of Conservation Concern in Ireland: Amber List
Little Grebe			X
Whooper Swan	X		X
White-fronted Goose	X		X
Teal			X
Tufted Duck			X
Hen Harrier	X		X
Kestrel			X
Merlin	X		X
Red Grouse		X	
Water Rail			X
Ringed Plover			X
Golden Plover	X	X	
Dunlin			X
Snipe			X
Woodcock			X
Greenshank			X
Common Sandpiper			X
Common Gull			X
Kingfisher	X		X
Snowy Owl	X		X
Swift			X
Skylark			X

Species	EU Birds Directive Annex 1	Birds of Conservation Concern in Ireland: Red List	Birds of Conservation Concern in Ireland: Amber List
Sand Martin			X
Swallow			X
Wheatear			X
Grasshopper Warbler			X
Starling			X
Twite			X
Linnet			X

Little Grebe (Amber list)

Recorded at two well developed ponds, with breeding considered probable in each year. Breeding proved in 2009 (Copland 2010[51]). Little Grebe is a species associated with still or slow moving waters and for a breeding site requires submerged and emergent vegetation. Although widespread in Ireland, it is considered a scarce species in north and west Mayo.

Whooper Swan (Birds Directive Annex I; Amber list)

Whooper Swans were recorded in small numbers on several of the water bodies on site during the 2011/12 winter (plus one record was reported in November 2012 – C. Farrell) see Table 9.22.

Table 9.22: Whooper Swan records

Number	Location	Date
4	lake at F998 216	14-11-11
5	lake at F998 216	15-11-11
4	lake at G035 229	16-11-11
4	Lough Dahybaun	12-01-12
2	lake at F998 216	12-01-12
5	Lough Dahybaun	13-01-12
2	lake at G004 204	07-02-12
3	lake at F998 216	05-11-12

No swans were present on site during surveys from December 2012 to March 2013. Further, no swans were recorded passing over the site during the various vantage point watches in winters 2011/12 and 2012/13.

During a survey on 15th March 2011 for the Cluddaun wind farm development (Cluddaun wind farm EIS), two Whooper Swans were flushed from a small lake (Lough Doo) within the Knockmoyle Nature Reserve and flew south-east towards the Furnought/Corvoderry area. The same study also reported a flock of 14 Whooper Swans flying in a north-north-west direction over the Crocknacally and Ummerantarry area on 15th March 2011.

The pattern of occurrences suggests that swans may use Lough Dahybaun and the other small lakes on site on an occasional basis. The feeding potential for swans within these oligotrophic systems is likely to be limited.

In the wider context of NW Mayo, a large population of Whooper Swans winters on the Mullet Peninsula (average peak of 191 for 1994/95-1998/99 period) (Crowe 2005[64]). Whooper Swans also winter on Lough Conn (average peak of 56 for 1994/95-1998/99 period), with smaller numbers (13) on Carrowmore Lake. It is probable that the small number of birds recorded on the Oweninny site may be associated with any of these larger populations.

Greenland White-fronted Goose (Birds Directive Annex I; Amber list)

There was only one record of Greenland White-fronted Geese during surveys in February 2010, winter 2011/12 and winter 2012/13. This comprised two birds (in company with 4 whooper swans) which were flushed from ponds in the Laghtanvack area of the site on the morning of 16th November 2011. The geese took off in misty conditions and flew in a westerly direction over Knockmoyle bog. It is considered likely that these birds may have taken temporary refuge on the site during heavy fog the previous night (perhaps attracted by the swans).

The only other known recent record of Greenland White-fronted Geese in the area is a flock of 23 which flew over the existing wind farm area towards Knockmoyle Bog on 31st October 2012 (reported by Denis Strong, NPWS). Ten 'grey' geese in the northernmost part of the site in late October and early November 2012 (reported by Catherine Farrell & Gabriel Walsh) are likely to have been part of the same group of birds. The early date of these birds would suggest that they were recent arrivals which were attracted to the Knockmoyle Bog area.

Up to about 1940, a large population of Greenland White-fronted Geese occurred in the Keenagh-Dooleeg More-Bellacorick bogs but the geese deserted the boglands with the arrival of commercial peat extraction. However, a flock of c.100 geese subsequently utilised reclaimed grassland in the same area up to the 1970s (Ruttledge & Ogilvie

[64] Crowe, O. 2005. *Ireland's Wetlands and their Waterbirds: Status and Distribution.* Birdwatch Ireland, Wicklow.

1979[65]). This population had become extinct by the late 1980s (Fox et al. 1994[66]).

The traditional Bog of Erris population includes two sub-populations in the vicinity, the Owenduff flock and the Carrowmore Lough flock. Local NPWS staff have been monitoring Greenland White-fronted Geese in and around the Nephin SPA and have recorded an overall reduction in goose numbers and contraction in their range in recent years. Some of the feeding sites on the level blanket bog in the northernmost part of the SPA now appear to be deserted, though flocks of geese are still using the level blanket bogs extending southwards. A flock of up to 40 Greenland White-fronted Geese still uses grass fields on the north side of Carrowmore Lake, and these may be using the lake as their night roosting site. However, in winter 2009/10, no geese were recorded at Carrowmore Lake during autumn and spring censuses, and a peak of only 22 birds (in December) was recorded on the Owenduff bogs (Fox et al. 2010[67]). For the entire Bog of Erris population, which includes birds on the Mullet peninsula, a figure of 40 is given. In winter 2010/11, the peak for the Bog of Erris population was 66 (Fox et al. 2011[68]). On a morning in December 2012 approximately 20 geese flew over Carrowmore Lake (G. Fennessey) and in January 2013, 20 Greenland White-fronted Geese were reported on Dereens Island at the north end of Carrowmore Lake (I. O'Brien, NPWS pers. comm.).

No Greenland White-fronted Geese were recorded during surveys in 2011 for the Cluddaun or Corvoderry wind farm projects.

It is concluded that since the commercial exploitation of the Oweninny peatlands in the 1960s, Greenland White-fronted Geese have abandoned the wider area. Occasional birds, probably associated with the Carrowmore Lake flock, can be expected to pass through the Oweninny-Knockmoyle area at times.

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[65] Ruttledge, R.F. and Ogilvie, M.A. (1979). The past and present status of the Greenland White-fronted Goose in Ireland and Britain. *Irish Birds* 3:293-363.

[66] Fox, A.D., Norriss, D.W., Stroud, D.A. & Wilson, H.J. (1994). *Greenland White-fronted Geese in Ireland and Britain, 1982/83-1993/94. The first twelve years of international conservation monitoring.* Greenland White-fronted Goose Study and National Parks & Wildlife Service, Dublin.

[67] Fox, A., Francis, I. & Walsh, A. (2010) *Report of the 2009/2010 International Census of Greenland White-fronted Geese.* Greenland White-fronted Goose Study and National Parks & Wildlife Service, Dublin.

[68] Fox, A., Francis, I. & Walsh, A. (2011) *Report of the 2010/2011 International Census of Greenland White-fronted Geese.* Greenland White-fronted Goose Study and National Parks & Wildlife Service, Dublin.

Teal (Amber list)

Recorded at six locations and considered that at least three to four pairs breed on site each year (one pair confirmed). Copland (2010[51]) considered that up to 6 pairs may have been present on site in 2009. Teal is a localised breeding species in Ireland and is particularly associated with bog lakes and pools.

Occurs scattered in small flocks (max. 12) on suitable water bodies throughout site in autumn and winter.

Tufted Duck (Amber list)

Small numbers (max. 4) of Tufted Duck occur on Lough Dahybaun during winter.

Tufted Duck is a widespread breeding and wintering species in Ireland. Wintering birds are particularly associated with large midland and western lakes.

Hen Harrier (Birds Directive Annex I; Amber list)

Only one bird was recorded during the summer surveys: on 25th June 2012 a foraging male flew low (<5 m) from the Laghanvack area in a south-east direction towards the area of the old power station (Figure 9-7). Also in 2012, local farmer Mr Gabriel Walsh had seen a male Hen Harrier towards the northern end of the existing wind farm road in mid-August. The bird was being harassed by Hooded Crows.

While there is no recent history of Hen Harriers breeding in north-west Mayo (Ruddock et al. 2012[69]), the sightings in 2012 suggest that there may now be at least some prospecting pairs in the wider area. Territorial birds had been seen elsewhere in north-west Mayo early in the 2012 season (D. McLoughlin pers. comm.).

Hen Harrier in Winter

A regular night time Hen Harrier roost occurs within the site on the ridge to the east of Lough Dahybaun. The birds utilise the well grown heather (up to waist height in places) within this area. A summary of the morning and evening roost watches during winters 2011/12 and 2012/13 is given in Table 9.23.

In winter 2011/12, the roost was occupied by at least four harriers - 2 males, a large ringtail (probable female) and a smaller ringtail (probable immature male). In winter 2012/13 at least six birds were present in December (5 males, 1 small ringtail). However, only one male was seen in January 2013 – an ongoing cold spell at the time with

[69] Ruddock, M, Dunlop, B.J., O'Toole, L., Mee, A., & Nagle, T. (2012*) Republic of Ireland National Hen Harrier Survey 2010.* Irish Wildlife Manual No. 59. NPWS, Dublin.

morning temperatures of minus 1°C on the ridge, may have led the harriers to temporarily seek a more hospitable roost site elsewhere (perhaps towards the coast). Three male harriers were at the roost in February and two males in March 2013.

The surveys have established the behaviour of the harriers at this important roost. The core area where the birds roost is the ridge itself which includes a small oligotrophic lake backed by dense heather slopes (Figure 9-8). While late arriving birds appear to go to roost immediately on arrival in the area, others spend time (up to 1 hour or more) flying, with some hunting and/or socialising (especially late in the winter), in the area extending from the ridge to the cutover bog to the south (towards the N59) and west to Lough Dahybaun as far as the forest edge. At times birds have been observed to drop into heather as if going to roost but then rising again and flying further. The main area used by the birds is shown in Figure 9-8 There have been only five sightings of birds on the cutover bog to the north of the ridge extending to the Corvoderry forest (and one of these was of a bird which flew onto the bog after being flushed from the ridge during a morning walk) - these outlying flightlines are also shown in Figure 9-8.

With activity continuing often up to darkness, the exact locations where the birds finally roost can be difficult to determine but a fair number of birds have been seen to drop into the heather where they presumably remained for the night. On one occasion two birds were observed ‘dropping’ almost simultaneously approximately 10-20 metres apart. On two occasions birds have been flushed from dense heather on morning walks after dense fog.

Determining the arrival and departure routes of the harriers to and from the roost can be difficult as birds typically ‘appear’ in the roost area without their route been seen (sometimes due to low light levels). On evening watches, there have been five instances where birds have been seen flying into the Oweninny site, while on morning watches there have been six instances where birds have been seen leaving the site (see Table 9.24, Figure 9-9 and Figure 9-10).

Table 9.23: Summary of Hen Harrier activity at roost, winters 2011/12 and 2012/13.

Date	Peak number	Comments
Winter 2011/12		
14-16 Nov 2011	4 total (2 adult males, 1 large ringtail, 1 small pale ringtail)	On 14th, first sighting at 15.55 hrs and last sighting 17.10 hrs. Two of the birds first seen on cutover bog north of ridge but then all activity focused on top of ridge and around small lake. On morning of 15th (08.55 hrs) ringtail flew from base of ridge south-south-west over N59 and continued southwards over bog. At 10.30 hrs, two males in area of lake on ridge top until at least 11.10 hrs. On evening of 15th, two birds observed on ridge from 16.28 hrs onwards. On morning of 16th (08.38 hrs) male observed flying east from ridge over forest to south-east and continued east out of site.
12-14 Jan 2012	4 total (2 adult males, 1 large ringtail, 1 small pale ringtail)	On 12th, first sighting at 15.15 hrs – four birds present at 16.00 hrs with lot of activity over ridge, on bog to south of it and west to Dahybaun until 16.50 hrs. Ringtail seen dropping into heather at small ridge lake. On morning of 13th, heavy mist until at least 11.00 hrs. Large ringtail (probable female) flushed from heather/bracken on north side of ridge during walk at c.11.45 hrs – flew north onto cutover bog where it landed. On evening of 13th, two birds on ridge from 16.40 hrs to 17.00 hrs. On morning of 14th, ringtail hunting on bog east of Dahybaun & dropped on possible prey at 08.43 hrs. Male flew over bog to south of ridge and over N59 in a SW direction at 08.44 hrs
6-8 Feb 2012	2 total (1 adult male	On 6th, ringtail over ridge at 17.08 hrs – not seen subsequently. At 17.35 hrs male on south side of ridge. On morning of 7th, one ringtail on ridge at 09.30 hrs but not seen leaving area. At 16.50 hrs on

Date	Peak number	Comments
	1 large ringtail)	7th, male seen arriving from south of N59, flew east site of Dahybaun and then to ridge top. No harriers seen on morning of 8th.
28 Feb-1 Mar 2012	4 total (2 adult males, 1 large ringtail, 1 small pale ringtail)	On 28th, first sighting at 16.40 hrs. Then four birds from 17.40 to 18.20 hrs over ridge – very active with interactions between birds. At 18.20 the 2 males seen dropping into heather about 10 m apart. On morning of 29th, one male at 08.55 hrs between ridge and N59, second male at 10.15 hrs leaving site in a SE direction. On evening of 29th, three birds from 17.24 to 17.51 hrs. One dropped into heather on top of ridge immediately on arrival. On morning of 1st March, male on ridge at 10.15 hrs – flew east and out of site.
Winter 2012/13		
11-12 Nov 2012	1 total (male)	On evening of 11th, male hunting over bog to south of ridge at 16.40 hrs. Probable same male observed briefly on top of ridge at 17.02 hrs. Then dropped out of sight and not seen again. No harriers seen on morning of 12th but weather very poor (and poor all day until evening).
17-18 Dec 2012	6 total (5 adult males, 1 ringtail)	On evening of 17th, first bird arrives from east at 15.45 hrs, skirts ridge and out of sight. A minute later possibly same bird seen skirting edge of south side of Corvoderry forest and landed on pine tree. At 15.51 hrs male on NE shore of Dahybaun and shortly afterwards male flew from ridge and landed on cutover bog to north. At 16.15 hrs, ringtail flew towards ridge from NW direction, with male for part of way - ringtail not seen again. At 16.30 hrs, 2 males seen dropping into heather on ridge, then a further two arrived and also dropped. No sightings after 16.35 hrs. On morning of 16th, dense fog precluded observations but ringtail flushed from heather during

Date	Peak number	Comments
		walk at 08.40 hrs. On evening of 16th, first male appeared at 15.25 hrs with second shortly after. Another male over bog to north of ridge and flew over ridge at 15.55 hrs. All dropped into heather over next 15 minutes. At 16.30 hrs 2 males arrived from east and dropped immediately into heather on ridge. No further activity.
23-24 Jan 2013	1 total (male)	One male seen over ridge briefly at 15.55 hrs on 23rd. No further activity. No sightings on morning or evening watches of 24th.
20-21 Feb 2013	3 total (males)	On evening of 20th, first male seen at 17.43 hrs and dropped into heather after about 2 minutes of flying on ridge. Another arrived in from east at 17.51 hrs and dropped into heather immediately. A third male arrived at 17.57 hrs and dropped into heather on ridge top. On morning of 21st, male circled ridge top lake at 07.58 hrs and in area until at least 08.10 hrs. Second male rose from heather at 08.20 hrs and seen leaving site in a south-east direction.
13-14 Mar 2013	2 total (males)	On evening of 13th, a male arrived from east at 18.04 hrs and after a few short flaps and glides over the ridge was observed to drop into tall heather. No birds seen on morning watch on 14th from 06.45-09.00 hrs. On evening of 14th, two males arrived to roost – one at 17.56 hrs arriving across Lough Dahybaun and one at 18.02 hrs arriving in from east – both dropped into heather shortly afterwards and not seen again. No birds seen on morning watch on 15th from 07.00-09.00 hrs.

Table 9.24: Hen Harrier arrival and departure routes at winter roost site, winters 2011/12 and 2012/13.

Arrivals
7th February 2012 - male arrives into site from south of the N59 at 16.50 hrs
17th December 2012 – male arrives into site from east at 15.45 hrs
17th December 2012 – 2 males arrive into site from east-south-east at 16.30 hrs
20th February 2013 – male arrives from east, circles ridge top lake, and drops into high heather at 17.51 hrs
13th March 2013 – male arrives into site from east at 18.04 hrs, drops into heather shortly afterwards
Departures
15th November 2011 – female flies from ridge south-south-west over N59 at 08.55 hrs
16th November 2011 – male flies from ridge eastwards over forest and out of site at 08.38 hrs
14th January 2012 – male flies from ridge south-west direction over N59 at 08.44 hrs
29th February 2012 – male flies from ridge/cutover bog in south-east direction and out of site at 10.15 hrs
1st March 2012 – male flies from ridge in an east direction and out of site at 10.15 hrs
21st February 2013 – male flies up from heather at ridge top lake and departs over the ridge in a south-easterly direction at 08.20 hrs

The above evidence indicates that there are southerly and easterly routes used to and from the site, which suggests birds frequent the Nephin Beg complex of bogs, lakes and forests and possibly the Lough Conn complex during daytime. Birds may also fly westwards towards the coast where a concentration of prey items can be expected (especially when prolonged cold conditions prevail inland). Birds may of course hunt over agricultural lands during the day where species such as finches, thrushes and starlings can be common.

The greater part of the Oweninny site does not appear to be used at all by foraging birds during the main winter period. This is not surprising as small bird species (the main prey items of harriers) are very scarce. The winter transect survey data show that Skylarks are completely absent from the site for the main part of the winter, with birds only returning in late February. Meadow Pipits also largely abandon the site in winter – the winter 2011/12 transect survey (7 km) recorded only 12 pipits on 14th November 2011, none on 12th January 2012, one on 6th February 2012 and 21 on 28th February 2012. It is noted, however, that Mr Gabriel Walsh (local farmer) reported a male Hen Harrier in the northern part of the site during the evening of 29th February 2012. This bird probably later came to roost at Dahybaun.

During the surveys for the Cluddaun wind farm, a single Hen Harrier (ringtail) was seen in the Ummerantarry area on 18th March 2011 and an adult male was observed to the northwest of the Croaghnacally area in March 2012. Theses may have been lingering wintering birds or perhaps prospecting breeding birds.

Kestrel (Amber list)

A pair of Kestrels bred in a building in the northern sector of the site in 2011 (no evidence of nesting there in 2010 or 2012). A sighting of three together in August 2012 suggests a local breeding pair with a juvenile. Otherwise, sightings of single birds, often hunting, were made throughout the site on several of the summer site visits.

Kestrels are occasional throughout the site in autumn and winter.

Merlin (Birds Directive Annex I; Amber list)

A call, probably from this species, was heard from conifer forest north of Lough Dahybaun in May 2010 (Figure 9-7). However, no further evidence of Merlin presence was detected during the 2010 summer period despite intensive monitoring in the area.

On 2nd May 2012, a female Merlin was recorded flying low over bog to the east of the Corvoderry plantation (Figure 9-7). The bird landed on a pile of pine stumps and was not seen subsequently.

No signs of Merlin presence were found during searches along forest margins in summers 2011 and 2012.

Merlin breeds sparsely in north-west Mayo, with a known territory to the north-west of the Oweninny site. However, from the various surveys over the three breeding seasons it seems unlikely that there is a breeding territory within the wind farm site.

Merlin in Winter

One male bird recorded in the western sector of site (Srahnakilly) on 6th February 2012 was the only winter record of this scarce falcon.

Two winter Merlin records are reported in the EIS for the Cluddaun wind farm. One was seen on 27th January 2011 north-east of the Sheskin forest and the other on 22nd February 2011 in the Ummerantarry area.

Merlin can travel widely during winter especially during periods of inclement weather. Records in late January and February may be early returning birds to the breeding territories.

Red Grouse (Red list)

Red grouse are resident within the site and on adjoining bogs. They are regular on the larger expanses of intact or relatively intact site, notably at O'Boyle's Bog and along the eastern and north-eastern margins of the site. They can occur on any of the bog remnants though probably only have an occasional presence on the smaller remnants. Grouse have also been recorded on some of the re-vegetating areas of cutaway where ling heather has a good cover.

The diet of Red Grouse is almost exclusively ling heather and studies have shown that birds are absent from bog sites with less than 25% heather cover (various studies cited in 'The status of Red Grouse in Ireland', Irish Wildlife Manuals No. 50, NPWS). Good habitat for grouse requires a mixture of age classes of heather: tall or rank heather is required for nesting and sheltering chicks, with a combination of ages for feeding, including younger plants for chick feeding. Within the Oweninny site there are still extensive areas of the site where heather cover is absent or sparse and grouse are expected to be largely absent from such areas.

Studies on Red Grouse in the Owenduff-Nephin Beg SPA indicated that between 1.41 and 1.66 birds are present per square kilometre, which is considerably lower than the figure of 5 birds per square kilometre recorded from Glenamoy in the 1970s (Murray & O'Halloran 2003[70]).

Water Rail (Amber list)

One Water Rail was heard in suitable wetland habitat in July 2012. Water Rail is seldom seen and breeding is usually established by calling birds. There is likely to be a few breeding pairs on site.

Ringed Plover (Amber list)

Ringed Plover is a summer visitor to the site, with an estimated 21 breeding territories throughout the site. The favoured habitat is sparsely vegetated bog often associated with stony surfaces and at or close to pools. The locations of breeding territories can vary between years, reflecting seasonal water levels and, in the medium term, local changes in vegetation cover. Returning breeding birds were recorded on site as early as 28th February 2012.

In Ireland, Ringed Plover is largely confined to coastal areas but was discovered breeding on cutover bogs in Co Offaly in 1997 (Cooney 1998[71]). The species has been breeding at Oweninny since at least April 2003 (Goodwillie 2003[72]).

Golden Plover (Birds Directive Annex I listed; Red list)

A pair of Golden Plover was present holding territory on O'Boyle's Bog in the northwest sector of the site in each of the three survey years. There were no sightings elsewhere

[70] Murray, T. & O'Halloran, J. (2003) Population estimate for Red Grouse in the Owenduff – Nephin Special Protection Area, County Mayo. *Irish Birds* 7: 187-192.

[71] Cooney, T. (1998a) Ringed Plovers Charadrius hiaticula nesting on cut-away peat in County Offaly. Irish Birds 6: 283-284.

[72] Goodwillie, R. (2003) *Breeding Bird Survey of the Bellacorick Bog (Oweninny), County Mayo*. Prepared for Bord na Móna.

on site though in 2009 an alarm calling adult was observed at Srahnakilly (cited in Copland 2010[51]). In Ireland, Golden Plover is now a rare breeding bird (probably less than 300 pairs), being confined largely to the western bogs from Galway to Donegal.

Golden Plover in Winter

Occasional in small numbers throughout site, see Table 9.25.

In Ireland, Golden Plover is a common winter visitor throughout much of the country. The majority of the population breeding in Ireland are immigrants from the population breeding in Iceland and the Faeroes. Typically they occur in large, densely-packed, flocks and in a variety of habitats, both coastal and inland. Small groups of birds, such as recorded in the present study, can be expected in most areas of northwest Mayo dominated by bog.

Table 9.25: Record of Golden Plover

Date	Record
16 November 2011	6 flew over site (>100 m height) in Srahnakilly area
6 February 2012	2 flew over site (<100 m height) at several locations in western sector
28 February 2012	2 flew over Dahybaun area (c.50 m height)

Lapwing

In October 2011, a party of 14 Lapwing was recorded flying south-east over the Lough Dahybaun area. Lapwing does not breed on site but is likely to be an occasional visitor in autumn and winter.

Dunlin (Amber list)

A single Dunlin was present in a flooded area to the north-west of Bellacorick flush on 24th June 2012. Despite further observations in this area the bird was not seen again. A single Dunlin had also been recorded on site by Copland (2010) in July 2009.

Today, Dunlin is a rare breeding species in Ireland, with small numbers surviving on the wet bogs and coastal machairs in the west. While breeding is possible at Oweninny, it is more likely that the birds recorded in 2009 and 2012 were failed or non-breeding birds passing through.

Snipe (Amber list)

Snipe are well distributed through the site with at least 10 pairs recorded in suitable breeding habitat (i.e. wet bog) and showing evidence of breeding (chipping etc.). More intensive walk-over surveys would almost certainly result in additional breeding pairs as Snipe is a difficult species to census due to its secretive nature.

While generally distributed throughout Ireland as a breeding species, numbers of Snipe have declined in recent decades as a result of habitat degradation.

Snipe in Autumn/Winter

In autumn and winter Snipe are widely distributed throughout the site. Generally birds occur singly or in small scattered groups of up to five, occasionally more.

Woodcock (Amber list)

Woodcock is a winter visitor to the Oweninny site. Birds were recorded regularly (between 5 and 11 individuals) along the track between Lough Dahybaun and the site entrance when returning after darkness from the Hen Harrier evening roost watches.

Greenshank (Amber list)

A Greenshank was recorded in suitable breeding habitat to the north-west of the Bellacorick Iron Flush from May to July 2012. A single bird was heard in song and observed in full aerial display on 2nd May and a bird was heard in song or calling excitedly on several dates afterwards. On 19th June, an interaction with a passing kestrel was witnessed. On several dates the amount of calling suggested that two birds were present though two birds together were never observed. On one date, a bird was seen flying into the Knockmoyle Nature Reserve.

These observations indicate, at the least, attempted breeding (Probable category according to the Breeding Atlas criteria). This record is of significance as Greenshank has only once before been recorded breeding in Ireland – at Achill Island in the early 1970s (Ruttledge 1978[73]).

Common Sandpiper (Amber list)

Common Sandpiper is a summer visitor to the site and it is estimated that up to 30 pairs breed within the site. The species is confined to areas of open water and along the main rivers. In Ireland, Common Sandpipers breed on lakes and along rivers and is a typical bird of western Ireland. The species has been recorded breeding on cutover bogs in Co Offaly (Copland et al. 2008[74]). Common Sandpiper has been breeding at Oweninny since at least April 2003 (Goodwillie 2003).

Common Gull (Amber list)

Common Gull is a summer visitor to the site. The numbers of breeding pairs in any one year varies between about five to ten pairs. In 2012, two pairs bred successfully at Lough

[73] Ruttledge, R.F. (1978) Greenshank nesting in Ireland. *Irish Birds* 1: 236-237.

[74] Copland, A.S., Bayliss, J., Power, E. & Finney, K. (2008) Breeding waders in cutaway peatlands in County Offaly. In: *After Wise Use – The Future of Peatlands*. Proceedings of the 13th International Peat Congress, International Peat Society, Jyväskylä, Finland.

Nagrumpaun (beside Lough Dahybaun) and at least one pair bred successfully at Laghtanvack. A 2010 survey of inland breeding gulls in counties Mayo and Galway recorded eight pairs at Bellacorick (McGreal 2011[75]). This survey showed that the overall breeding population in the two counties has been in decline since the 1980s

Kingfisher (Birds Directive Annex I; Amber list)

A Kingfisher was recorded flying west along the River Muing from the bridge at the entrance to the existing wind farm on 18th December 2012. Kingfisher is a widespread but scarce bird throughout Ireland. Occasional birds would be expected outside of the breeding season on any of the watercourses within the site.

Snowy Owl (Birds Directive Annex I; Amber list)

It appears that a Snowy Owl was largely resident within the site and the wider area around the site during the 2009-2011 period. It had been seen within and around the Corvoderry wind farm site on three occasions during surveys in 2011 (Corvoderry EIS) and was also reported from near Ummerantarry in the period March-June 2011 (Cluddaun EIS). In the present study, the owl was observed between Furnought and Fermoyle on 16th November 2011.

Snowy Owl is a rare vagrant to Ireland, with a grand total of 78 recorded in the country up to 2010 (*Irish Birds* 9: 302). An adult female which was recorded on the Mullet Peninsula (Tarmon Hill and Blacksod Bay area) from 2006 to 2010 is considered likely to be the same bird seen elsewhere in the west (including south to Galway) over this period. The bird at Oweninny is considered to be the same individual (*Irish Birds* 9: 476). While Snowy Owl is listed on Annex I of the EU Birds Directive, a lone individual such as this has limited conservation value.

Swift (Amber list)

A party of four Swifts was recorded over the site (in association with swallows) on 20th August 2012. Likely to be occasional over site in spring and autumn.

Skylark (Amber list)

Skylark is widely distributed throughout the site being absent only from the completely bare peat surfaces and the conifer forests. Numbers of individuals recorded along the

[75] McGreal, E. (2011) Census of inland breeding gulls in Counties Galway and Mayo. *Irish Birds*: 9: 173-180.

survey transect in each of the survey years (including 2009 by Copland[76]) are shown in Table 9.26. These numbers indicate a stable population across the site.

Table 9.26: Skylark Record

Year	2009	2010	2011	2012
No. of birds	67	59	50	68

The majority of Skylarks leave the site in autumn to winter in more hospitable areas in the south, east and midlands and especially in cereal growing regions.

Sand Martin (Amber list)

Sand Martins breed locally on site utilising peat banks to excavate nesting holes. The locations of these breeding banks can vary between years. The somewhat unusual choice of peat banks for nest sites was noted by Ruttledge (1994[77]) as a feature of some of the bogs in Cos. Mayo and Galway.

Swallow (Amber list)

Swallows breed in some buildings on site and in surrounding areas and may be seen anywhere over the site during summer. Swallows, probably local migrants, occur widely over the site in autumn.

Wheatear (Amber list)

Wheatears were recorded in small numbers in summers 2011 and 2012 and it is possible that a few pairs breed. This species typically breeds in crevices amongst stones and boulders and the most likely breeding habitat on site would be the exposed areas of gravel. A large movement of migrant birds was present on site in early May 2012 – this involved many hundreds of birds passing though the site to breeding grounds elsewhere.

Individual Wheatears recorded on site in autumn were probably migrants.

Grasshopper Warbler (Amber list)

Grasshopper Warblers occur sparsely throughout much of the site. Birds are seldom seen and evidence of their presence is usually by singing males in suitable vegetation

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[76] Copland, A. (2009) *Birds on Cutaway Peatlands at Boora, Co. Offaly: Project report 2009.* Unpublished report for Bord na Móna, Leabeg, Co. Offaly and BirdWatch Ireland, Co. Wicklow.

[77] Ruttledge, R.F. (1994) *Birds in Counties Galway and Mayo*. Irish Wildbird Conservancy, Dublin.

(i.e. rush dominated areas). A peak of ten singing birds were recorded along the survey transect in 2011.

Starling (Amber list)

Starlings breed in buildings within and around the site. Post breeding birds form flocks from mid-summer onwards and were often present in the fields north of the power station.

In winter larger flocks can form in the fields which surround the site. On the morning of 13th January 2012, two flocks of approximately 200 and 100 Starlings passed the Dahybaun area flying eastwards. On the morning of 21st February 2013, a dense flock of 200+ birds was observed flying from a roost in the conifers just inside the existing wind farm entrance.

Linnet (Amber list)

Linnets breed sparsely within the site. This is a species typical of heathland and was recorded in dry cutaway bog with associated scrub. In autumn and winter, small flocks of Linnets feed within the site, often along the tracks.

Twite (Red list)

A party of seven Twite was recorded feeding along the edge of a track in the westernmost sector of the site on 14th November 2011.

Twite is an extremely localised breeding species in Ireland being confined largely to the west Donegal and west Mayo coasts (McLoughlin & Cotton 2008[78]). In winter, the population is augmented by immigrants from Scotland and the distribution is generally from Achill north-eastwards to Strangford Lough. Wintering birds are almost entirely found in coastal areas where they feed on salt marshes and machair.

The occurrence of Twite at Oweninny is unexpected and the record is one of the furthest inland locations where they have been recorded (D. McLoughlin personal communication).

9.4.5 Evaluation Of Conservation Importance Of Site

9.4.5.1 Habitats and flora

While the Oweninny site has been intensively exploited for peat extraction since the

[78] McLoughlin, D. & Cotton, D. (2008) The status of Twite *Carduelis flavirostris* in Ireland 2008. *Irish Birds* 8: 323-330.

1950s, the site retains considerable importance in terms of habitats and flora.

Foremost is the direct association of three SAC sites, rated of International Importance, with the Oweninny site, as follows:

- Bellacorick Iron Flush SAC - while not part of the development site, this unique site which supports a protected plant species, is located entirely within the Oweninny site.
- Lough Dahybaun SAC – this lake site supports a protected plant species and is partly (at least two-thirds) within the Oweninny development site
- Bellacorick Bog Complex SAC – a small sector of the SAC extends into the north-east corner of O'Boyle's Bog within the site.

The site also supports a substantial number of remnants of blanket bog that were not cut for peat though some were drained in preparation for cutting and others have marginal disturbance from local cutting or tracks. Remedial works have involved the blocking of drains at most of these sites in an attempt to restore their hydrological integrity. While lowland blanket bog is the main habitat (some of which is considered as active), other Annex I habitats are associated with these remnants, including wet heath, dry heath, dystrophic lakes and oligotrophic lakes. After the Bellacorick Iron Flush, O'Boyle's Bog is by far the most important of the remnants and also the largest in size (rated of County Importance). One other remnant is rated as of County Importance, with eight rated as of Local Importance (higher value). The remaining remnants are all rated as of Local Importance (lower value) as they are generally small in size and disturbed to varying degrees. Overall, the bog remnants have an area of 1,043 ha, the majority of which is lowland blanket bog. Apart from the intrinsic value of each remnant, as a whole they provide useful corridors for plant and/or animal species and also are a source of local species in the long-term re-vegetation process of the cutaway areas. Some of the larger remnants occur along the margins of the site and adjoin the extensive bogs of the Bellacorick Bog Complex SAC thereby extending the total area of continuous bog.

An important feature of the site is the presence of a petrifying spring. This is considered a good example of this rare habitat which is listed with priority status in Annex I of the EU Habitats Directive. This habitat is rated as having County Importance.

The majority of the remainder of the site is dominated by cutover blanket bog of varying quality. Much of this has developed relatively recently and has been encouraged by the Bord na Móna rehabilitation programme which was initiated in 2001. At present, all of the cutover bog area is rated as Local Importance (lower value) but this rating is expected to increase in the medium to long-term as bog vegetation becomes better established. Indeed, it has been demonstrated from on-site studies that areas that have been successfully re-wetted are proving to have reverted to carbon sinks (Wilson et al. 2012[79]).

9.4.5.2 Fauna

The site supports a fairly typical mammalian fauna of open boglands. The presence of otter, albeit rather sparsely, on the main river and associated channels is of particular note as Otter is listed in Annex II and Annex IV of the EU Habitats Directive. Otter is also listed as 'Near threatened' in the Irish Red List. Ireland is a European stronghold for the species, and the larger rivers in the study area provide good habitat for otter. Other species which occur on site, such as Pine Marten and the Irish Hare, are listed in Annex V of the Habitats Directive. The Red Deer is not a native population and hence is of low conservation importance. All the bat species which occur on site are listed in Annex IV of the Habitats Directive, with Leisler's bat also listed as 'Near threatened' in the Irish Red List.

The Common Frog, a widespread species throughout the site, is listed on Annex V of the Habitats Directive.

[79] Wilson, D., Renou-Wilson, F., Farrell, C., Bullock, C. and Muller, C. 2012. *Carbon Restore – the potential of restored Irish peatlands for carbon uptake and storage; CCRP Report.* EPA Wexford.

Table 9.27: Legal status of protected fauna encountered or considered likely to occur within the study area.

Common Name	Scientific Name	Habitats Directive Annex no.	Wildlife Act 2006 and Amendment 2000	Irish Red List status (after Marnell et al. 2009[80] or et al 2102)
Badger	*Meles meles*	-	P	Least concern
Otter	*Lutra lutra*	II, IV	P	Near threatened
Pine Marten	*Martes martes*	V	P	Least concern
Hedgehog	*Erinaceus europaeus*	-	P	Least concern
Irish Hare	*Lepus timidus hibernicus*	V	P	Least concern
Pygmy Shrew	*Sorex minutus*	-	P	Least concern
Common pipistrelle	*Pipistrellus pipistrellus*	IV	P	Least concern
Soprano pipistrelle	*Pipistrellus pygmaeus*	IV	P	Least concern
Daubenton's bat	*Myotis daubentonii*	IV	P	Least concern
Leisler's bat	*Nyctalus leisleri*	IV	P	Near threatened
Natterer's bat	*Myotis nattereri*	IV	P	Least concern
Red Deer	*Cervus elaphus*	-	P	Least concern
Common Frog	*Rana temporaria*	V	P	Least concern
Common Lizard	*Zootoca vivipara*	-	P	Least concern

P = Protected under the Wildlife Act (1976) and Wildlife [Amendment] Act (2000)

[80] Marnell, F., Kingston, N. and Looney, D. 2009 *Ireland Red List No. 3: Terrestrial Mammals.* National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin

9.4.5.3 Birds

While a total of 29 species of conservation importance was recorded on site, the majority (21) of these are in the Amber list category only (i.e. of medium conservation concern in Ireland) and many of the 29 occur on site only in small numbers or on an occasional basis.

Of the seven EU Birds Directive Annex I species recorded, the presence of wintering Hen Harriers roosting (up to 6 individuals) is undoubtedly the most significant and is of high importance in a local/county or even regional context. This is a well established roost and provides optimum conditions for night roosting. The breeding of Golden Plover on site (1 regular pair) is also of note as this is now a rare breeding species in Ireland and very characteristic of the extensive Atlantic blanket bogs of north-west Mayo (also a Red List species). It seems unlikely that Merlin breeds on site though it does breed in the wider area and the site provides useful foraging habitat. While Whooper Swans occur on site, numbers are low and occasional and the potential for this species is probably limited due to the oligotrophic nature of the lakes. Similarly, the potential for Greenland White-fronted Geese at the site is limited and it seems certain that there is no longer a regular population in the wider area of Oweninny (though birds are probably still attracted at times to Knockmoyle Bog). The single record of Kingfisher was in winter when birds move a lot and could be expected on any watercourse in the area. While the presence of Snowy Owl is of ornithological interest, this is a wandering vagrant bird with no prospect of colonising and hence of low conservation importance.

The presence on site of Red Grouse, a Red List species, is of note as this species has suffered an estimated 50% population decline in Ireland over the last four decades (Cummins et al. 2010[81]). The Red Grouse 2006-08 national survey found that the northern half of County Mayo had reasonable populations, with grouse recorded in 46 out of 70 sites surveyed. The survey noted that the presence of ling heather, and especially heather aged between 2 and 8 years, is critical for the occurrence of the species. At Oweninny, there is presently a good combination of different age classes of heather, with older, mature plants on the remnant bogs and young plants on re-vegetating areas of cutover. With continuing re-vegetation over extensive areas within the site, the value of the site for Red Grouse is likely to increase in the future.

Lapwing was recorded flying over the site in October 2012 and is likely to be an

[81] Cummins, S. et al. (2010) The status of Red Grouse in Ireland and the effects of land use, habitat and habitat quality on their distribution. *Irish Wildlife Manuals, No. 50*. NPWS, Dublin.

occasional autumn and winter visitor. While not recorded in summer, the site appears to have potential for nesting.

Overall, the assemblage of breeding wetland bird species (all at least Amber listed), and especially waders, is notable. Of particular interest is the population of Ringed Plover, a species otherwise almost entirely confined to coastal areas. The site also has a significant population of Common Sandpiper and a good scatter of breeding Snipe. The discovery of a probable breeding event by Greenshank is only the second recorded instance of breeding by this species in Ireland and so is of high significance. In the British Isles, Greenshank is confined to Scotland as a breeding species, where it is found on the extensive blanket bogs and moorlands. The breeding at Oweninny in 2012 may have been a once-off event as rare breeding birds will often breed or attempt to breed in an area for a season and then move on without becoming established. However, Greenshank is known to be highly site-faithful and so there is some chance that the same bird(s) could return in the coming years (Nethersole Thompson & Nethersole-Thompson 1979[82]). The breeding of Teal and Common Gull is also significant as both of these are nowadays scarce breeding species in Ireland.

The site supports a very large population of Skylark, a further Amber listed species.

Overall, the Oweninny site supports an important diversity of bird species that is characteristic of western blanket bog, wetland habitats and forest/scrub habitats.

9.5 IMPACT ASSESSMENT

9.5.1 Characteristics of the Development

Full technical details of the project are given in Chapter 2, Description of Project.

Sensitive design of the Phase 1 and Phase 2 component of the Oweninny project has ensured that the wind farm infrastructure is outside areas rated as of ecological importance, especially the areas of relatively intact bog (bog remnants).. In particular, the project design and appropriate mitigation (as necessary) will ensure that sites designated for nature conservation both within the site boundary and in adjoining areas are not affected in any way (directly or indirectly). Overall, the mitigation followed in this project has been a policy of avoidance, which is considered the best form of mitigation for projects in ecologically sensitive areas (details of measures are given in mitigation

[82] Nethersole Thompson, D. & Nethersole-Thompson, M. (1979) Greenshanks. Poyser, London.

section).

9.5.2 Loss of Habitats

The entire development will result in a permanent loss of habitats (i.e. covered by hardcore) estimated at 111 ha total.

As well as the actual loss of habitats, adjoining areas will be disturbed to some extent to accommodate the construction works. Also, there will be loss of existing habitats for temporary facilities, especially the borrow pit (17 ha) and associated gravel storage area (13.2 ha) and the peat depository area (37 ha) but these will eventually regenerate to bog type vegetation (see under changes to habitats as a result of works).

The principal habitat affected by construction will be cutover bog varying from bare or sparsely vegetated surfaces to surfaces where bog vegetation is in the process of becoming re-established. The re-establishing bog vegetation varies greatly, ranging from dry heather dominated areas to wet bog dominated by bog cotton (*Eriophorum angustifolium)* and rushes (mostly *Juncus effusus)*.

One of the bog remnants (remnant no. 9) will be impacted slightly by the placement of turbine infrastructure along its margins. Turbines 64, 65 and 79 are located along the margins of bog remnant No. 9 (see Figure 9-2) and the construction of these turbines and associated hard standings will result in the direct loss of a small area of modified blanket bog habitat (estimated as 0.5 hectares). Further, the proposed track which runs between Turbine No. 79 and Turbine No. 81 will clip the south-western edge of bog remnant area No. 9, with the loss of an estimated 0.2 ha (maximum) of bog. However, the blanket bog habitat at bog remnant No. 9 has been previously drained and is not considered to be actively peat forming (bog remnant No. 9 is rated as Local importance, lower value). The loss of an estimated 0.7 ha of generally low quality bog remnant is considered an impact of Slight significance.

In addition it is noted that the work areas for five turbines come close to various bog remnants but will not actually encroach upon them (and care will be taken during construction to ensure that there is no overlap – see mitigation section). The turbine number and calculated distances to the bog remnants are given in Table 9.28.

Table 9.28: Distance from nearest bog remnants to construction area

Turbine	Bog remnant	Distance
T1	41	29 m
T19	4	0 m
T42	22	15 m
T52	8	6 m
T89	11	16 m

The proposed track which passes through the middle of bog remnant No. 19 follows the line of an old railway embankment and the land adjoining this embankment is dominated by dry-humid acid grassland on mineral soil and small areas of exposed gravel. In this section of road any loss of habitat will be restricted to the existing track surface and adjoining grassland which is of relatively low ecological value – this impact is not considered significant.

All of the affected cutover bog, as well as bog remnants Nos. 9 and 19, are rated as having low conservation value (Local Importance, lower value) and the significance of the impact by loss of habitat is rated as, at most, Slight.

9.5.3 Changes to Habitats as a Result of Works

9.5.3.1 Habitats affected directly by construction works

It is noted that there will be substantial change or alteration of habitats at the locations of the borrow pit (up to 17 ha), gravel storage area (up to 13.2 ha) and peat repository area (18.6 ha).

When the construction is complete, the borrow pit may be allowed to flood which would provide useful habitat for wetland plants and birds. Alternatively if backfilled with peat, it would be expected to re-vegetate naturally with rushes over a relatively short space of time and eventually a more diverse bog vegetation would be expected to develop.

The gravel storage area could also provide useful habitat diversity if left as a stony substrate and could be particularly attractive for bird species such as Red Grouse (availing of grit for digestion), Wheatears and possibly nesting Ringed Plover.

As the peat repository area will be covered with shallow peat (up to 1m depth), it is expected to re-vegetate naturally with bog vegetation over a relatively short space of time.

As already noted, in addition to habitat loss there will be disturbance to adjoining areas of habitats around the construction work areas, though this can be minimised with care. Areas of bare peat, such as are expected to occur along the access tracks and around the turbine bases and other infrastructure, will quickly become colonised by a range of rushes and grasses, with soft rush (*Juncus effusus*), bulbous rush (*Juncus bulbosus*) and bent grasses (*Agrostis* spp.) typically prominent. With time, various other bog species will colonise, with ling heather (*Calluna vulgaris)* favouring dry substrates and species such as bog cotton (*Eriophorum angustifolium*) favouring the wetter areas and drainage channels. Scrub, mainly willow (*Salix* sp.), may also develop where disturbance has occurred.

Overall, various areas of mostly cutover bog will be affected on a temporary basis by a number of components of the development but all are expected to revert to cutover bog of some type after the works are complete. The significance of this impact is rated as Slight or Neutral in medium to long-term (with potential for positive impacts from proactive habitat management - see mitigation).

9.5.4 Changes to habitats during operation phase

Once constructed, it can be anticipated that some habitat changes will occur over time due to the presence of the new tracks and other infrastructure. In particular, new tracks may act as water retaining berms leading to local cutover bog areas becoming wetter or even flooded resulting in the formation of ponds. Similarly, drainage may be improved in some areas as a result of the works, with drier surfaces encouraging the growths of species such as ling heather or willow scrub. It is intended that such changes, which may well be beneficial for wildlife, will be managed as appropriate in the post construction phase (see mitigation section). As the cutover bog has already been managed and is in a transient state, such changes which may occur are anticipated to be at least Neutral and probably Positive.

9.5.5 Potential Hydrological Impacts on Flush Systems

The Oweninny boglands are characterised by the presence of flush systems. Apart from the well documented Bellacorick Iron Flush, a series of flushes occur on the blanket bog to the east of the site in the area of Formoyle. Also in this category of habitat is a petrifying spring located in an area of cutover bog within the south-east of the site. Phase 1 and Phase 2 of the project would not have any potential to impact on the Formoyle flushes or on the petrifying spring in the south-east sector of the site.

As the Bellacorick Iron Flush is critically dependent on its groundwater catchment area and groundwater chemistry, a hydrological and hydrogeological assessment was commissioned to assess the potential impacts of the wind farm development on this sensitive system (refer to Chapter 18 for full report). This study was carried out in association with the project ecologists and was approved by the National Parks and Wildlife Service.

For the Bellacorick Iron Flush, the study concluded that all of the proposed development areas in the vicinity of the iron flush are significantly outside the delineated groundwater and surface water catchment of the flush. As a result, there is no potential to impact on groundwater flows or surface water to the flush area. To ensure that no impact on groundwater level will occur, turbine foundations in the vicinity of the iron flush will be shallow excavated and piled and no dewatering of the foundation will occur.

Also, the proposed drainage network is designed so that all surface water runoff from hardstanding areas will be discharged into the same surface water catchment that it was originally collected in. The collected surface water runoff will be released by controlled outfalls onto the existing natural ground surface locally within the catchment. The use of swales will also be used to promote recharge. These methods, which will assist in maintaining recharge volumes, will ensure that there will be no impact on the water balance of the flush. Therefore, there will be no net reduction in groundwater recharge or surface water runoff within individual catchment areas.

9.5.6 Potential Pollution of Watercourses

A full aquatic assessment of the local watercourses and water bodies is presented in Chapter 10 of the EIS.

Briefly, in the absence of appropriate mitigation, there is some risk to the watercourses and water bodies within the site as a result of water impairment during both the construction and operational phases. This could arise as follows:

- Pollution of watercourses with suspended solids due to runoff of soil/peat from construction areas
- Pollution of watercourses with other substances such as fuels, lubricants, waste concrete and waste water during the construction phase.

- Pollution of watercourses with nutrients due to ground disturbance during clear felling of forestry to facilitate construction. Pollution of watercourses with nutrients due to decomposition of brash after forestry clear felling.
- Pollution of watercourses with surface drainage water from paved areas and road surfaces.

9.5.7 Potential Impacts from Peat Slippage

A Peat Stability Risk Assessment (PSRA) was carried out by ESBI (see Appendix 4 of the Oweninny EIS submitted for planning for full report). The PSRA assessment is based on the Natural Scotland Scottish Executive "Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments" (2006) and is supplemented by the experiences of ESBI on previously developed sites. This document sets out four categories of risk and recommends various mitigation/avoidance actions for each category.

Peat stability risk is categorised as insignificant, significant, substantial or serious. Construction can take place in areas where risk categories range from insignificant to substantial with varying mitigation requirements. The insignificant and significant categories represent areas where the risk of peat instabilities are either considered negligible in a standard construction environment or considered manageable by the adoption of specific additional mitigation measures respectively. In the context of this development, the substantial risk category represents areas where more rigorous site investigation is required prior to construction at detailed design stage, more onerous mitigation measures are actioned and a higher level of site supervision is locally imposed in order to reduce the risk to lower levels.

While peat stability risk assessments are of consequence in both upland peat areas and lowland peat areas there are some distinguishing features of this lowland site that are considered more favourable than those of a typical upland site. The relatively flat topography of this site differentiates Oweninny from an upland peat site where, unlike an elevated site, the likelihood of a substantial downslope reaction to a trigger event is significantly reduced. In the main the historical extensive drainage and removal of peat across the site has also served to mitigate against the impact of a peat instability event by reducing the thickness of peat and thereby providing buffer areas where an instability of peat is most likely to lessen rather than intensify.

The following Table 9.29 summaries the recommended action for each risk zone.

Table 9.29: Peat Stability Risk Assessment Risk Rating

Risk Rating	Risk Level	Action Required
0.0 - 0.18	Insignificant	Normal Site Investigations
0.19 - 0.42	Significant	Targeted Site Investigation. Design of specific mitigation measures. Part time supervision during construction.
0.43 - 0.66	Substantial	Avoid construction in the area if possible. If unavoidable, detailed SI and design of specific mitigation measures. Full time supervision during construction.
0.67 - 1.0	Serious	Avoid construction in this area.

A PSRA was carried out using information on the ground conditions, topography, hydrology, ecology, land use and other factors. The impact of a potential peat instability event was also considered. The likelihood and impact of a peat failure at different areas of the site were combined to form the risk. An assessment of the potential for peat instability was undertaken at each turbine/hardstand, substation, section of road and building to determine a risk rating for the construction works in the area. The results of the peat stability risk assessment show that the site contains areas of insignificant risk to substantial risk.

The risk rating at the site varies from insignificant to substantial. Areas of insignificant risk are identified on site based on the recommendation that where peat depths are less than 0.5m no specific peat instability risk is present. Significant or substantial risks at this site are largely driven by two factors; the distance from the nearest defined watercourse which in turn affects the quantity of material that could arise in a displacement and the depth of peat at the location under consideration. Therefore some locations are shifted into the substantial category of risk because of their distance from the nearest watercourse even though other important factors such as ground slope would be considered relatively favourable.

The following Table 9.30 summarises the results of the PSRA in term of construction area.

Table 9.30: Result of PSRA

Risk Level	% Construction Area (approx.)
Insignificant	60%
Significant	30%
Substantial	10%
Serious	0%

In order to supplement the PSRA information, a computer generated analysis of the peat stability at the site has also been carried out. This analysis involves modelling the site assuming a translational slip failure. For this case a very low undrained shear strength value has been assumed in the analysis i.e. 2.5kPa and a surcharge of 10kPa. The analysis identifies areas of varying potential of peat instability based on a quantitative analysis. This analysis is a crude and conservative (assumes a very low undrained shear strength for all of the peat across the site) assessment of the peat stability and by itself is only indicative. It is however a tool to be considered in the assessment of the risk at the site.

The outcomes of the peat stability risk assessment and the slope stability analysis broadly align in so far as the higher risk rating areas are predominantly clustered in the areas identified by the analysis as having a more likely potential of instability. The PSRA also suggests that except for the areas to the north and south of the Muing River and to the east of Furnought Hill the risk of peat instability across the majority of the remainder of the site is low. There is also only one short section of access track (AT67) within the Lough Dahybaun catchment which falls into the substantial risk category. It is noted that Phase 1 and Phase 2 of the project will not have any potential to impact on these areas which are within the substantial risk category.

Overall, the risk of peat instability has been minimised and mitigated by optimising the design of the wind farm. However, without additional appropriate mitigation during the construction phase, there is some risk that slippage could affect the ecological interests within and around the site and especially areas of intact or relatively intact blanket bog and the various lakes and ponds.

9.5.8 Potential Impacts on Birds of Conservation Importance

9.5.8.1 Impacts on Annex I and/or Red Listed bird species

Hen Harrier

The baseline data have demonstrated that the wintering Hen Harriers are very much confined to a relatively small area of the south-east sector of the site for roosting purposes and that daytime foraging is predominantly off site.

As the roost area is at a closest distance of approximately 3 km from the Phase 1 work area, it is considered that there is no potential during the construction phase for disturbance to the birds arriving at or leaving the roost.

Also it is considered that there is no significant risk of collision with operational turbines as flightlines to and from the roost are predominantly in an easterly or southerly direction (see Figure 9-8 and Figure 9-9).

From the above, it is considered that Phase 1 and Phase 2 of the project will not have any adverse impacts on the roosting behaviour of the wintering Hen Harriers on site.

Merlin

The baseline surveys indicated that it is unlikely that Merlin is breeding on site but does breed in the wider area and may hunt on site through the year.

It is considered that the presence of turbines would not deter Merlin from hunting over the site. Further, there is no significant risk of collision with turbines as Merlin typically flies low and fast close to ground level.

Overall it is considered that this species will not be affected by the proposed development.

Red Grouse

From the baseline surveys, it is considered that Red Grouse is distributed throughout much of the site where there is good heather coverage. As research has shown that grouse require at least 25% heather coverage, it can be assumed that the site will become more important for grouse in the future as re-vegetation of bare surfaces proceeds.

Recent studies in the United Kingdom have suggested that while Red Grouse densities declined significantly at wind farms during the construction phase they appeared to recover by the first year of operation (Pearce-Higgins *et al*. 2009[83], Douglas *et al*. 2011[84], Pearce-Higgins *et al*. 2012[85]). In fact, the analysis of species distribution highlighted a positive association between Red Grouse occurrence and turbine and track proximity. Reasons for the association between grouse and wind farms are likely to include the following: 1. birds attracted by good growth of heather for feeding along the margins of tracks, 2. birds attracted by supplies of grit on tracks which they need to ingest to aid digestion, and 3. birds attracted by the actual tracks to dust bathe so as to maintain their plumage. A monitoring programme at the Derrybrien wind farm in Co Galway has also recorded Red Grouse along the tracks and elsewhere within the site (BES 2011[86]).

Based on available information, it is considered that grouse will be disturbed from areas of the site where construction works are ongoing but are expected to become re-established in these areas when works are complete and the turbines are operational. Importantly, due to the large size of the site and the phased basis for wind farm construction, disturbance will be confined to only certain sectors of the site at any one time. As this is a temporary impact with full recovery expected, it is rated as an impact of Slight significance. Mitigation will be taken to ensure that works do not commence in

[83] Pearce-Higgins, J.W., Stephen, L, Langston, R.H.W., Bainbridge, I.P., & Bullman, R. (2009) The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology*.

[84] Douglas, D.J.T, Bellamy, P. & Pearce-Higgins, 2011. Changes in the abundance and distribution of upland breeding birds at an operational wind farm. *Bird Study* 58: 37-43.

[85] Pearce-Higgins, J.W., Stephen, L., Douse, A. & Langston, R.H.W.. 2012. Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. *Journal of Applied Ecology* 49: 386-394

[86] BioSphere Environmental Services (2011) *Derrybrien Wind Farm, Hen Harrier Monitoring 2011*. Prepared for Hibernian Wind Power.

vegetated areas where breeding grouse may be present.

Red Grouse is a species that is not associated with collision risk with turbines as it seldom flies and when it does it normally keeps at low heights (> 10 m) (the rotor sweep at Oweninny will be at least 45 m above ground level).

Golden Plover

There is one regular Golden Plover territory within the site. This is within O'Boyle's Bog which has been totally excluded from any development (and the actual nesting area is approximately 1 km north of the Sheskin river which separates the bog from the remainder of the site). On this basis, it is considered that the development will not interfere in any way with this breeding territory.

As re-vegetation of the site progresses, there is some chance that Golden Plover could establish a territory elsewhere on site in the future. The presence of the wind farm is not expected to deter future prospecting by plover as a recent study at an upland wind farm in the United Kingdom has shown no evidence of a decline in population abundance in Golden Plover over a 3-year period (Douglas *et al*. 2011[84], Pearce-Higgins *et al*. 2012[85]).

The Oweninny site does not support significant numbers of Golden Plover in autumn or winter and small flocks would still be expected to land within the site to feed or rest when the wind farm is operational.

Whooper Swan

The winter surveys have shown that Whooper Swans visit the Oweninny site in small numbers (max. flock size 5) and on an occasional basis. This pattern reflects the low feeding potential of the lakes due to their oligotrophic nature. The surveys also showed that there are no regular flightlines over the site.

Whooper Swan is considered a species prone to collision with structures such as turbines and particularly overhead power lines, especially during inclement weather (fog, heavy rain etc.). The risk at Oweninny, however, is considered of low significance due to the small numbers of swans involved and the irregular usage of the site.

Greenland White-fronted Geese

Available evidence indicates that nowadays Greenland White-fronted Geese are only occasional visitors to the area since the former population based at Bellacorick abandoned the area in the 1980s due to the exploitation of the bog habitats which they formerly frequented.

Should Greenland White-fronted Geese be passing over the site, the risk of colliding with the wind turbines is negligible when light and visibility during the day allow flying geese to see the turbines and avoid them, by diverting their flightlines or by gaining altitude. However, when flighting in very poor light at dawn and dusk, or in very poor weather conditions and visibility (fog, mist, heavy drizzle etc.), the geese would be at some risk of potential collision.

While accepting that a risk of collision exists if geese were passing through the site during inclement weather conditions, the chances of this actually happening are considered remote due to the rarity of geese in the wider area.

Kingfisher

Kingfisher is a very occasional visitor to the site (only one record through the study) and would not be expected to be affected by the proposed development.

Snowy Owl

The Snowy Owl recorded is considered a wandering vagrant throughout north-west Mayo. There were no sightings of the bird on site during the 2012 surveys though it is possible it could visit again in the future. It is expected that the owl would avoid areas where construction works are underway. When operational, the risk of collision would be low as the bird spends much of its time on the ground and generally flies close to ground level, (within 10-20 m).

9.5.8.2 Impacts on Amber Listed species

Ringed Plover and Common Sandpiper

These two wader species have a fairly widespread distribution throughout the site. The numbers and locations of territories occupied can vary between years. Ringed Plover is associated with the permanent lakes and ponds though can also occur on bare open areas of peat with associated gravel exposures and perhaps seasonal flooding. Common Sandpiper is also associated with the permanent lakes and ponds but also occurs along the rivers.

The impact on these species is rated as of Slight significance as most of the existing water bodies and all the main river channels have been largely avoided by construction works. Elsewhere on site prospecting birds are likely to avoid areas of ongoing construction (probably to a distance of several hundred metres). Mitigation will be required to ensure that works don't commence in areas where breeding birds have already established territories.

It is considered that the operational turbines would have little if any disturbance impacts on these species. It is also considered that the risk of collision is negligible as during the breeding season the movements by these species is very localised and flight lines tend to be close to the ground (mostly <10 m).

An objective of the post construction habitat management will be to create further permanent ponds and wet areas which will suit these species. There is also an opportunity to create an open gravel/stony area at the gravel storage area beside the borrow pit – this would particularly suit the requirements of nesting Ringed Plover.

Snipe

The baseline surveys have shown that breeding Snipe is generally distributed within the site where suitable habitat occurs (i.e. wet re-vegetated cutover bog).

A recent review of monitoring data from upland wind farms in the United Kingdom has shown that densities of Snipe were significantly reduced at wind farms during construction, with no recovery apparent by the first year post-construction (Pearce-Higgins *et al*. 2012[85]). Snipe had also been shown by Pearce-Higgins *et al*. (2009[83]) to use areas of habitat within 400 m of turbines less than expected, leading to an expected 48% decline in abundance within 500 m of the turbines.

At Oweninny, it is inevitable that some of the wind farm development will encroach on suitable breeding habitat for Snipe. While ample areas of potential habitat will still exist within the site, it is considered that the overall breeding population of Snipe may be reduced by the presence of the wind farm (though any decrease may be offset by the further development of suitable wetland habitat elsewhere on site). As Snipe is an Amber Listed species that has declined as a breeding species throughout Ireland in recent decades, this likely impact is rated as Significant.

Snipe is also a widespread winter visitor to Oweninny and can occur in most habitats (from dense stands of rushes or bog vegetation to bare peat). It seems unlikely that wintering birds would be disturbed during winter by either construction works (apart from the immediate area of the works) or the operational wind farm.

It is considered that the risk of collision for Snipe during both summer and winter is negligible due to their behaviour of staying on the ground for the majority of the time and then only flying in short bursts of flight.

Greenshank

The presence of breeding Greenshank (at the least a breeding attempt) at this site in 2012 was unexpected as this species has been recorded breeding in Ireland on only one previous occasion. There is some chance that the same bird(s) may return to the Oweninny site in subsequent years though colonisation in the long term by more than one pair would seem unlikely.

If a breeding pair is on site at the time of construction, it is likely that construction works within a distance of several hundred metres of their territory would force them to abandon any breeding attempts for that season. Mitigation would be required to ensure that possible breeding birds present are not disturbed.

Whether the presence of the operational wind farm would deter prospecting birds from settling in the site is not known but as this is a case involving a single pair in an area without any previous history of the species, there is a reasonable probability that there may be a deterring effect due to the presence of the turbines. While this impact would be of some significance, the impact would need to be interpreted in the context of this being a single, isolated breeding pair without much prospect of long-term colonisation of a wider area.

Common Gull

Common Gull has a scattered breeding distribution across the site and will utilise different sites between years. Breeding birds would be expected to be disturbed by construction works within a distance of several hundred metres of the nesting area. Mitigation would be required to ensure that possible breeding birds present are not disturbed.

An objective of the post construction habitat management will be to create further permanent ponds within the site, which will suit this species.

Teal and Little Grebe

These two species breed sparsely across the site where well developed wetland habitats occur. As with other wetland species, breeding birds would be expected to be disturbed by construction works close to the breeding area (within several hundred metres). Mitigation would be required to ensure that possible breeding birds present are not disturbed.

Once operational it is unlikely that birds would be deterred from breeding due to the presence of the turbines. During the breeding season, these birds stay close to the nest area and flight lines tend to be close to the ground (mostly <10 m). Neither species is considered at risk of collision with turbines.

Wintering Teal occur on site in small numbers and are mostly confined to the various lakes. The wind farm development is unlikely to have any adverse impacts on wintering birds.

An objective of the post construction habitat management will be to create further permanent ponds within the site, which will suit these species.

Other Amber Listed species

There are unlikely to be any significant adverse impacts by the wind farm on the amber listed passerine species which occur regularly on site (skylark, sand martin, swallow, wheatear, grasshopper warbler, starling, linnet). Construction works during the nesting season would cause disturbance to birds in the immediate work area but this can be mitigated by site clearance works taking place outside of the breeding season (and thus removing the potential for nesting to occur).

Generally, wind farm developments can be expected to have fewer effects on passerine species than on waterfowl or birds of prey (Devereux *et. al*. 2008[87]). There may actually be beneficial effects for some species as recent research by Pearce-Higgins et al. (2012) suggests potential positive effects of wind farm construction on skylarks, meadow pipits and stonechats. Such effects may result from vegetation disturbance during construction creating greater openness in the sward structure, known to benefit these species (though at Oweninny there already are vast areas of open habitats, as reflected by the high numbers of skylarks and meadow pipits).

9.5.9 Potential Impacts on Terrestrial Mammals

9.5.9.1 Otter

The assessment for Otters showed that they tend to occur throughout the main river

[87] Devereux, C.I., Denny, M.J.H. & Whittingham, M.J. (2008) Minimal effects of wind turbines on the distribution of wintering farmland birds. *Journal of Applied Ecology* 45: 1689-1694.

channels on the site, with some use of the larger tributaries.

As the development includes a 100 m buffer from all main river channels, and requires strict measures to maintain water quality, it is considered that Otters will not in any way be affected by the proposed wind farm and will continue to utilise the site during and after construction.

9.5.9.2 Badger

Badgers occur on site with several sightings close to the various conifer plantations where the sets are likely to be located. The project will require the removal of 36 ha of conifer forest. This is a small proportion of the total on site (325 ha) and, apart from temporary disturbance, is unlikely to have a significant impact on the overall badger population on site.

Mitigation will be required, however, to ensure that construction works in forest plantation areas (involving ten turbines in the south-east of the site) do not interfere with any badger setts that may be present.

9.5.9.3 Other mammal species

Apart from temporary disturbance in immediate work areas, the proposed development would not be expected to have any significant adverse impacts on the other mammal species which inhabit the site and surrounding areas.

All the species recorded, or considered likely to occur, would be expected to continue to be found in the area after construction of the wind farm is complete.

9.5.10 Potential Impacts on Bats

The most favourable bat habitats on-site are the larger watercourses and bodies and their riparian vegetation, scrub areas and the woodland edges of the coniferous plantations, all of which offer shelter for swarming insects on which bats feed. The large areas of regenerating cut-over bog are windswept, open landscapes that are poor for these animals. The present assessment has confirmed the presence of five bat species on-site and others may be expected to occur on occasion. Apart from one, each of the bat species confirmed or expected on-site are normally low fliers, e.g. <10m above ground level, and as such are considered to be at a low risk from turbine impacts. The exception is Leisler's bat which is a high-flying species and as such is of most concern.

Leisler's bat is classified as a high risk species in relation to wind turbines as it is a high flier (Carlin and Mitchell-Jones 2009[88]), which travels considerable distances (up to 13.4km has been recorded in Ireland, Shiel *et al*. 1999[89]) between roosts and foraging areas. The species has evolved for fast flight in excess of 40km/h (Dietz et al. 2007[90]) and is less manoeuvrable as a consequence. It therefore avoids cluttered environments by keeping above the tree canopy normally flying between 10m and 70m above the ground (Russ 1999[91]) but which has been known to reach heights of 500m (Bruderer and Popa-Lisseanu 2005[92]). Flying at such heights potentially brings it into conflict with wind turbines.

In mainland Europe and North America, evidence of bat collisions has led to growing concern about the siting and operation of wind turbines. The most serious incidents have involved bat species that fly very high and for long journeys, particularly species on long distance migrations. Many of these overseas turbine / bat mortality studies are at wind farms with significantly large numbers of turbines, sited along known bat migration routes where many hundreds or even thousands of bats commute seasonally resulting in numerous deaths and injuries. There is currently no evidence that mortality of bats on the same scale occurs in Ireland and indeed such mortality would not be expected as Ireland does not support comparable bat migrations.

Additionally, there is some international evidence that barotrauma, which involves tissue damage to air containing structures caused by rapid or excessive pressure change, rather than collision may be a contributory factor where bat mortalities have been recorded.

The EUROBATS Secretariat has recently published guidelines on bats and wind farm

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[88] Carlin, C. and Mitchell-Jones, T. 2009 Bats and Onshore Wind Turbines – Interim Guidance (1st Edition – 11th February), Technical Information Note TIN051. Natural England, Peterborough, UK

[89] Shiel, C.B., Shiel, R.E. and Fairley, J.S. (1999) Seasonal changes in the foraging behaviour of Leisler's Bat *Nyctalus leisleri* in Ireland as revealed by radio-telemetry. *Journal of Zoology*, London 249: 347 - 358

[90] Dietz, C., Helversen, O. von and Nill, D. 2007 *Handbuch der Fledermäuse Europas und Nordwestafrikas: Biologie, Kennzeichen, Gefährdung.* Franckh-Kosmos Verlags GmbH & Co., Stuttgart, Germany

[91] Russ, J. 1999 The Bats of Britain and Ireland: Echolocation Calls, Sound Analysis and Species Identification. Alana Books, Powys, Wales

[92] Bruderer, B. and Popa-Lisseanu, A.G. 2005 Radar data on wing-beat frequencies and flight speeds of two bat species. *Acta Chiropterologica* **7** (1): 73 - 82

projects (Rodrigues et al. 2008[93]), the primary purpose of these generic guidelines being to raise awareness amongst developers and planners of the need to consider bats and their roosts, migration routes and feeding areas, and to prioritise research.

To date, there is no published research or survey evidence that the same scenarios apply in Ireland and there is no evidence of Leisler's bat mortality due to wind turbines in this country.

9.5.10.1 Adjudged likely impact of the proposed development on bats

The planned turbine development is to be sited within an area of cutover blanket bog currently over-flown by Leisler's bat and whose scrub, forest edge and watercourse habitats are currently in use by at least three bat species.

From a review of research from mainland Europe and North America, risks to bats from wind turbines are acknowledged and it is possible that some bat mortality may arise as a result of the planned development. Therefore, some general mitigation measures are recommended to reduce the likelihood of adverse impacts on local bat populations.

9.5.11 Potential Impacts on Amphibians and Reptiles

The Common Frog is widespread throughout the site where suitable standing water occurs. The construction and operation of the wind farm is not expected to have any adverse impacts on the frog population though mitigation will be required during construction to ensure frogs and spawn are removed (under licence) from work areas.

The Common Lizard is likely to be widespread throughout much of the site. The construction and operation of the wind farm is not expected to have any adverse impacts on the lizard population.

9.5.12 Potential Impacts on Sites Designated for Nature Conservation

9.5.12.1 European Sites

A full assessment of the potential impacts of Phase 1 and Phase 2 of the Oweninny Wind Farm project on designated sites (SACs, SPAs), alone and in-combination with other projects, is presented in the Natura Impact Statement which accompanies the application. A summary of the possible impacts on the sites within a 15 km radius of

[93] Rodrigues, L., Bach, L., Dubourg-Savage, M-J., Goodwin, J. and Harbusch, C. 2008 *Guidelines for Consideration of Bats in Wind Farm Projects:* EUROBATS Publication Series No. 3. UNEP/EUROBATS Secretariat, Bonn, Germany

Oweninny is given here.

The Screening Phase of the NIS identified 13 Natura sites within a 15 km radius of the Oweninny Wind Farm site boundary. It was determined that eight of these sites could not be impacted in any way by the proposed wind farm project (all 3 Phases), mainly due to geographical separations. These eight sites are:

- Owenduff/Nephin Complex SAC
- Broadhaven Bay SAC
- Slieve Fyagh Bog SAC
- Glenamoy Bog Complex SAC
- Owenduff/Nephin Complex SPA
- Lough Conn and Lough Cullin SPA
- Carrowmore Lake SPA
- Blacksod Bay/Broadhaven SPA

However, for five sites it was considered that the relevant conservation objections could potentially be impacted upon by the project (all 3 Phases) in the absence of appropriate mitigation. These sites are as follows:

- Bellacorick Bog Complex cSAC
- Bellacorick Iron Flush SAC
- Lough Dahybaun SAC
- River Moy SAC
- Carrowmore Lake SAC

For each of these sites, the potential impacts by Phase 1 and Phase 2 of the project are described in the following text:

Bellacorick Bog Complex Special Area of Conservation

The proposed Phase 1 of the Oweninny project site adjoins the Bellacorick Bog Complex SAC along a substantial part of the northern boundary of the wind farm, though is separated by the main channel of the Oweninny River and its tributary the Fiddaunnamuingeery River. In addition, there is a small area of overlap between the wind farm site and the SAC in the eastern part of O'Boyle's Bog but this part of the SAC would not be affected in any way as there will no development works within O'Boyle's Bog.

While there would be no direct impacts on the SAC site by the construction works, consideration is given here to the possibility that the SAC could be affected indirectly by peat slippage due to construction works. The turbines closest to the SAC boundary are (from east to west) as follows: T10, T2, T4, T1, T3, T7, T12, T23, T41 and T45.

The Peat Stability Risk Assessment has categorised these turbines and associated roads as having a risk rating of insignificant to significant. As described in section 9.4.7 of this report the insignificant and significant categories represent areas where the risk of peat instabilities are either considered negligible in a standard construction environment or considered manageable by the adoption of specific additional mitigation measures respectively.

On the basis of the risk assessment and the mitigation that will be implemented for the relevant risk category, and considering that the wind farm is separated from the SAC by a river channel, it is considered that there is no realistic risk of the works within the wind farm causing instability to the bog habitats within the adjoining SAC to the north.

River Moy Special Area of Conservation

As there is no hydraulic connectivity between the Phase 1 and Phase 2 development areas and the Deel River tributaries, which drain the south-east sector of the Oweninny ownership site and subsequently flow into the Moy SAC, it can be concluded with full scientific certainty that the proposed Phase 1 and Phase 2 of the Oweninny project does not have potential to impact on the River Moy SAC.

Bellacorick Iron Flush Special Area of Conservation

While this small site is entirely surrounded by the Oweninny wind farm site, the hydrogeological assessment showed that there is no real potential to impact on groundwater flows or surface water to the flush area as all of the proposed development areas in the vicinity of the iron flush are significantly outside the delineated groundwater and surface water catchment of the flush.

Nevertheless, because of the high conservation importance of this sensitive site, it is considered that further focused mitigation is required to provide certainty that there can be no impacts on the site (and the qualifying Annex II species Marsh Saxifrage) throughout the construction period. Monitoring will also be required in the pre-construction, construction and post-construction periods.

Lough Dahybaun Special Area of Conservation

It is noted that all elements of Phase 1 and 2, including the peat repository, borrow pit and access road, are outside the Lough Dahybaun Catchment.

Hence, it can be concluded with full scientific certainty that the proposed Phase 1 and Phase 2 of the Oweninny project does not have potential to impact on the Lough Dahybaun SAC.

Carrowmore Lake Special Area of Conservation

Carrowmore Lake SAC extends from Carrowmore Lake to the road leading to Sheskin Lodge on the western boundary of the Oweninny site.

T33 is located 216m from the western site boundary, while T39 is 205m from the site boundary. A minor public road separates the Largan More Bog sector of the SAC from the Oweninny site. The peat at the locations of these turbines, which lie downslope of Largan More Bog, is just over 1 m depth. While there is a substantial risk of peat slippage associated with the roads leading to these two turbines, the likelihood of a peat slippage occurring (in the absence of further mitigation) is low as historically peat slides caused by construction activities tend to start at the point of construction and "flow" downhill and generally are due to loading of the surrounding peat from sidecasting on the downslope side (the peat at these 2 locations will be excavated and not sidecast and is relatively shallow).

Despite a low risk factor, it is considered that in the absence of appropriate mitigation at the construction stage, the conservation objectives of the SAC could be affected by peat slippage.

Conclusion on potential impacts by Phase 1 and Phase 2 on European sites

Whilst the proposed Phase 1 and Phase 2 of the project could potentially have adverse impacts on three European sites it is considered that the sensitive design of the project along with the rigorous mitigation measures proposed will ensure that the project, either alone or in-combination with other projects, will have no significant adverse impacts on the conservation objectives of these European sites (full details of mitigation are given in the accompanying NIS).

9.5.12.2 Other designated Sites

Natural Heritage Areas

Three NHAs (designated under the Wildlife Amendment Act 2000) occur in the vicinity of Oweninny as follows:

Forrew Bog NHA

This lowland blanket bog is located approximately 3 km east of the eastern boundary of the Oweninny site. It is on the eastern side of the Owenmore River and a public road and is also separated from the Oweninny site by some blocks of forestry.

Ummerantarry Bog NHA

This area of upland blanket bog is located approximately 5 km north-east of the Oweninny site and is separated by extensive blocks of forestry.

Inagh Bog NHA

This upland blanket bog is located approximately 7 km north of the Oweninny site and is separated by extensive blocks of forestry.

As these three sites are geographically well separated from Phase 1 and Phase 2 of the Oweninny site (distances of 6 km, 4 km & 6 km respectively), and with the absence of hydraulic connectivity between the wind farm and the NHA sites, it is concluded that Phase 1 and Phase 2 of the proposed wind farm project would not have any impacts, direct or indirect, on the NHA sites.

9.5.12.3 Proposed Natural Heritage Areas

Eight proposed NHAs occur in the vicinity of Oweninny as follows:

Bellacorick Iron Flush pNHA

The boundary of this site is the same as the Bellacorick Iron Flush SAC and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

Bellacorick Bog Complex pNHA

The boundary of this site is the same as the Bellacorick Bog Complex SAC and the issues relevant to the SAC site are discussed in detail elsewhere in this report and in the

NIS.

River Moy pNHA

The boundary of this site is the same as the River Moy SAC – as discussed, it can be concluded with full scientific certainty that the proposed Phase 1 and Phase 2 of the Oweninny project does not have potential to impact on the River Moy SAC and pNHA.

Owenduff/Nephin Complex pNHA

The boundary of this site is the same as the Owenduff Complex SAC and SPA and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

Carrowmore Lake pNHA

The boundary of this site is the same as the Carrowmore Lake Complex SAC and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

Broadhaven Bay pNHA

The boundary of this site is the same as the Broadhaven Bay SAC and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

Slieve Fyagh Bog pNHA

The boundary of this site is the same as the Slieve Fyagh Bog SAC and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

Glenamoy Bog Complex pNHA

The boundary of this site is the same as the Glenamoy Bog Complex SAC and the issues relevant to the site are discussed in detail elsewhere in this report and in the NIS.

9.5.12.4 Statutory Nature Reserves

Two statutory nature reserves occur in the vicinity of the Oweninny site as follows:

Knockmoyle Sheskin Nature Reserve

This site, which is wholly within the Bellacorick Bog Complex SAC, adjoins the Oweninny wind farm site with the Oweninny River forming the boundary between the nature reserve and the development site. The nature reserve is also a Ramsar site and a Council of Europe Biogenetic Reserve.

The issues relevant to the SAC site are discussed in detail elsewhere in this report and in the NIS.

Owenboy Nature Reserve

This site, which is wholly within the Bellacorick Bog Complex SAC, is located less than 2 km to the south-east of the Oweninny wind farm site and the two areas are separated by the N59 road. The nature reserve is also a Ramsar site and a Council of Europe Biogenetic Reserve.

With the Nature Reserve at a closest distance of approximately 6 km from the proposed work area, and with no hydraulic connectivity between the two locations, it is concluded with full scientific certainty that Phase 1 and Phase 2 of the proposed wind farm project would not have any impacts, direct or indirect, on the Nature Reserve.

9.5.12.5 National Parks

The northern end of the **Ballycroy National Park** lies within 5 km of the Oweninny wind farm site. Due to the substantial geographical separation of the two areas, and the absence of any indirect linkages, it can be concluded that the proposed Phase 1 and Phase 2 wind farm project will not have any impacts on the conservation interests of the park.

9.6 MITIGATION MEASURES

9.6.1 Habitat Avoidance

Mitigation by avoidance, which is the most effective method of mitigation, has been followed in this project as far as was feasible. The following specific measures to preserve habitats of conservation importance influenced the final layout of Phase 1 and Phase 2 of the scheme:

- Complete exclusion of O'Boyle's Bog from the design layout – this is a substantial tract (c. 325 ha) of largely intact lowland blanket bog with high conservation importance (including nesting golden plover and red grouse).
- Exclusion of turbines, apart from two, from the remnant bog areas scattered through the site. Remnant (No. 9), which could not be avoided entirely by a turbine and its access track, is of low value and only a small part (<1 ha) will be affected. While a track passes through further bog remnants (No. 19), this track was already established. In addition, in most cases suitable distances (minimum of 50 m) have been maintained by construction works from the bog remnants to avoid hydrological impacts, though in sensitive areas further mitigation will be taken (see next section).
- Avoidance of permanent wetland areas developed from post peat production rehabilitation measures – these areas are now well established wetlands and support breeding waterbirds.
- Maintenance of an exclusion/buffer zone of at least 100 m from main river channels to preserve riparian habitats and water quality.
- Maintenance of a 200 m buffer zone from all designated nature conservation sites within and around the development site.

9.6.2 Sensitive Design to Maintain Habitat Integrity

The following measures will be incorporated into the detailed project design to ensure that habitat integrity is maintained, especially for those habitats with high dependence on ground water:

- For turbines in proximity of sensitive habitats with high dependence on ground water, and especially in area of Bellacorick Iron Flush, it is anticipated turbine foundations will be piled (probably by bored piles rather than driven piles – (see Construction Method Statement in Appendix 5). Detailed geotechnical investigations will be undertaken at the site prior to commencement of construction to enable structural design of foundations.

- Where possible the existing tracks on site have been incorporated into the design though these will need to be upgraded (6 km). Peat probing along the proposed routes of new tracks (49 km) was undertaken to identify the optimum route along corridors of minimal peat depth and also the avoidance of the wetter areas of the site. The new access tracks have been developed to follow the natural contours of the site. Where the tracks pass through areas of wet cutover bog the foundations will be raised to the level of the adjoining bog so as to prevent water loss from the wetland areas.
- Floating roads may be used on areas of deeper peat so as to minimise disturbance to the local area. The locations for floating roads will be subject to detailed geotechnical investigations at the site prior to commencement of construction.
- A detailed site drainage plan has been developed to manage surface run off from the access tracks and cranepads, turbine bases and other structures associated with the development (see Chapter 19).
- As the borrow pit is located in the vicinity of the Bellacorick Iron Flush, it is essential that there would be no impact on the local groundwater level which could affect the hydrology of the flush. To achieve this, it is proposed that the top metre will be dry excavated and below this the material from the borrow pit will be wet extracted to prevent a reduction in the water table level.

9.6.3 Measures Specific for Protection of Bellacorick Iron Flush SAC

9.6.3.1 Access restrictions

While the Bellacorick Iron Flush is located entirely within the development site, it is not part of the development site. During the construction works, access to the flush will not be permitted under any circumstances and this will be highlighted to construction staff by the implementation of an exclusion zone of a recommended 50 m around the flush boundary. The project ecologist will carry out regular inspections of the area during the construction phase to ensure that all is in order.

9.6.3.2 Hydrological monitoring

While no hydrological impacts on the flush are anticipated, the hydrological assessment has recommended as a precautionary measure that monitoring of groundwater levels should be undertaken prior to, during and for a period after the operation of the borrow pit.

9.6.3.3 Vegetation monitoring

The project will fund a vegetation monitoring programme to be undertaken at intervals (after 1 year, after 3 years and up to 5 years) over a period of up to 5 years after the construction works are complete. The objective of this will be to detect any changes in vegetation that could be attributed to possible hydrological changes as a result of the project. This programme will include both the flush and the adjoining blanket bog. A main report will be prepared at the end of the five year period to establish if any effects have been detected on the vegetation of the flush and will recommend whether further monitoring of vegetation is necessary.

The programme is likely to comprise establishing a number of permanent quadrats (probably No. 20-30) arranged along transects running across the flush and the bog. The quadrats will be set up during the summer before construction commences and will be monitored annually according to the proposed programme.

As this work will be within an SAC (owned by NPWS and An Taisce), it is anticipated that a working group will be set up between the stakeholders (i.e. Oweninny Power Ltd., NPWS & An Taisce) to approve the programme and review as necessary. The appropriate permits will be obtained from the Minister for Arts, Heritage and the Gaeltacht to undertake this monitoring work.

9.6.4 Measures to Maintain Bog Remnants

In the one instance where the construction works are expected to impinge onto the margins of a bog remnant (i.e. remnant No. 9), close supervision of the initial clearance works will be undertaken by an ecologist to ensure that the minimal disturbance is caused. Also, supervision will be provided at those construction sites that are within 20-30 m of the bog remnants. If considered necessary at the time, appropriate fencing will be erected to protect nearby sites from construction activities.

9.6.5 Measures to Reduce and Prevent Water Pollution during Construction Works

Risks of significant amounts of potential pollutants from construction activities reaching local watercourses are considered minimal due to the strict pollution control measures which will be taken. A Drainage and Sediment Control Plan has been prepared and will be implemented during construction of the site (see Chapter 19). A Construction and Environmental Management Plan (CEMP) will be prepared which will include the following best practice measures for works in the vicinity of watercourses (also see hydrology and aquatic section):

- Good construction practice will be implemented at all construction areas throughout the site.
- Work method statements will be developed and implemented by construction crews for the construction activities.
- The drainage and sediment control plan will be implemented. The drainage system and settlement ponds will be constructed as a first step before major site clearance activities occur. Existing drainage will be identified and surface water diverted from the construction site to the extent possible.
- Excavated materials from construction works will be deposited in pre-arranged locations where there is no danger of run-off into local watercourses. Excavated material will be side cast in areas as approved by the Site Geotechnical Supervisor so that there is no risk to peat stability. In deeper peat areas excavated material will be removed to the central peat repository area of the site. In addition, all run-off water from side cast areas and repository location shall be captured and discharged to appropriate receiving water after being clarified through the drainage settlement system provided.

- Where excavated materials are used to form embankments the drainage collection system will be installed first to collect any runoff and direct it to the settlement ponds.
- Re-fuelling of vehicles will take place in a secure bunded area well away from any watercourse.
- Care will be taken that no oils or hydraulic fluids are allowed to leak from machinery during construction.
- An oil spill response plan will be developed for the construction works and appropriate containment equipment will be available at work locations in the event of a spillage.
- Raw or uncured waste concrete or similar will be disposed of by removal to approved/licensed disposal site. It is noted that there will be a concrete truck wash out at the batching plant area. This washout will be directed to the three bay water recycler provided at this location.
- Construction materials such as hydrocarbon, cement and grout will be stored in bunded areas or silos which will be regularly inspected.
- Check dams, such as rock with geotextile membrane, will be placed in the existing drainage network prior to the establishment of the settlement ponds. These will be inspected and cleaned regularly and a log will be maintained by the contractor
- General construction practices will adhere to the requirements for the protection of fisheries habitat during construction and development works at river sites published by the Eastern Regional Fisheries Board (Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites http://www.fishingireland.net/environment/constructionanddevelopment.htm)
- Discharge of settled water from the settlement ponds will be directed to the wetland area and not discharge directly to the stream.
- Weather conditions will be taken into account when planning construction activities to minimise risk of extreme run off from site.

9.6.6 Measures to Reduce and Prevent Water Pollution during Tree Felling

The forest within the Oweninny site, like all of Coillte's forests, is being managed under the principles of Sustainable Forest Management (SFM) and is certified by the Forest Stewardship Council (FSC). Coillte's forests and forest operations have been FSC certified since 2001, demonstrating that they are managed in accordance with strict environmental, social and economic criteria. Forestry is discussed in more detail in Chapter 15.

For Phase 1 and Phase 2 of the development, there is a need to clearfell 1.05 ha of forest plantation which requires a felling licence from the Department of Agriculture, Food and the Marine. Clearfelling of the site will take place either using a harvester or processor, which incorporates the felling of trees, de-branching, and cutting them into required lengths or by motor mechanical means.

Before any harvesting works commence on site, all personnel, particularly machine operators, will be made aware of the following and have copies of relevant documentation:

- The felling plan, surface water management plan, construction management plan, emergency and any contingency plans.
- Environmental issues relating to the site.
- The outer perimeter of all buffer and exclusion zones.
- All health & safety issues relating to the site.
- The layout of extraction racks or routes are site dependant but will be designed to:
    - Avoid streams or other watercourses
    - Be as short as possible
    - Avoid any areas of poor crop or bare areas where brash to carry the machine is in short supply
    - Generally extract to existing site roads with the extraction racks laid out at right angles to the road to prevent water flowing down wheel ruts.

Dense, fresh brash mats are the most important part of a felling site as they serve to avoid soil damage, erosion and sedimentation. They will be replenished where they become heavily used or worn. Where damage or serious rutting has started to occur, extraction will be suspended immediately. Relocation of the extraction rack or additional brashing will be used to remedy the situation. Operation of all machinery will be suspended during and following heavy rainfall periods. Excess brash will be removed to the repository areas during wind farm construction.

Tree felling will be subject to a felling licence from the Forest Service and will be in accordance with the conditions of such a licence.

The following specific steps will be taken to minimise any potential adverse impacts as a result of tree felling, including:

- Harvesting extraction routes will be the shortest possible and avoid the crossing of watercourses. Felling and extraction of timber will only be permitted by experienced and fully trained operators.
- Brash mats will be used as necessary on any off-road harvesting routes and will be removed and transported to the repository areas to avoid release of nutrients arising from decay.
- Branches, logs or debris will not be allowed to accumulate in aquatic zones and will be removed as soon as possible.
- The drainage system along existing forest roads will be maintained and improved where required, which will entail for example the clearance of roadside drains of obstructions and overgrown vegetation. Silt traps will be provided at regular intervals in the existing drains along the forest roads to mitigate any increase in suspended solids in the surface water run-off due to machinery traffic on these roads adjacent to the proposed construction areas.
- Further to the above, all construction of forest roads, including the creation of buffer zones and roadside drainage, will adhere to Forest Service Guidelines:
    - Forestry and Water Quality Guidelines

- Forest Harvesting and Environmental Guidelines

With the implementation of the mitigation measures as outlined and considering that the level of forest harvesting required to facilitate the proposed development is relatively small, no significant residual impacts on the ecological interests of the site are expected.

9.6.7 Measures to Maintain Peat Stability

While the risk of peat instability has been minimised and mitigated by optimising the design of the wind farm, it is considered that without additional appropriate mitigation during the construction phase there is some risk that slippage could affect various ecological interests within and around the site.

The following section outlines the proposed mitigation measures for the site based on the preliminary site investigation and the outcomes of the peat stability risk assessment.

The peat stability risk assessment demonstrates that the risk rating across the site varies from insignificant to substantial and the varying degrees of risk require varying degrees of investigation and mitigation. The mitigation measures are further developed from the detailed site investigation through the detailed design process and construction phase of the project. During the detailed design Zonal Peat Stability Risk Assessments (ZPSA) will be required for the areas of substantial risk and in specific areas of significant risk.

9.6.7.1 Mitigation Measure for Areas of Insignificant Risk

In accordance with the Natural Scotland Scottish Executive “Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments” (2006) areas of insignificant risk are considered to only require standard site investigation, detailed design and construction procedures.

- In these areas peat depths are less than 500mm and excavated material can be side cast upslope of roads.
- All roads are to be solid in these areas
- The quantity of excavated material will be accurately calculated and a detailed materials management plan written following detailed design. Consideration will be given to the quantity of the mineral soils which will be excavated.
- These areas are suitable for the side casting of peat from areas of the site at higher risk in accordance with the Geotechnical Engineer/Site Geotechnical Supervisor recommendations.

9.6.7.2 Mitigation Measures for Areas of Significant Risk

Design mitigation measures

The risk assessment of the wind farm site suggests that the risk of peat instability at the site can be classified as significant in areas. As the project proceeds into the design stage, detailed site investigations may identify new risks. The following mitigation measures are recommended during the design stage:

- A targeted detailed site investigation will be undertaken prior to site works commencing as necessary. Peat depths down slope of the works will be considered where necessary as part of this work.

- The site layout will be optimised following the detailed site investigations to avoid or minimise new risks if identified within the parameters of the planning permission if granted.
- A Geotechnical Risk Register will be developed for the site inclusive of a targeted Zonal Peat Stability Assessment as identified in the detailed site investigation.
- A method statement will be developed for the construction of the roads, turbines and substations. This will include but not be limited to the recommendations made below in the Construction Mitigation Measures.
- All roads to be solid in areas of significant risk unless approved by the geotechnical engineer.
- The quantity of excavated material will be accurately calculated and a detailed materials management plan written following detailed design. Consideration will be given to the quantity of the mineral soils to be excavated as part of the work.
- Side casting of materials in areas of significant risk will generally take place upslope of roads or as approved by the Site Geotechnical Supervisor.
- Consideration will be given to sequencing of the works. Where deemed necessary by the Zonal Peat Stability Risk Assessment, peat excavations are not to be left unsupported for extended periods and will be backfilled with compacted material in a sequenced manner.

Construction mitigation measures

Documentation/quality assurance: Construction works in areas of significant risk, where required by the ZPSA, will be strictly controlled by the Client’s Site Geotechnical Supervisor and other site supervisory staff. The following Quality Assurance procedures are proposed:

- Contractor to be supplied with a Geotechnical Risk Register (GRR) detailing peat stability risks.
- Construction methods will be directed by Client’s Geotechnical Engineer/Site Geotechnical Supervisor and strictly adhered to by the Contractor.
- Contractor to produce individual Method Statements for work in peat taking due account of the peat related risks and other geotechnical risks detailed in the GRR.
- Client’s Geotechnical Engineer to review the Contractor’s Method Statement by the issuing of a certificate.
- A toolbox talk is required for the Contractor’s operatives prior to commencing work in the peat area.
- Excavation in peat areas is subject to part time supervision by the Site Geotechnical Supervisor at this site depending on the outcome of the GRR and the Zonal Peat Stability Assessment.
- A daily record of peat excavations will be completed by the Site Geotechnical Supervisor. Any new risks that come to light will be communicated to the Geotechnical Engineer.

9.6.7.3 Construction control measures

The following control measures will be enforced during construction works in general:

- Side casting of materials in areas of significant risk will generally take place upslope of roads or as approved by the Site Geotechnical Supervisor.
- No stockpiling of materials or parking plant on peat.
- Minimise tracking machinery on peat.
- Where required by the ZPSA the length of unsupported excavations in peat is to be minimised by backfilling excavations in a sequenced manner.
- No work is to be carried out down slope of a peat excavation at any time
- Water build up in excavations is to be avoided
- Peat excavations are not to be left unsupported for extended periods or overnight
- The use of vibrating rollers not permitted (dead weight permitted)
- Stringlines with posts at 10m centres downslope of access tracks. They will be installed prior to commencement of construction and remain in place for the duration of the works.
- Upslope cut-off drains will be installed in advance of construction
- The existing drainage patterns in the peat will be maintained as far as is practicable
- There will be no uncontrolled discharges of water onto peat
- If there is any deviation from the agreed work methodology, or if work practices are unsafe, the Site Geotechnical Supervisor will give instructions to the Contractor's Supervisor or directly to the Site Operatives.
- The Site Geotechnical Supervisor will suspend work if work practices or weather conditions are unsafe.

9.6.7.4 Substantial Risk Mitigation Measures

Design mitigation measures

The risk assessment of the wind farm site suggests that the risk to peat instability at the site can be classified as substantial in areas. As the project proceeds into the design stage, detailed site investigations may identify new risks. The following mitigation measures are recommended during the design stage:

- A detailed site investigation will be undertaken prior to site works commencing. It is prudent to consider peat depths, peat strengths and peat base slopes down slope of the works.
- The site layout will be optimised following the detailed site investigations to avoid or minimise new risks if identified.
- A Geotechnical Risk Register will be developed for the site inclusive of a Zonal Peat Stability Assessment for each turbine/hardstand, length of access track and other infrastructure on the site in areas which have been identified as having substantial risk. This is a more focussed assessment of peat stability carried out following the detailed site investigation. The input of geotechnical, hydrology and other experts is recommended.
- A method statement will be developed for the construction of the roads, turbines and all other structures in these areas. This will include but not be

limited to the recommendations made below in the Construction Mitigation Measures.

- All roads to be solid in areas of substantial risk unless approved by the geotechnical engineer.
- The quantity of excavated material will be accurately calculated and a detailed materials management plan written following detailed design. Consideration will be given to the quality of the mineral soils to be excavated as part of the work.
- Peat excavated in these areas should be removed to areas of insignificant risk and stored upslope of a suitably designed retention structure such as a solid road or embankment to a maximum height of 1 m unless otherwise approved by the Site Geotechnical Supervisor.
- Consideration will be given to sequencing of the works. Peat excavations are not to be left unsupported for extended periods and will be backfilled with compacted material in a sequenced manner.

9.6.7.5 Construction mitigation measures

Documentation/quality assurance: Construction works in areas of substantial risk will be strictly controlled by the Client’s Engineer and other site supervisory staff. The following Quality Assurance procedures are proposed:

- Contractor to be supplied with a Geotechnical Risk Register (GRR) detailing peat stability risks.
- Construction methods will be directed by Client’s Geotechnical Engineer/Site Geotechnical Supervisor and strictly adhered to by the Contractor.
- Contractor to produce individual Method Statements for work in peat taking due account of the peat related risks and other geotechnical risks detailed in the GRR.
- Client’s Geotechnical Engineer to approve the Contractor’s Method Statement by the issuing of a certificate.
- No work in peat will take place without a Geotechnical Approval Certificate.
- A toolbox talk is required for the Contractor’s operatives prior to commencing work in the peat area.
- Excavation in peat areas is subject to full time supervision by the Site Geotechnical Supervisor at this site depending on the outcome of the GRR and the Zonal Peat Stability Assessment.
- A daily record of peat excavations will be completed by the Site Geotechnical Supervisor. Any new risks that come to light will be communicated to the Geotechnical Engineer.

9.6.7.6 Construction control measures

The following control measures will be enforced during construction works in general:

- Peat excavated in these areas should be removed to areas of insignificant risk or stored upslope of a suitably designed retention structures such as a solid road or embankment to a maximum height of 1m unless otherwise approved by the Site Geotechnical Supervisor.
- No stockpiling of materials or parking plant on peat.

- Minimise tracking machinery on peat.
- Minimise length of unsupported excavations in peat by backfilling excavations in a sequenced manner.
- No work is to be carried out down slope of a peat excavation at any time
- Water build up in excavations is to be avoided
- Peat excavations are not to be left unsupported for extended periods or overnight
- Finished Road/Hardstand level to be within 1.0 m of upslope peat surface
- The use of vibrating rollers not permitted (dead weight permitted)
- Stringlines with posts at 10m centres downslope of access tracks. They will be installed prior to commencement of construction and remain in place for the duration of the works.
- Upslope cut-off drains will be installed in advance of construction
- The existing drainage patterns in the peat will be maintained as far as is practicable
- There will be no uncontrolled discharges of water onto peat
- If there is any deviation from the agreed work methodology, or if work practices are unsafe, the Site Geotechnical Supervisors will give instructions to the Contractor's Supervisor or directly to the Site Operatives.
- The Site Geotechnical Supervisor will suspend work if work practices or weather conditions are unsafe.

9.6.7.7 Peat Stability Risk Conclusions and Recommendations

The preliminary site investigations and peat stability risk assessments have shown that there is an insignificant to substantial risk of peat instability on the Oweninny Wind Farm Site in the absence of mitigation measures. This risk will be minimised and mitigated by optimising the design of the wind farm by choosing a safe and controlled construction methodology, by having a rigorous documentation and quality control system during construction and by controlling construction activities carefully. Further site investigations, which will take place at the detailed design stage, will inform the construction methodology.

In the preliminary Peat Stability Risk Assessment report, the following recommendations are made:

- A detailed site investigation will be carried out prior to detailed design.
- The design of the wind farm will be optimised with a view to minimising peat risks following the detailed site investigation.
- In areas of significant risk material will be stored upslope of solid roads or berms unless otherwise approved by the site geotechnical engineer.
- In areas of substantial risk excavated material will be removed to areas of insignificant risk or upslope of a suitably designed retention structure such as a road or embankment to a maximum height of 1m unless otherwise approved by the site geotechnical supervisor.
- A GRR inclusive of ZPSA will be developed at detailed design stage and incorporated in to the Method Statements for the works for specific areas of significant risk and substantial risk.

- A material's management plan will be written for the site, estimating the volumes of excavated material and specifying how and where material is to be disposed.
- A documentation and quality assurance system for construction in peat will be put in place.
- The construction methodology chosen will minimise the risk of peat instability. Construction control measures will be strictly enforced on site.
- This site is considered as having insignificant to substantial risk of peat instability based on the preliminary PSRA. Approximately 80% of the construction area is classified as having insignificant or significant risk. The risk at these areas will be mitigated with good design and construction practices and part geotechnical supervision. The remaining 20% of the construction area is categorised as having substantial risk of peat instability, however, in these cases the level of risk is on the lower end of the substantial (i.e. close to the significant risk category) and is suitable for construction with suitable site investigation, good design and construction practices and geotechnical supervision during the works in peat. No areas are categorised as serious.

From the above, it is concluded that the measures which are proposed to mitigate for peat slippage will ensure that there is no significant risk from peat stability to the ecological interests which occur within and around the Oweninny site.

9.6.8 Measures for Construction of Overhead Power Lines

9.6.8.1 Substation No. 1 line

Structure No. 6 of the power line leading from substation No. 1 is located in an area with a high cover of soft rush (*Juncus effusus)* and *Sphagnum cuspidatum* in shallow standing water (<20cm). Although the underlying peat is firm in this area, bog mats will be required for machines to access this area and erect the poles.

Between structures 8 and 9 there is a narrow area of dry remnant bog habitat - this remnant area can be avoided by accessing the nearby poleset locations from the south (structure 9) and the north-east (structure 8).

9.6.8.2 Substation No. 2 line

Structures 11, 12, 15 and 16 leading from substation Number 2 are located in wet cutover areas where there is standing water for much of the year. At these poleset locations bog mats will be required for machine access and the erection of poles.

9.6.9 Habitat Management and Enhancement

9.6.9.1 Re-establishment and promotion of wetland habitats

Between 2001 and 2012 comprehensive site rehabilitation works were carried out throughout the Oweninny site by Bord na Móna. The main aims of the rehabilitation programme were as follows:

- Stabilisation of the peat production areas (as required under Condition 10 of IPPC Licensing)

- Mitigation of silt run-off into watercourses (highlighted by North Western Regional Fisheries Board, now known as Inland Fisheries Ireland, & National Parks and Wildlife Service)
- Re-establishment of peat-forming communities where possible (identified as occurring spontaneously on the Oweninny cutaway where drains were blocked and former peat production fields were rewetted).

The main rehabilitation methods employed were:

- blocking of former peat production field drains to raise the level of water of the remaining peat areas;
- blocking of main outfalls within the former production area to create long term silt settlement areas;
- ploughing of gravel slopes to prevent soil and gravel erosion and to encourage re-vegetation of those exposed gravel hills and sloping areas.
- Where possible, some drained areas of remnant blanket bog were also restored

The main rehabilitation work was completed in 2005 and the recovery of the site has been monitored since to track changes in vegetation. The rehabilitation has been successful in promoting the establishment of typical peatland species such as bog cottons and peat-forming mosses where the peat was successfully rewetted. A vegetation map has been developed for the entire site in 2001 and 2011 showing the changes in vegetation and the emergence of a range of vegetation types. Vegetation has increased across the site resulting in bare peat reduced significantly (approx. 53% bare peat in 2001 assessment and 11% bare peat in 2011 assessment). Of particular interest is the increasing cover of peat-forming (Sphagnum) mosses (Fallon *et al.* 2012[94]).

When the Phase 1 and Phase 2 wind farm construction works are complete, there will be potential to create further wet areas and enhance existing wetland habitats within the Oweninny site.

The project will allocate resources to post-construction rehabilitation to ensure this potential is realised. This will involve a post-construction assessment by Bord na Móna ecologists with the objective of drawing up a programme of rehabilitation works along the

[94] Fallon, D., McCorry, M., Farrell, C. and Moran, J. 2012. Ten years in rehab – what have we learned in Mayo? Proceedings of the 14th International Peat Congress, Stockholm 2012. IPS Finland.

new track network. Works identified will be completed by contractors on site.

The following will be objectives of the post-construction plan:

- Further drain blocking once turbine and road drainage network has been completed to increase wet areas to promote Sphagnum growth and establishment within the site.
- Identification of new areas to enhance long-term replacement siltation ponds. Creation of substantial ponds could be achieved by using the newly installed roads as potential water retention berms. As already noted, creation of such ponds would be beneficial for a range of bird species, including Little Grebe, Teal, Ringed Plover and Common Sandpiper.
- Targeted drain blocking on deep peat areas and adjacent bog remnants to enhance rewetting of deep peat areas and re-vegetation by typical peatland species (also offset potential drying out and carbon losses)
- Optimise usage of borrow pit excavated area (17 ha) as wetland habitat. It is recommended that allowing the pit to flood and develop as a lake would be useful for a range of wildlife, especially wetland birds and insects.
- Creation of a stony substrate at the gravel storage area (13.2 ha) which adjoins the borrow pit. This presumably could be easily achieved by spreading any remaining gravel and stones left over from the works. Such an area would be of particular value for birds such as Ringed Plover and Wheatears. Also, Red Grouse would be expected to avail of a plentiful grit supply (which they require to aid digestion).
- Rehabilitation of the peat depository area (37 ha). As the stored peat will be shallow (up to 1m), it is expected that colonisation by peatland species will be fairly rapid.

Mapping of vegetation recovery at the various sites will take place at regular intervals to monitor the rate of re-vegetation.

The implementation of this post construction work following construction of the project will continue the ecological work that has been ongoing on the site since 2001 and can be considered as a net positive ecological impact for the site and wider area in the medium to long terms. It will commence once the main infrastructure and drainage networks have been established.

9.6.10 Removal of self-seeded conifers and Rhododendron

As noted in the baseline assessment, self-seeded trees of lodgepole pine are widespread in parts of the cutover bog throughout the site. If allowed to continue to spread, the trees will form areas of open scrub and will lead to localised drying of the redeveloping bog vegetation. Important bird species of open bog habitats, such as breeding Red Grouse, Snipe and Skylark, would be discouraged from areas with high numbers of pine trees. Rhododendron, an invasive alien species, has also become established in a few areas and if allowed to continue to spread will out-compete the local bog plants.

The project is committed to eradicating the self-seeded pine trees and Rhododendron so as to maintain open bog type habitats (i.e. the natural situation). As this is a considerable task due to the size of the site, it will be done in phases over a 5 to 10 year period. A focused plan will be drawn up which will include the following points:

9.6.10.1 Removal of pine trees

Pine trees will be removed as follows:

- Removal of trees will be done by hand with the use of a chainsaw or equivalent
- Trees will be cut close to base and the root stock allowed to rot in situ – as re-sprouting of cut conifer stumps rarely occurs, there is no need to treat the cut stump
- The fallen trees will be left to rot on site
- As the works could cause disturbance to ground nesting birds such as Skylarks, cutting will be conducted outside the main bird nesting season (April – July inclusive)

9.6.10.2 Removal of Rhododendron

The objective will be the complete eradication of Rhododendron from the site. Methods to be used will follow technical guidance in the NPWS publication '*Rhododendron ponticum: A guide to management on nature conservation sites*' (Higgins, G.T. 2008[95], NPWS Irish Wildlife Manual No 33).

An initial assessment of the distribution of Rhododendron on site will be carried out at the commencement of the programme. This will inform the work programme but the following outline approach is likely:

Preliminary Clearance (Phase 1) [Year 1]

This is initial clearance of rhododendron from infested areas of site that is carried out during a single initial work phase. It includes the cutting of large plants and removal of all visible smaller plants. It may also include stump treatment and direct foliar treatments. The uprooting or extraction of stumps is also an option.

Advanced Clearance and Final Clearance (Phase 2) [Year 1-3]

This phase follows initial clearance. Its purpose is to ensure the effectiveness of Phase 1 clearance and to check for, and deal with, any plants that may have been missed.

Final clearance has been achieved when all mature plants that were present at the time

[95] Higgins, G.T. (2008) *Rhododendron ponticum*: A guide to management on nature conservation sites. *Irish Wildlife Manuals,* No. 33. NPWS, Department of the Environment, Heritage and Local Government, Dublin.

of preliminary clearance are dead, and when systematic coverage of the site has ensured that all plants aged approximately 5 years and older have been removed.

Initial Maintenance (Phase 3) [Year 8]

All cleared areas will require ongoing maintenance so that reinfestation from seed in not allowed to succeed. This part of the management is as important as Phases 1 and 2 if the control programme is to succeed in the medium to long term.

If the site is systematically covered and all visible plants are removed, then it can be reasonably confidently assumed that no plant will flower within the site for at least another 8-10 years.

Ongoing Maintenance (Repeat Phase 3) [Every 6-8 years after Year 8]

As long as an external seed source remains, repeated systematic sweeps through the site will be required, to prevent newly established plants from reaching flowering age and setting seed.

9.6.11 Measures for Sensitive Breeding Birds

As there is potential for sensitive nesting birds to occur within virtually the entire of the Oweninny site (as even the bare areas of peat can support nesting Ringed Plover), and allowing for different sites to be used by breeding birds between years (i.e. sites used in 2015 will be somewhat different from those used in the 2010-12 period), it is proposed that the following approach will be taken in order to avoid disturbance to sensitive species during works taking place from March to August inclusive.

A survey of the work area and a distance of up to 500 m radius (depending on local habitats) will be undertaken by an ornithologist. The target species to be surveyed where restrictions may be required are set out in Table 9.31.

Table 9.31: Survey target species

Target Species	
Common Gull	Little Grebe
Common Sandpiper	Merlin
Dunlin	Red Grouse
Golden Plover	Ringed Plover
Greenshank	Snipe
Kestrel	Teal

Should any of these species (or indeed any additional sensitive species not previously recorded on site) be found to be holding territory, there will be a restriction on all works within an agreed distance from the known or suspected nest location until breeding has been completed successfully or otherwise (as confirmed by repeat site visits). The restricted distance will vary between species, for instance a distance of up to 500 m may be required for very sensitive species such as Golden Plover while a distance of 100 m may be adequate for less sensitive species such as Ringed Plover. It is suggested that practical distances will be agreed with NPWS at pre-construction stage. Should it be found that the avoidance of work in certain areas where sensitive breeding species are present poses a major problem for the progress of the project, consideration can be given to the erection of screening between the work area and the nest location – the success of this would depend on the species in question and local topography and would need to be agreed with NPWS.

9.6.12 Measures Applicable to All Breeding Birds

Section 40 of the Wildlife Act 1976, as amended by Section 46 of the Wildlife (Amendment) Act 2000, restricts the cutting, grubbing, burning or destruction by other means of vegetation growing on uncultivated land or in hedges or ditches during the nesting and breeding season for birds and wildlife, from 1 March to 31 August.

Where practical, vegetation clearance at work areas will be carried out outside of the restricted period.

Where ground clearance is required within the closed season, an appropriate survey will be carried out by an ornithologist for the presence of breeding birds. This survey will include all of the required work area as well as access routes, storage areas etc. If an occupied nest is found of any bird species, works in this area will be delayed where feasible until the nesting attempt is complete. If avoidance is not feasible, a derogation licence will be sought from the NPWS.

It is noted that areas of conifer forest will invariably hold some common breeding species (chaffinch, goldcrest, coal tit etc.) and due to the difficulties of locating nest sites in forest it can be anticipated that a derogation licence will be required from NPWS if felling is to occur during the restricted period.

9.6.13 Monitoring for Birds during Operation Phase

As the site supports a substantial number of bird species of conservation importance, it is recommended that a bird monitoring programme be implemented in the post construction phase to establish populations and distribution of these species. The programme should include the following:

- Transect survey for breeding birds following route in present baseline survey
- Focused surveys at wetland areas for breeding water birds and especially waders
- Survey of selected areas of bog (remnants and regenerating cutover bog) for Red Grouse
- Survey for wintering roosting Hen Harriers

The frequency of survey should be for the first three years of the wind farm operation and thereafter at 5 year intervals.

9.6.14 Measures for Otters

As adverse impacts on otters are not anticipated, specific mitigation measures are not considered necessary.

The measures being taken by the project to maintain local water quality will suffice for the needs of otters.

9.6.15 Measures for Badgers

Badger presence on site was established during the baseline surveys and sets are likely to occur within the conifer forests. As required under the Wildlife Acts, mitigation is required to ensure that active setts are not disturbed. Owing to the difficulty of surveying for badgers within closed canopy conifer forests, the following approach is recommended:

Phase 1 and Phase 2 of the project requires the felling of 1.05 h of forest plantation. Prior to tree clearance, a survey for presence of badgers will be carried out in the area to be felled by an ecologist with experience of badger survey. This should be done during the period November to April when vegetation cover is low. This survey will identify signs of badger presence and will aim to establish the general locations of setts (if any).

Depending on the results of the survey, the ecologist will recommend mitigation as considered necessary. If a sett(s) is found, mitigation may include application to NPWS for a licence to close an active sett that could be disturbed by the works. Note that since closure of active setts is prohibited during the breeding season (December to June inclusive), scheduling of the survey is important to avoid delays.

If the results of the survey are inconclusive due to difficulty of access through conifer forest, the ecologist may be required to be on site to monitor for setts during the actual tree clearance works. Should a sett be found then, all works will cease and the ecologist will recommend a procedure to be followed. If sett closure is considered necessary, the approach of obtaining a licence will be followed (and again it is noted that sett closure is not permitted during the December to June period).

9.6.16 Measures for Bats

The following specific measures will be required to protect bats on-site.

9.6.16.1 Trees

As the site is open bog without any mature deciduous trees, the issue of tree felling affecting bat roosts does not arise and the normal precautionary measures to prevent disturbance to potential bat roosts (e.g. timing of felling) are not applicable.

9.6.16.2 Lighting restrictions

In general, artificial light creates a barrier to bats so lighting shall be avoided where possible. Where lighting is required, directional lighting (i.e. lighting which only shines on work areas and not nearby countryside) shall be used to prevent overspill. This shall be achieved by the design of the luminaire and by using accessories such as hoods, cowls, louvers and shields to direct the light to the intended area only.

9.6.16.3 Bridges

If any local bridge is to be strengthened prior to use for haulage of construction materials for this development, it shall first be surveyed for bat presence prior to any upgrading or maintenance works. Bats, especially Daubenton's, regularly use bridges for roosting and are vulnerable within such structures due to infilling of crevices during which they may be entombed. If bats are found, subject to safety considerations, some crevices beneath the bridge shall be retained for their continued use according to best practice bat mitigation measures for bridge works (see National Roads Authority 2006a[96]/2006b[97] and Shiel 1999). Any re-pointing or pressure grouting of bridges shall only proceed after an inspection of the structure for bats and will be in accordance with statutory procedures.

9.6.16.4 Vegetation-free buffer zone

Bats commuting and foraging along on-site woodland edge boundaries shall be safeguarded by providing a 50m minimum buffer zone between the rotors of planned turbines and the nearest vegetation to reduce the risk of collision and/or barotrauma. N.B. this distance should be measured from the vegetation to the tip of the rotor blades, not to the base of the turbine. This is in line with current UK (Carlin and Mitchell-Jones 2012[98]) and Northern Ireland guidelines on vegetation-free buffer zones on wind development sites and should prevent impacts to bats that mainly fly low along linear features, e.g. the pipistrelles.

9.6.17 Measures for Common Frog

Areas where construction works are due to commence during the period February to August will be checked by an ecologist for the presence of frog spawn, tadpoles and adult frogs. If present, these will be removed under licence from NPWS and transferred to suitable ponds or wetlands in the vicinity.

9.6.18 Project Ecologist

Due to the scale of the project and the sensitive ecological interests within and around the site, it is recommended that an ecologist be employed during the construction phase to ensure that the various mitigation measures and any planning conditions specific to ecology are being undertaken in a correct manner. The ecologist would also be available

[96] National Roads Authority (2006a) Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes, NRA, Dublin

[97] National Roads Authority (2006b) Guidelines for the Treatment of Bats during the Construction of National Road Schemes, NRA, Dublin

[98] Carlin, C. and Mitchell-Jones, T. 2009 *Bats and Onshore Wind Turbines – Interim Guidance (1st Edition – 11th February),* Technical Information Note TIN051. *Natural England*, Peterborough, UK

to address any ecological issues that arise on a day to day basis.

9.7 Cumulative Impacts

9.7.1 Cumulative Impacts with Other Wind Farms

The proposed and permitted wind farm developments in the general region and those within 20 km of Oweninny (as shown in Figure 2.12 are as follows:

- Corvoderry Wind Farm Development comprising 10 wind turbines with 100m overall height (Planning reference 11838). This consented wind farm is located within the Oweninny site. There is a right of way to the Corvoderry site through the Oweninny site.
- Planning permission 09/259 for a wind farm development at Dooleeg, Bellacorick (one 2MW wind turbine) granted on appeal to ABP (PL16.236402). Application 002822 for a wind farm development at Dooleeg (two 1MW turbines) permission granted on the 14/03/2002 for the same site.
- Bellacorick Wind Farm - this 21 turbine wind farm has been operational since 1992 with an installed capacity of 6.45 MW. It is located within the Oweninny project site. If it is still operating at the time, this existing wind farm will be decommissioned and new turbines forming part of the final phase of the Oweninny Wind Farm project will be installed near where the existing turbines are located.
- Oweninny Wind Farm comprising 180 wind turbines was granted permission in December 2003 by ABP (Planning reference PL 16.131260). This project occupies the same site as the present project and would not be built should the present project be granted permission.
- Tawnanasool Wind Farm comprising 8 wind turbines is currently in the planning process (Planning reference P14/666). Notification of refusal was issued by Mayo County Council on the 14th August 2015. The applicant appealed the decision to An Bord Pleanála on the 20/08/2015 with case listed to be decided by the 23/12/2015. This proposed project is located between the N59 and Tullaghan Bay and is approximately 10 km to the west-southwest of the Oweninny project site.
- Potential future development of Oweninny Phase 3. This development would comprise an additional 51 wind turbines on the Oweninny site itself as per the layout provided in the original Planning application to An Bord Pleanála in 2013

Should all the above projects be eventually built, there will be a total of 131 turbines in the area (allowing for the decommissioning of the existing Bellacorick wind farm and the rescinding of the existing Oweninny planning for 180 turbines). There follows a review of possible impacts of the Corvoderry, Dooleeg and Tawnanasool projects on nearby Natura sites.

Corvoderry Wind Farm Development

The Natura Impact Statement for the development identified potential (in absence of mitigation) for adverse impacts on Lough Dahybaun SAC as a result of possible changes in water quality entering the lake during the construction and operation phases. There is a distance of 1.13 km between the Corvoderry site and Lough Dahybaun but there are no direct linkages via watercourses. A mitigation package for the Corvoderry project has been recommended in the NIS to minimise or eliminate the risk.

Without appropriate mitigation, there is potential for a significant adverse cumulative impact through water quality issues on the conservation objectives of the Lough Dahybaun SAC as a result of the Oweninny and Corvoderry wind projects. However, as it has been demonstrated for the Oweninny project that mitigation can minimise the risk of water pollution, the Oweninny project will not contribute to impacts which may arise during the construction phase of the Corvoderry project.

The Corvoderry NIS (Jennings O'Donovan & Partners, 2011) did not identify risks, such as from forest clearing, to any other Natura site in the vicinity.

It is understood that there is a right of way along the existing Bellacorick wind farm road to the Corvoderry site. This is not expected to increase the risk to any Natura site relevant to the Oweninny development.

Dooleeg, Bellacorick Wind Farm

This wind farm has permission to construct a single one 2 MW turbine at Dooleeg, Bellacorick (it appears same site had previous permission for two turbines). The location is a few hundred metres south of the Oweninny site. The site had formerly been within the Bellacorick Bog Complex SAC but was excluded by NPWS on appeal by the landowner.

The planning application concluded that the project would have no adverse impacts on any designated site.

Tawnanasool Wind Farm

The Screening for AA assessment (dated December 2014) identified six Natura 2000 sites where there was potential for adverse impacts in absence of mitigation as a result of the wind farm project. These sites, which were brought forward for Stage 2 AA Assessment, were: Owenduff/Nephin Complex SAC, Owenduff/Nephin Complex SPA, Owenduff Catchment Ramsar Site, Blacksod Bay/Broad Haven Bay SPA, Blacksod Bay/Broad Haven Bay Ramsar Site & Carrowmore Lake SPA.

The main potential negative impacts identified relate to the pollution of waterways downstream of the drains/streams within the proposed wind farm site. The NIS concluded as follows: "*No adverse impact is expected to arise to Natura 2000 sites as a result of the proposed development provided the mitigation outlined is implemented in a full and proper manner*."

A request for further information had been issued by Mayo County Council to the developer (dated 1 July 2015) which includes the following in respect of the NIS:

> "A particular concern is that the European sites, and their special conservation interests (SPAs) or qualifying interests (SACs), that are considered to be at risk from the proposed development are not identified

clearly in the NIS. The assessments and analyses are not then carried out with specific reference to the implications for the conservation objectives, and the conclusions of the NIS lack clarity and precision regarding whether or not there will be adverse effects on the integrity of a European site."

Further information was provided on the 21st July 2015 by the developer, however, a notification of refusal was issued by the Planning Authority on the 14th August on the grounds of impact on visual amenity and natural character of the landscape and also due to the creation of a traffic hazard at the access point to the windfarm on the N59. In respect of Appropriate Assessment, the Planning Report and Recommendations (dated 12/08/15) noted the following:

"Mayo County Council carried out an Appropriate Assessment of the proposed development and having regard to the nature and scale of the proposed works, the nature of the receiving environment and the mitigation measures set out in the course of the planning application, Mayo County Council is satisfied that the proposed development, on its own or in-combination with other plans and projects, would not adversely affect the integrity of an European site."

9.7.1.1 Cumulative impacts on habitats

While the four wind projects will extend over a large area of north-west Mayo, all will be constructed on habitats that are not of significant conservation importance (i.e. mainly cutover bog and forestry) and hence the cumulative impact on habitat loss is not of significance despite the relatively large numbers of turbines between the four projects.

The right of way to the Corvoderry site is not expected to increase the risk of ecological impacts within the Oweninny site as no additional areas of habitat will be affected.

9.7.1.2 Cumulative impacts on birds

While the Oweninny site is centred on cutover bog, the Corvoderry project is entirely within conifer forest. The bird survey areas for these two projects partly overlapped both spatially and temporally and the findings for each were broadly similar in respect of the habitats within the respective survey areas. From a review of the documentation relating to the Corvoderry project, it is considered that there is no potential for a significant adverse cumulative effect on birds within the Oweninny site when both projects are considered together.

It is noted that the single turbine proposed for Dooleeg is within the corridor used by wintering Hen Harriers associated with the winter roost within the Oweninny site and this turbine could pose a collision risk to the birds arriving at or leaving the night roost. It is noted that Phase 1 and Phase 2 of the Oweninny Wind Farm project will not have any impacts on the winter roost due to the distances apart.

Access to the Corvoderry site through the right of way to the Corvoderry site is not expected to increase the risk of impacts on bird species within the Oweninny site as no additional areas of habitat will be affected.

While the NIS assessment for the Tawnanasool Wind Farm (dated December 2014) concluded that the proposed project would not have adverse effects on bird populations, it is noted that a request for further information has been issued by Mayo County Council to the developer (dated 1 July 2015) which includes the following in respect of birds:

"Birds are considered to be at risk from the proposed development of a windfarm in the area because of the potential direct, indirect and cumulative or in-combination effects on bird habitats and their usage, including feeding and roosting sites, and on their flightlines and migratory routes. The information and data that have been presented do not suffice at present to robustly assess the likely significant effects on birds in the EIS, or to assess the likely significant effects on European sites in view of their conservation objectives in the NIS."

Subsequent to the submission of further information by the developer planning permission was refused by Mayo County Council on the grounds of landscape visual impact and traffic hazard on the N59 but the planning authority were satisfied that the project on its own or in combination with other plans and project s would not adversely affect the integrity of a European Site. The planning refusal has since been appealed by the developer to an Bord Pleanála

From the above (but pending a final planning decision in respect of Tawnanasool Wind Farm), it can be concluded that the three other wind farm projects will not have any adverse impact on bird species associated with any Natura site in the wider area (c.10 km radius of each development site). Hence, it can be concluded that Phase 1 and Phase 2 of the Oweninny wind farm project would not add to any cumulative impact by wind farm projects on birds.

The present assessment has shown the Oweninny wind farm project would not have any adverse impacts on the bird species associated with the various SPAs and SACs in the vicinity of the site.

The conclusion from the screening assessment for the Corvoderry wind farm is that there are no likely potential impacts resulting from the proposal on the Owenduff/Nephin Complex SPA or on bird species associated with any SAC.

The assessment carried out for the Dooleeg wind farm concludes that their project would not have any adverse impacts on any bird species within or around the site.

While the Tawnanasool Wind Farm project was refused permission by Mayo County Council on 14th August 2015, as already noted Mayo County Council was satisfied that the proposed development, on its own or in-combination with other plans and projects, would not adversely affect the integrity of an European site.

Potential future development of Oweninny Phase 3

The potential impact of all three phases of Oweninny acting in combination formed the basis for assessment of the original wind farm application made to An Bord Pleanála in 2013. The main areas that could potentially be affected by Phase 3 and which were assessed fully in that application were the Lough Dahybaun cSAC, the Formoyle Flush component of the Bellacorick SAC, the petrifying springs and other designated sites within 15km or potentially hydraulically connected to the site. The impact on general ecology including birds, including the Hen Harrier, mammals, plant communities and habitats was also assessed. A separate Appropriate Assessment Screening and Natura

Impact Statement for the proposed development of Phase 1, 2 and 3 was prepared and submitted with the planning application which concluded that no adverse impact would occur to any Natura site as a result of the development.

Conclusion on in-combination effects with wind farm projects

In addition to the proposed Oweninny development of 112 turbines, there are 19 further turbines associated with three sites (consented or in planning) within a 20 km radius of Oweninny. There is no evidence to show that any of these developments (pending a planning decision from ABP on the Tawnanasool Wind Farm) would have adverse impacts on Natura 2000 sites or Annex I bird species. Hence, it can be concluded that the proposed Oweninny development would not contribute to an in-combination effect.

9.7.2 Meteorological Mast

ABO Wind Ireland Limited have applied (22nd July 2015) for permission to install a temporary (3 yrs) meteorological mast at Sheskin Townland, Bellacorick, Co Mayo. The mast comprises a 100 m high steel lattice tower, supported by cable stays. The site for the proposed mast is within conifer forest plantation.

A Statement for Screening for Appropriate Assessment was carried out. This concluded there will be no adverse effects on any Natura 2000 site as a result of the installation and operation of the meteorological mast. The site is not ecologically or hydrologically connected to any Natura 2000 sites and the proposed project is compatible with the Conservation Objectives for all the qualifying criteria of those designated sites.

As the Screening for Appropriate Assessment report for the mast project did not identify potential for adverse impacts on any site designated for nature conservation, it can be assumed that there would be no in-combination effect when the Oweninny Wind Farm development is considered with the proposed meteorological mast project.

9.7.3 Power Line Projects

Planning permission has been granted for the following overhead power line projects in the Bellacorick area:

Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410) – granted to EirGrid plc by An Bord Pleanála on 11th August 2015.

This project comprises the uprating of approximately 37 km of power line between Bellacorick and Castlebar. Substantial reinforcements are required to the existing transmission network in order to accommodate increasing levels of renewable generation (primarily wind generation) in the region. In 2013, Part 1 of the uprate was undertaken, comprising approximately 17km extending out of Castlebar substation. The project which is the subject of planning reference no. P14/410 refers to the remaining uprate works on the existing line between Bellacorick and Castlebar, approximately 19.5km extending from Bellacorick substation. As a significant portion of the circuit is situated within the Bellacorick Bog Complex SAC Screening for Appropriate Assessment (Stage 1 AA) was carried out by EirGrid. The Screening concluded that the potential for significant impacts could not be ruled out and hence a Natura Impact Statement and a planning application were required for Part 2 of the line uprate project.

A detailed ecological evaluation of the project corridor was carried out and this formed the basis for the NIS. The NIS concluded that the proposed project would not have any significant impacts on the integrity of the Natura 2000 sites in the area, namely the Bellacorick Bog Complex SAC, River Moy SAC and Newport Rover SAC. Further information on a variety of environmental matters was submitted by the developer to Mayo County Council in December 2014 following a Request for Further Information (dated 1st October 2014). Permission was granted by Mayo County Council on 25th February 2015 subject to 16 conditions. A planning appeal against the decision was lodged and the matter was considered by An Bord Pleanála. In the Inspector's report, the conclusion in reference to the Appropriate Assessment (section 11.88) is as follows:

"I consider it reasonable to conclude on the basis of the information on the file, which I consider adequate in order to carry out a Stage 2 Appropriate Assessment, that the proposed development, individually or in combination with other plans or projects would not adversely affect the integrity of the European site No 001922, Bellacorick Bog Complex, the European site No 002298, River Moy, and the European site No 002144, Newport River; or any other European site, in view of the site's Conservation Objectives."

The Board granted permission for the project on 11th August 2015 subject to 11 conditions.

Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45) – granted to EirGrid plc by Mayo County Council on 4th August 2015.

This project comprises the uprating of approximately 27 km of power line between Bellacorick and Gorteen.

The NIS submitted with the application identified potential impacts, without mitigation, on two Natura sites, namely Bellacorick Bog Complex SAC and the River Moy SAC. However, with mitigation in place the conclusion of the NIS was that the impacts were not considered to be likely to have a significant effect on the structure and function or overall integrity of the Bellacorick Bog Complex SAC.

Following receipt of further information on various issues within the NIS (following a request from Mayo County Council, dated 24/03/2015), the Council was satisfied that the proposed project would not adversely affect the natural heritage of the area.

Uprate Refurbishment of the Bellacorick to Bangor Erris 38 kV Overhead Line (planning reference P15/611) – application by ESB Networks to Mayo County Council in September 2015.

This project comprises the uprating of approximately 12.3 km of power line between Bellacorick and Bangor Erris.

The NIS submitted with the application identified that temporary significant impacts without mitigation could occur on Active Blanket Bog [7130] which is a qualifying interest of Carrowmore Lake Complex SAC (Site code: 000476).

However, with mitigation in place the conclusion of the NIS was that, provided the mitigation measures described in the NIS document were fully implemented no significant adverse impacts are expected on the features of interest of the Carrowmore Lake Complex SAC, through which the line passes and on Owenduff/Nephin Complex SPA or Bellacorick Bog Complex SAC which are in close proximity to the proposed project or on any of the Natura 2000 sites.

Conclusion on in-combination effects with power line projects

While the Bellacorick to Moy and Bellacorick to Castlebar approved power line projects commence at Bellacorick and traverse the Bellacorick Bog Complex SAC and have potential to impact upon the River Moy SAC, it has been shown that the projects with appropriate mitigation would not adversely affect the integrity of these SAC sites or any other European site. Similarly, for the Bellacorick to Bangor Erris 38kV overhead line it has been shown that no adverse effects will arise when identified appropriate mitigation is put in place.

It follows therefore the there is no potential for in-combination effects on these sites when the Oweninny Wind Farm project is considered with the two power line projects.

9.7.4 Substation Project

EirGrid have made a planning application to Mayo County Council (22/07/2015, Planning Reference 15/456) for a minor modification of the existing Bellacorick 110kV Substation. The works, all within the existing substation, comprise construction of an extension (approx. 60sqm and 3.2m high) to the south western elevation of the existing 110kv control room, installation of 1 no. new 110kv cable bay with equipment and apparatus comprising busbar disconnect, circuit breaker, combined current/voltage transformer, line/earth disconnect, surge arrestor and cable sealing end and all associated site development works.

A Stage 1 Screening Report for Appropriate Assessment was prepared by EirGrid. The report noted that given the location of the proposed works (within the confines of Bellacorick Substation) and the limited nature of the works, the only European site where a possible connection exists is Bellacorick Bog Complex SAC. However, following an objective evaluation, the AA Screening Report concludes that the proposed works pose no potential for significant effects on the conservation objectives of Bellacorick Bog Complex SAC, alone or in combination, with other projects or plans.

As the planning documentation for the above substation project did not identify potential for adverse impacts on any site designated for nature conservation, it can be assumed that there would be no in-combination effect when the Oweninny Wind Farm development is considered with this substation project.

9.7.5 Power Plants

Planning permission has been granted for the following power plants:

- 68 MW gas turbine peaking plant at Bellacorick – Bellacorick Power Plant (Planning reference 01/1250).

- Conventional 200 MW natural gas fired peaking plant along the Srahnakilla road (Planning permission 09/286 granted to Constant Energy on 16/11/2001). Site located between the eastern and western parts of the Oweninny site.

As the planning documentation for the above projects did not identify significant adverse impacts on any site designated for nature conservation, it can be assumed that there would be no in-combination effect when the Oweninny Wind Farm development is considered with these power plant projects.

9.7.6 Renewable Energy Strategy (RES) for County Mayo, 2011-2020

The Renewable Energy Strategy (RES) for County Mayo, 2011-2020 was adopted by Mayo County Council (MCC) on 9th May 2011. This Strategy was prepared by MCC in the context of EU and national renewable energy targets, and is underpinned by Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) of that plan. The primary purpose of the RES is the identification of suitable locations for renewable developments.

The SEA has evaluated five potential strategy options and their effects on the environment and designated sites, including Natura 2000 sites, and provides the justification for this Strategy.

The HDA assessed the effect the Strategy would have on the conservation objectives of any Natura sites in the County and within 15 km of the County boundary.

In the RES, Map 1 Wind Energy classifies potential areas for on-shore wind energy development. There are 4 classifications identified:

- Priority Areas
- Tier 1 – Preferred (Large Wind Farms)
- Tier 1 – Preferred (Cluster of Turbines)
- Tier 2 – Open for consideration

The proposed Oweninny wind farm is within a Priority Area for wind energy developments (i.e. areas which have secured planning permission and where on shore wind farms can be developed immediately). A large area to the north-northeast is classified as 'Tier 1 – Preferred (Large Wind Farms)', while much of the remainder of the lands around the Oweninny site (apart from Natura 2000 sites) are classified as 'Tier 2 – Open for consideration'

In conclusion, the Oweninny proposed wind farm is within an area that is classified as a Priority Area for wind farm development according to the Renewable Energy Strategy for County Mayo, and the project has been subject to the requirements set out in the RES (including EIS and Habitats Directive Assessment).

9.7.7 Oweninny Cutaway Bog Rehabilitation Programme

The work for the Bord na Móna Bog Rehabilitation Programme, which covers the entire Oweninny site, was completed in 2012. The objectives of the programme were:

- Stabilisation of the peat production areas (as required under Condition 10 of IPPC Licence Reg No. P0505-01)
- Mitigation of silt run-off into watercourses
- Re-establishment of peat-forming communities where possible (identified as occurring spontaneously on the cutaway where drains were blocked and former peat production fields were rewetted).

The success of the Programme can be seen by the decline in the area of bare peat between 2001 and 2011 – from 53% to 11% respectively.

The developer considered the work of the Rehabilitation Programme during the wind farm design and avoided sensitive areas, including the bog remnants on site (other than slight impacts on 2 remnants, #9 & #23, – see section 9.4.2 of EIS), developing wetlands and the carbon research study site.

Accordingly, the impact of the wind farm on the existing vegetation on site, which has developed partly as a result of the Rehabilitation Programme, has been considered in the EIS. Apart from the immediate area of the development, the remainder of the site will continue to develop in the context of the Rehabilitation Programme. Further, when the wind farm construction works are complete, as indicated in section 9.5.9.1 of the EIS, there will be potential to create further wet areas adjacent to the structures by using the same techniques as used during the Rehabilitation Programme.

As there are no adverse impacts associated with the Rehabilitation Programme, and as the present wind farm proposal has taken the objectives of the plan into account and will not have any significant adverse impacts on the objectives, it can be concluded that there will not be any in-combination effects as a result of the proposed wind farm development.

9.7.8 Forestry

Forestry operations are widespread in the vicinity of the Oweninny development site. Forestry is identified as an ongoing threat to the following designated sites: Lough Dahybaun SAC, Bellacorick Bog SAC and the River Moy SAC (source NPWS).

As well as direct loss of habitat within the designated areas, forestry activities can affect water quality and associated aquatic interests in a number of ways, as follows:

- Leaching of fertilisers, especially phosphorus, to local watercourses
- Disturbance of soils during clearfelling operations and subsequent runoff of nutrients and suspended solids to local watercourses
- Decomposition of brash after clearfelling and subsequent runoff of nutrients to local watercourses
- Sedimentation and acidification of waters is a particular threat to the conservation objectives of the River Moy SAC. Sedimentation can cover the gravel beds resulting in a loss of suitable spawning grounds for important species such as Atlantic salmon.

While the Oweninny project will require the removal of 36 ha of commercial forest, this is not within the catchment of any Natura site and hence the project will not contribute to a cumulative effect that forestry has had, and potentially will have, on three identified SAC sites in the vicinity of Oweninny.

9.7.9 Peat Harvesting

Industrial peat operations ceased on the Oweninny site in 2005. Peat harvesting operated under an Integrated Pollution Prevention Control License (IPPC License Number 505) issued to Bord na Móna by the Environmental Protection Agency (EPA). In accordance with the licence conditions for the site a bog rehabilitation programme has been developed and implemented to enhance recovery of parts of the site and reduce run-off from bare surfaces. The proposed wind farm development will be integrated into the bog rehabilitation already completed and the project will continue with management to encourage surface re-vegetation.

There is currently private peat cutting (non-industrial) at a few locations on the Oweninny site. This is small scale and occurs through local arrangements. This level of cutting is expected to continue when the wind farm is in operation.

Peat cutting is widespread on bogs in the surrounding areas, including the Bellacorick Bog Complex SAC and Carrowmore Lake Complex SAC. Peat cutting has both direct impacts (by habitat loss) and potential indirect impacts (by changes to hydrology and water pollution) on the conservation objectives of these SAC sites.

While industrial scale peat extraction had formerly occurred on the Oweninny site, nowadays there is only very limited localised cutting on site. The proposed wind farm project will not result in an increase in peat cutting on site and hence will not contribute to a cumulative effect that peat cutting outside the site is having on several SAC sites in the vicinity of Oweninny.

9.7.10 Agriculture

Agriculture, mostly sheep and cattle grazing, is practised widely in the vicinity of the Oweninny site. Within the wind farm site, low level sheep grazing is allowed within the Coillte plantations and this is expected to continue when the wind farm is in operation.

The NPWS site synopsis notes that overgrazing is a problem within parts of the Bellacorick Bog Complex SAC, while the spreading of slurry and fertiliser poses a threat to the water quality of the rivers and lakes within the River Moy SAC. Within the Bellacorick Iron Flush SAC, undergrazing is considered a problem leading to loss of plant diversity.

It can be concluded that farming operations pose threats to the conservation objectives of the Bellacorick Bog Complex SAC and the River Moy SAC. As the level of farming within the Oweninny site is not significant and is not expected to change as a result of wind farm project, the farming operations within the site will not contribute to a cumulative effect.

9.7.11 Overview of In-combination Effects

This review has shown that in addition to wind farm projects, there is a range of projects and existing landuse activities within and around the Oweninny site that have affected, or have the potential to affect, the conservation objectives of several Natura 2000 sites, as well as sensitive bird species.

Without appropriate mitigation, the consented Corvoderry wind farm project has potential to cause water pollution which could affect the Lough Dahybaun SAC. While the Oweninny project could potentially cause similar effects on this SAC site, the project can demonstrate that appropriate mitigation will be implemented to minimise the risk of such effects. Therefore there will be no significant contribution from the Oweninny project to any possible cumulative impact with the Corvoderry wind farm project on the Lough Dahybaun SAC site. The main potential negative impacts identified for the Tawnanasool wind farm project (in planning) relate to the pollution of waterways downstream of the drains/streams within the proposed wind farm site. There is no potential for the Oweninny project to contribute to an in-combination effect on Natura 2000 sites in the vicinity of this wind farm site.

A proposal by ABO Wind Ireland to install a meteorological mast at Sheskin (Bellacorick) is currently in planning. As it has been shown that this project poses no potential for significant effects on any European site, there would be no in-combination effect between the Oweninny wind farm project and the meteorological mast project.

Consideration has been given to possible in-combination effects between the Oweninny Wind Farm project and two approved power line projects (Bellacorick-Castlebar 110kV Line Uprate and Bellacorick-Moy 110kV Line Uprate), which commence at Bellacorick and traverse the Bellacorick Bog Complex SAC and have potential to impact upon the River Moy SAC. Consideration has also been given to possible in-combination effects with the Bellacorick to Bangor Erris 38kV proposed line uprate and currently in planning. As it has been shown that the power line projects with appropriate mitigation would not adversely affect the integrity of these SAC sites, it can be concluded that there is no potential for in-combination effects on these Natura sites when the Oweninny Wind Farm project is considered with the two power line projects.

A proposal by EirGrid to carry out works to the Bellacorick 110kV substation is currently in planning. However, as it has been shown that this project, which is entirely within the confines of the existing substation, poses no potential for significant effects on any European site, there would be no in-combination effect between the Oweninny wind farm project and the substation project.

Planning permission has been granted for two power plant projects at Bellacorick. However, as the planning documentation for these projects did not identify significant adverse impacts on any site designated for nature conservation, it can be assumed that there would be no in-combination effects on any Natura site when the Oweninny Wind Farm development is considered with these power plant projects.

A thorough evaluation has been made of potential in-combination effects between the Oweninny project and the underground and overhead options for the Grid West project as published by EirGrid in July 2015. While a preferred Grid West option has yet to be selected (which would be subject to AA assessment), environmental evaluations have been made for the identified underground and overhead corridors. The Moy River SAC is the principal site which could potentially be affected by both projects. However, from the evaluations carried out, it can be concluded that there is no potential for the Oweninny wind farm project to contribute to an in-combination effect with the Grid West project on River Moy SAC or any other Natura 2000 sites or on populations of Annex I listed bird species (especially Whooper Swan and Greenland White-fronted Goose).

Work for the Bord na Móna Bog Rehabilitation Programme, which covers the entire Oweninny Wind Farm site, was completed in 2012. The design of the wind farm considered the work of the Rehabilitation Programme and avoided sensitive areas and especially Annex I listed blanket bog. As there are no adverse impacts associated with the Rehabilitation Programme, and as the present wind farm proposal has taken the objectives of the plan into account and will not have any significant adverse impacts on the objectives, it can be concluded that there will not be any in-combination effects as a result of the proposed wind farm development.

Forestry, peat cutting and agriculture are identified as main threats to the conservation objectives of the Bellacorick Bog Complex SAC, the River Moy SAC and the Carrowmore Lake Complex SAC. While the Oweninny project will require the felling of 36 ha of commercial forestry, this will not affect the SAC sites as the area is outside the relevant catchments. Peat cutting and agriculture occur at low levels of intensity within the Oweninny site and the proposed wind farm project will not lead to an increase in these activities within the site. Hence the wind farm project will not contribute to in-combination effects relating to these activities.

An objective assessment of the proposed Oweninny wind farm project has shown that the sensitive design of the project, and appropriate mitigation where required, which includes effective measures for maintenance of peat stability and control of water quality during the construction phase, will ensure that there will be no significant impacts on the conservation objectives of any Natura site. Taking this into account, and considering the other projects and the various landuse activities carried out in the wider area, it can be concluded that there will not be any significant in-combination contribution by the Oweninny project to possible existing or potential future adverse impacts on any Natura site or Annex I bird species.

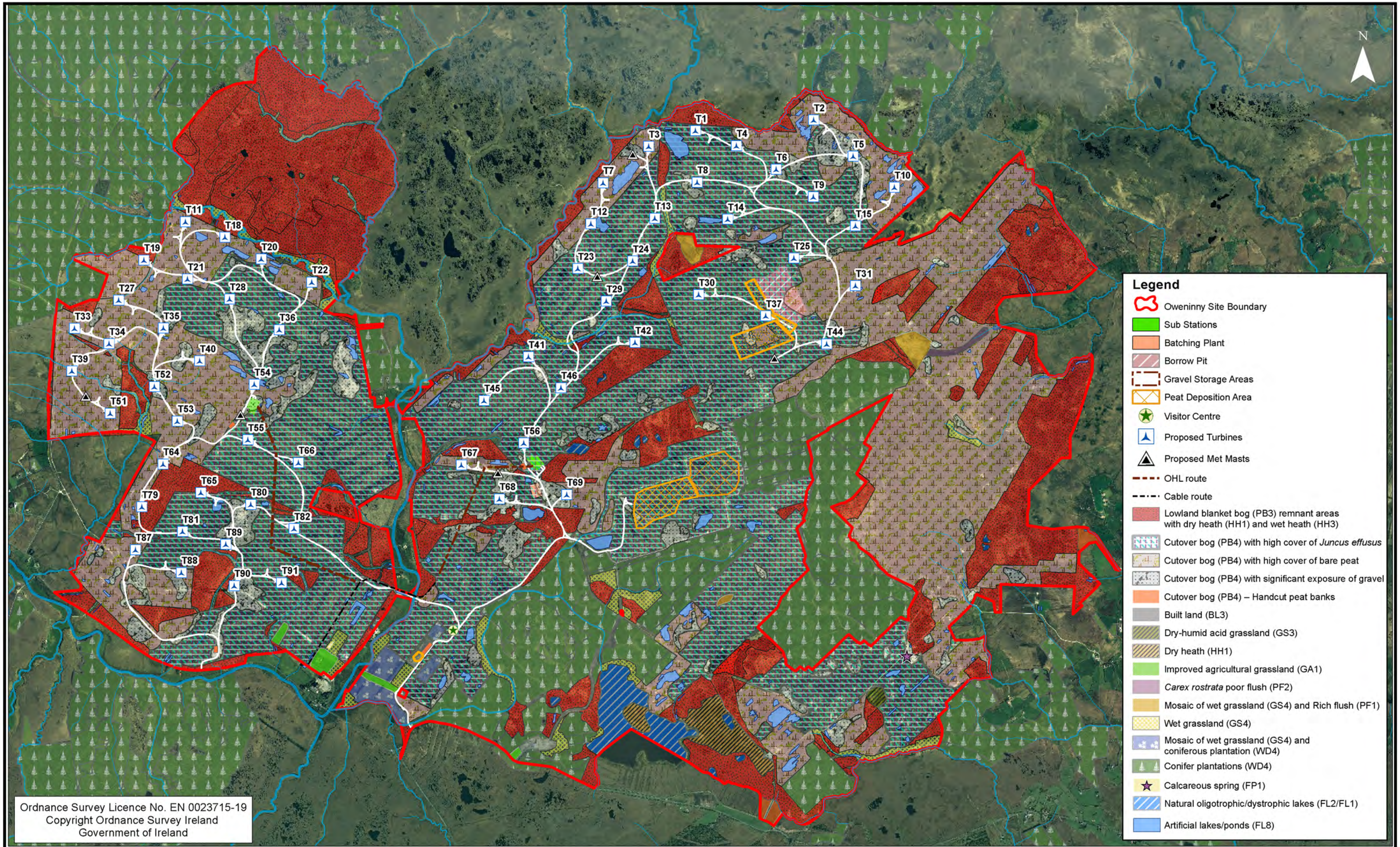
9.8 CONCLUSION

The proposed development site has substantial ecological interests and is within an area noted for the number of designated sites for conservation. However, it is considered that careful planning and design of Phase 1 and Phase 2 of the wind farm layout (with a high emphasis on avoidance of ecological receptors), along with appropriate mitigation as required, will minimise significant ecological impacts. In particular, it can be objectively shown that none of the designated sites within and around the site will be adversely affected in any way.

The development of the wind farm will result in some changes to the habitats within the site but these changes can be considered as being consistent with the rehabilitation of the site since commercial peat extraction ceased in the early 2000s and will be managed so as to maximise the further development of wetland habitats.

Most bird species, including the wintering Hen Harriers, will not be affected by the project. However, evidence from elsewhere shows that breeding Snipe have a low tolerance to the presence of turbines and the population on site can be expected to decrease (though any decrease may be offset by further development of suitable wetland habitat elsewhere on site). Some bird collisions may occur but species particularly prone to collision, especially swans and geese, occur within the site area only on an occasional basis and then in small numbers.

Other important fauna species, such as otters, bats and the common frog, are unlikely to be affected by the project.



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Habitat and vegetation map - Phasing 1 & 2

Production Unit
Civil, Building & Environment Group

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MAP REFERENCE

FIGURE 9.1

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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Distribution of Bog Remnant Locations

Production Unit
Civil, Building & Environment Group

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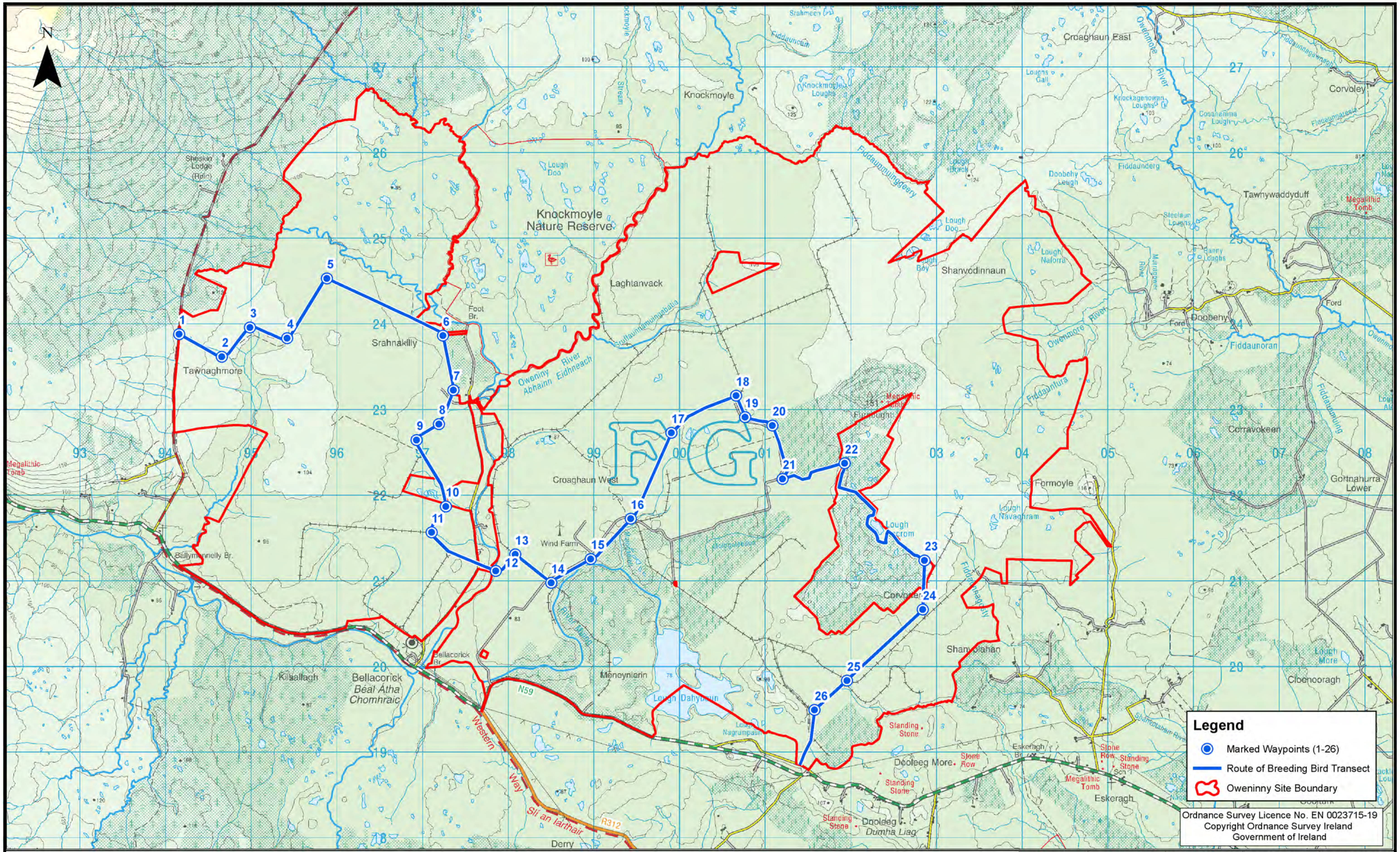
FIGURE 9.2



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Bird survey transect route
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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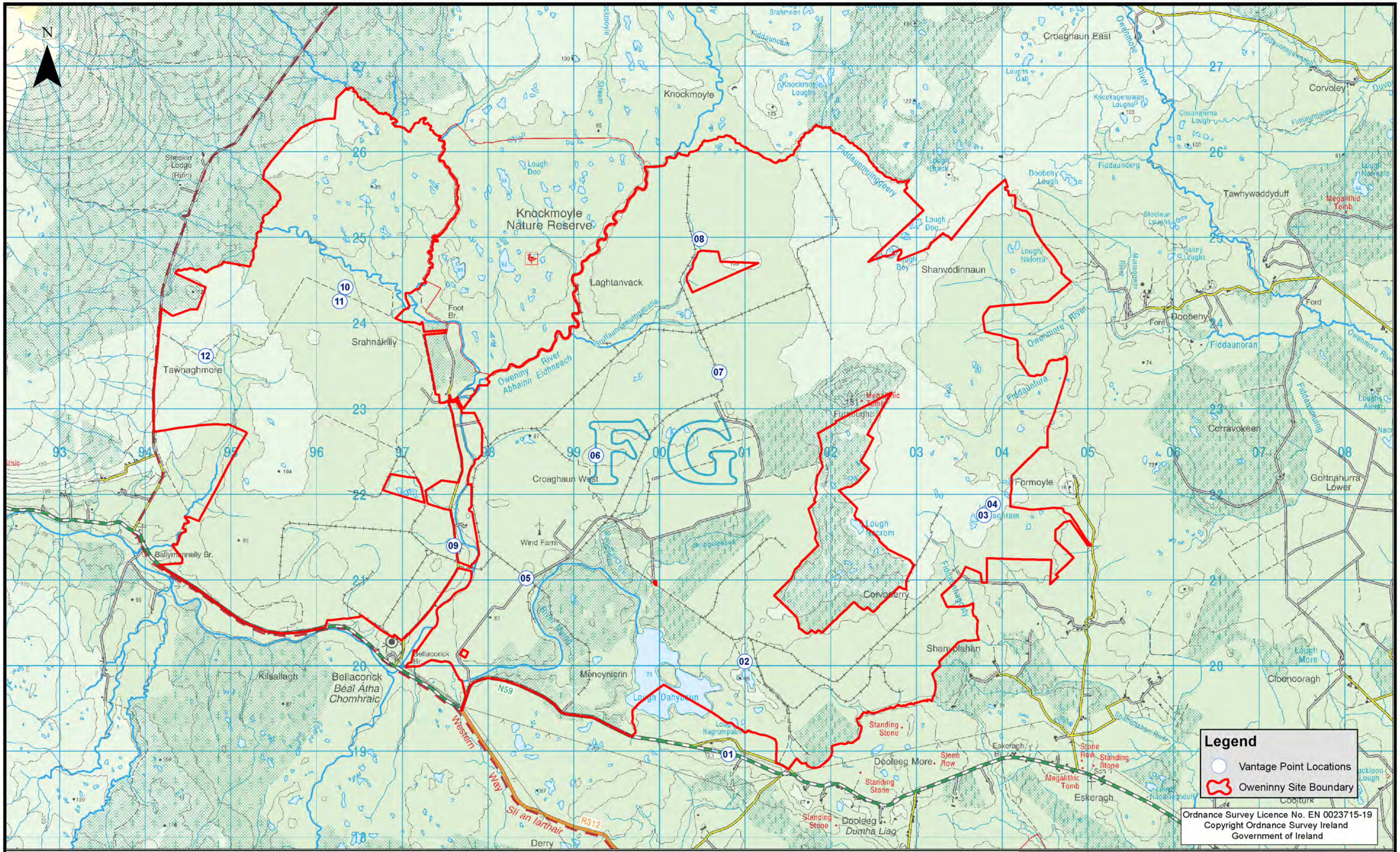
MAP REFERENCE

FIGURE 9.3



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Oweninny Power Ltd.

Client Oweninny Power Ltd.	**Title** Bird Survey Vantage Point Locations
Project Wind Farm at Oweninny, Co. Mayo	**Production Unit** Civil, Building & Environment Group

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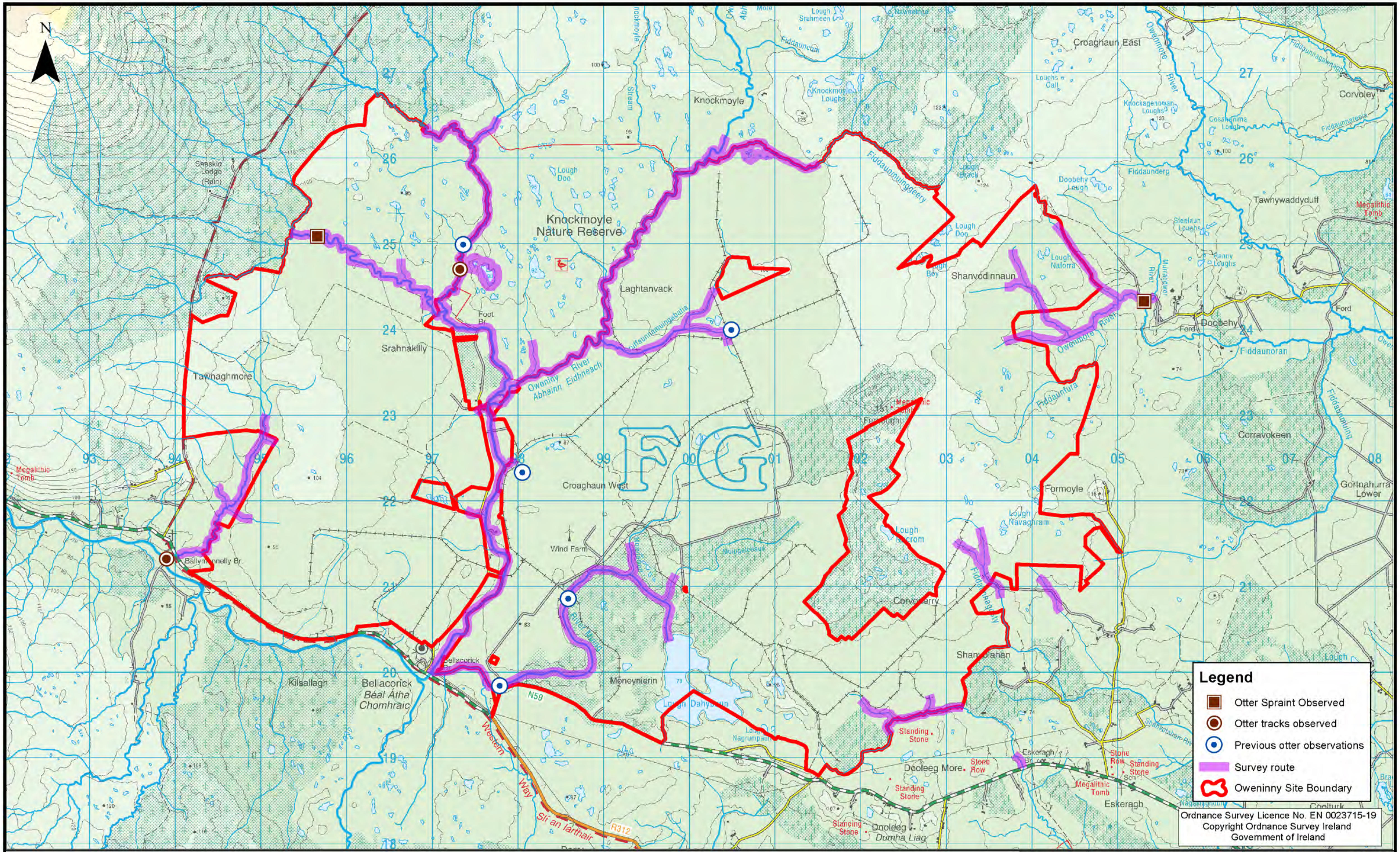
MAP REFERENCE

FIGURE 9.4



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Oweninny Power Ltd.

Client: Oweninny Power Ltd.	Title: Routes taken for Otter survey	DRAWN BY: C.F	PRODUCED BY: C.F	VERIFIED BY: P.K
Project: Wind Farm at Oweninny, Co. Mayo	Production Unit: Civil, Building & Environment Group	APPROVED BY: N.Q	APPROVED DATE: 10/09/2015	CLIENT REF.
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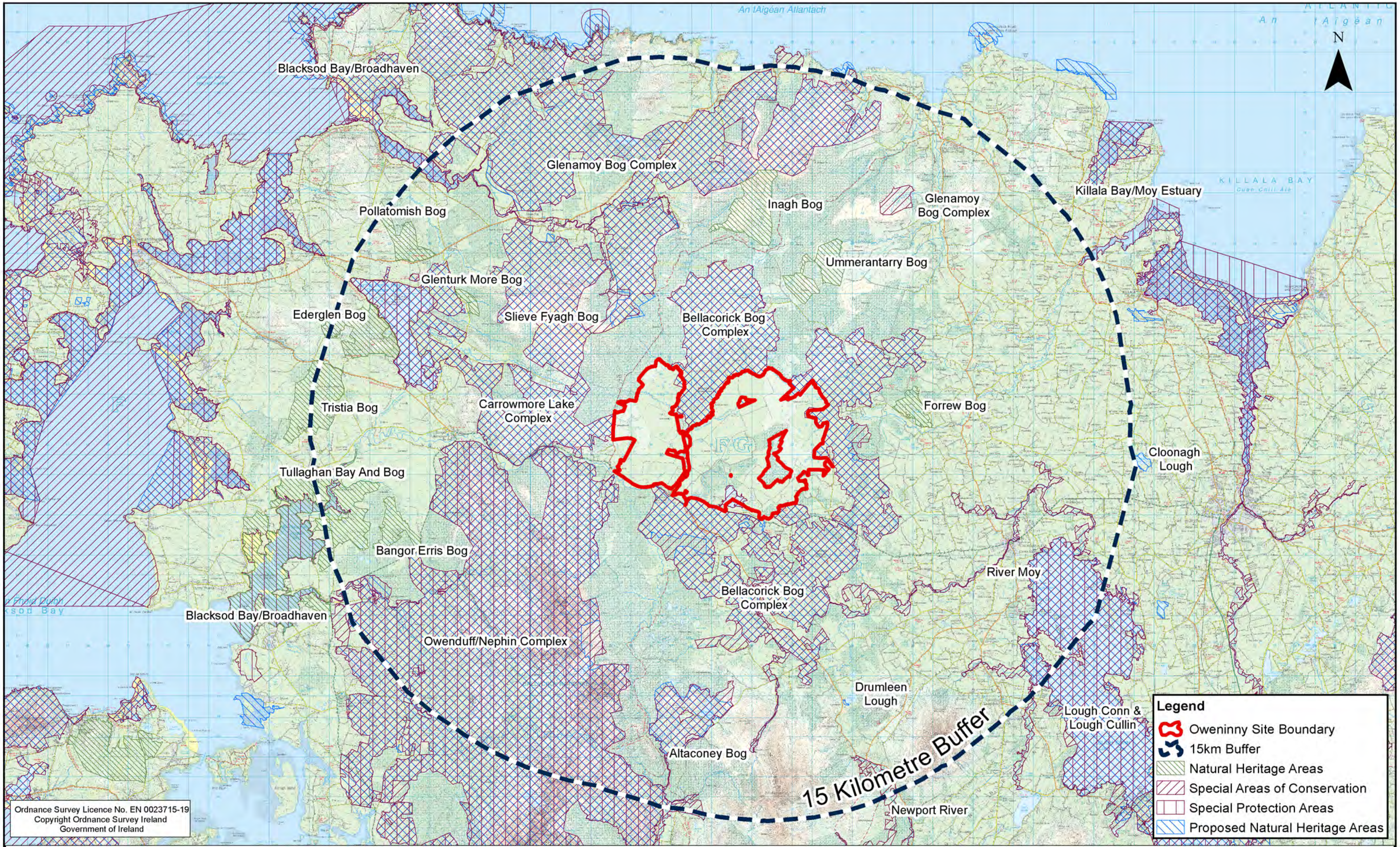
		MAP REFERENCE		

FIGURE 9.5



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Project	Wind Farm Project at Oweninny, Bellacorick, Co. Mayo
Title	Distribution of SACs, SPAs & NHAs within 15 km radius of Oweninny site
Production Unit	Civil, Building & Environment Group

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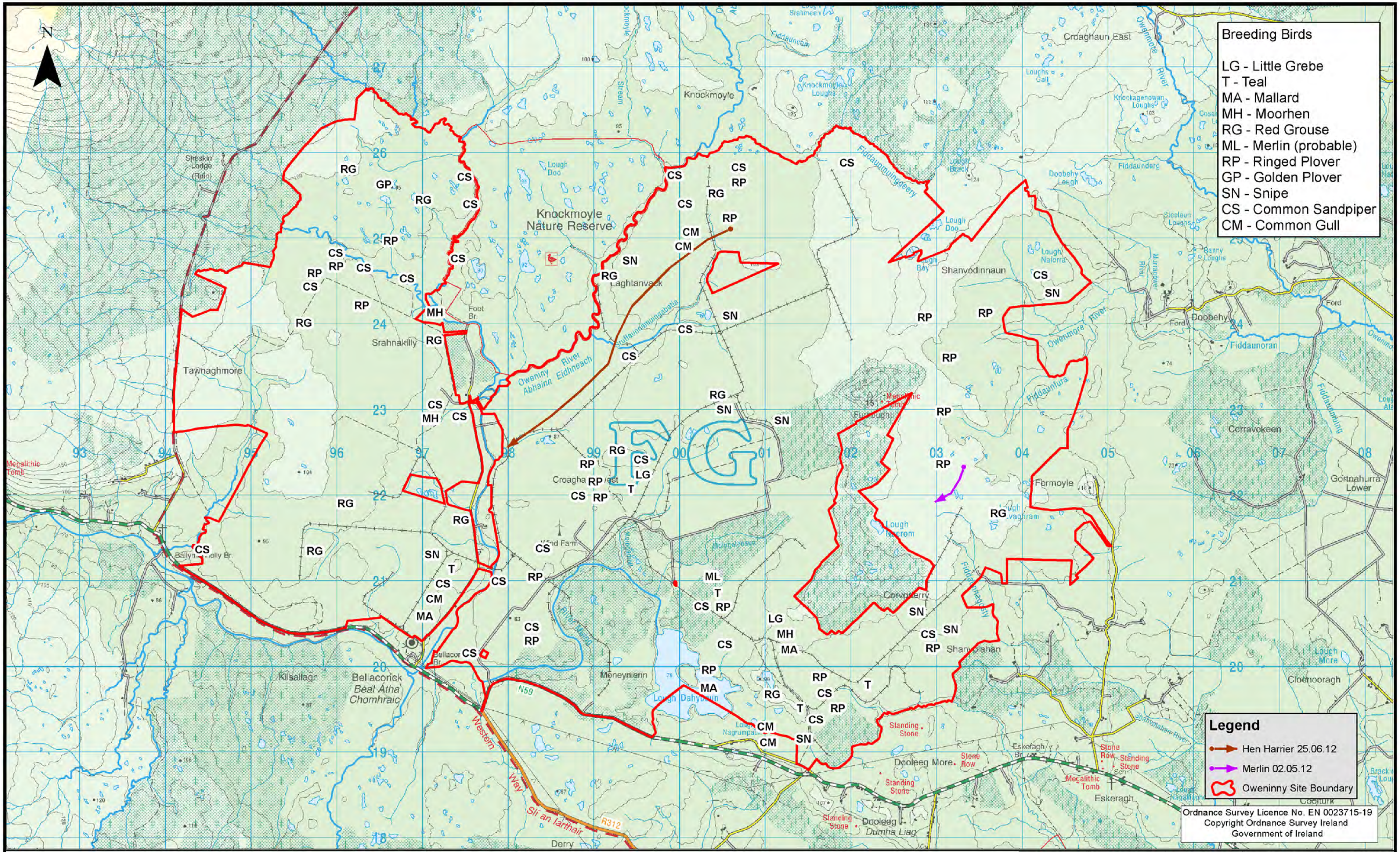
MAP REFERENCE

FIGURE 9.6



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Distribution of Selected Breeding Birds 2010 - 2012
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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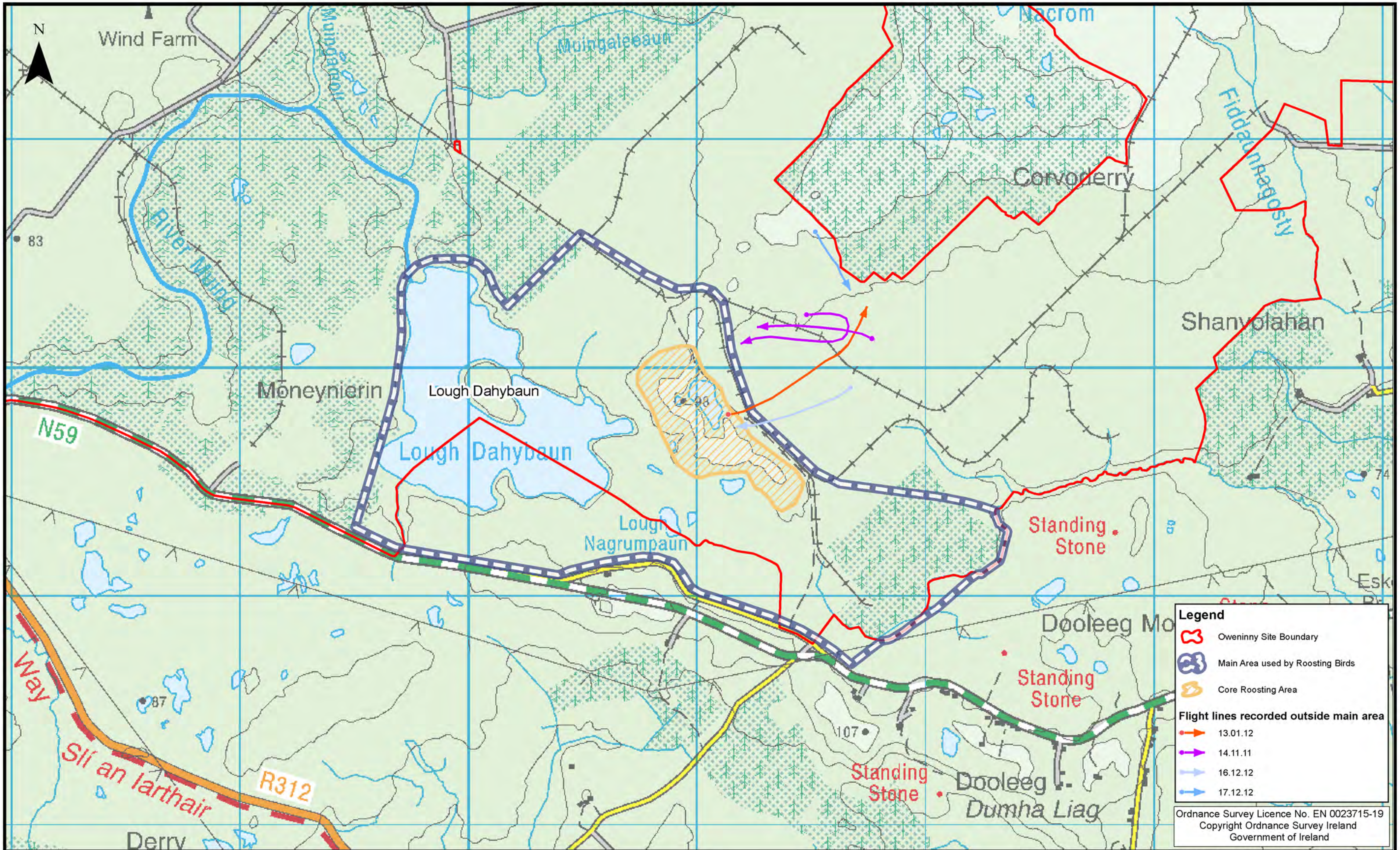
MAP REFERENCE

FIGURE 9.7



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Hen Harrier Winter Roost Locations
Project	**Production Unit**
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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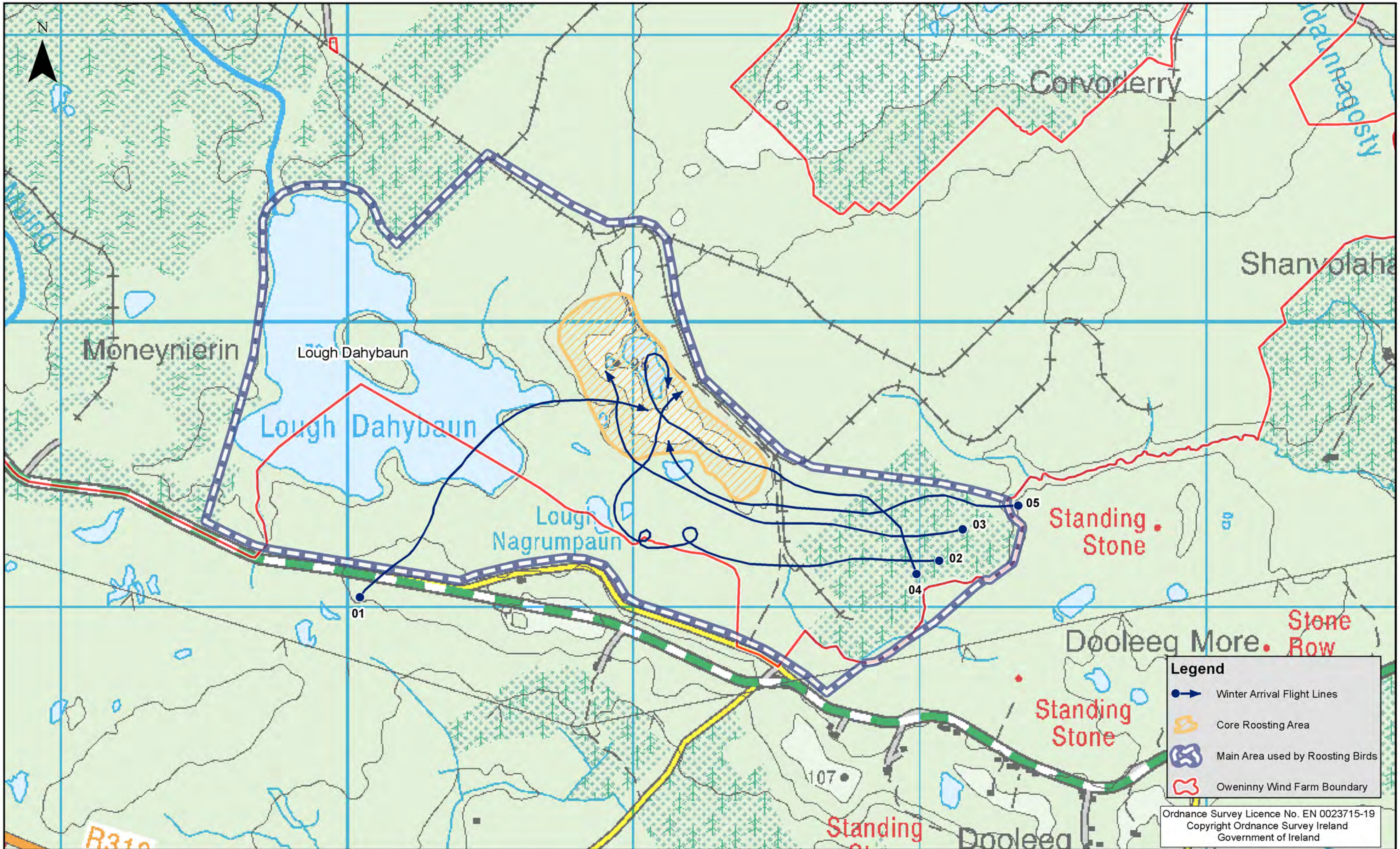
FIGURE 9.8



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Hen Harrier Winter Flight Lines Arriving to Winter Roost
Project	**Production Unit**
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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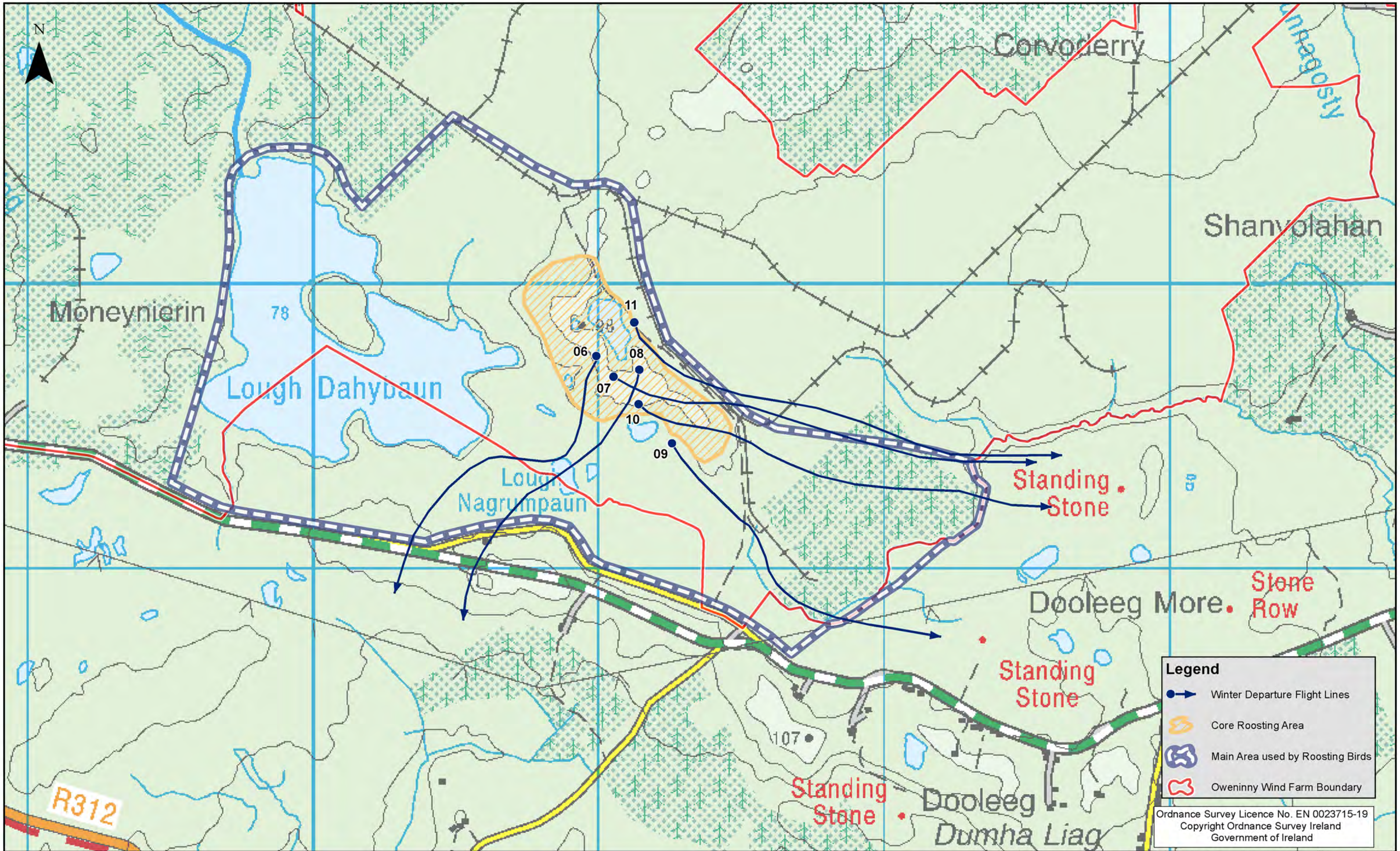
FIGURE 9.9



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Project	Wind Farm at Oweninny, Co. Mayo
Title	Hen Harrier Winter Departing Flight Lines
Production Unit	Civil, Building & Environment Group

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MAP REFERENCE

FIGURE 9.10

APPENDIX A. VEGETATION DESCRIPTIONS FOR TURBINE AND SUBSTATION LOCATIONS: PHASE 1 & PHASE 2

Turbine No.	Dominant habitat	% Bare peat cover	Main species in vegetation	Additional species present	Comments
1	Cutover Bog (PB4)	20	*Juncus effusus*	*Polytrichum commune, Juncus bulbosus, Eriophorum angustifolium, Molinia caerulea, Campylopus introflexus.*	*Bog remnant close*
2	Cutover Bog (PB4)	80	*Eriophorum angustifolium, Juncus effusus*	*Juncus bulbosus, Campylopus introflexus*	*Open water close*
3	Cutover Bog (PB4)	99	*Eriophorum angustifolium, Campylopus introflexus*	*Juncus bulbosus*	
4	Cutover Bog (PB4)	60	*Juncus effusus, Eriophorum angustifolium,*	*Juncus bulbosus, Campylopus introflexus*	
5	Cutover Bog (PB4)	80	*Polytrichum commune, Juncus effusus*	*Juncus bulbosus, Agrostis sp., Poa annua*	
6	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Hypnum jutlandicum, Holcus lanatus, Anthoxanthum odoratum, Rubus fruticosus, Dryopteris dilatata.*	
7	Cutover Bog (PB4)	90	*Eriophorum angustifolium*	*Campylopus introflexus*	*Open water close*
8	Cutover Bog (PB4)	<5	*Juncus effusus, Molinia caerulea*	*Pinus contorta, Calluna vulgaris, Polytrichum commune, Hypnum jutlandicum.*	
9	Cutover Bog (PB4)	10	*Juncus effusus*	*Agrostis sp., Holcus lanatus, Salix aurita, Eriophorum angustifolium, Polytrichum commune, Sphagnum palustre*	
10	Cutover Bog (PB4)	95	*Eriophorum angustifolium, Juncus bulbosus*	*Campylopus introflexus*	
11	Cutover Bog (PB4)	70	*Juncus effusus*	*Pinus contorta, Juncus bulbosus, Eriophorum angustifolium, Polytrichum commune*	
12	Cutover Bog (PB4)	90	*Eriophorum angustifolium, Juncus effusus*	*Campylopus introflexus, Polytrichum commune*	*Open water close*
13	Cutover Bog (PB4)	10	*Juncus effusus, Sphagnum cuspidatum*	*Polytrichum commune, Eriophorum angustifolium*	*Pooling shallow water*
14	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Eriophorum angustifolium, Holcus lanatus, Campylopus introflexus, Aulocomium palustris, Salix aurita*	
15	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Aulocomium palustris, Sphagnum capillifolium, Holcus lanatus, Salix aurita, Sphagnum palustre.*	
18	Cutover Bog (PB4)	50	*Juncus effusus, Eriophorum angustifolium*	*Sphagnum recurvum, Polytrichum commune, Juncus bulbosus*	
19	Cutover Bog (PB4)	95	*Juncus bulbosus, Carex panicea*	*Pinus contorta, Eriophorum angustifolium,*	*Bog remnant close*

Turbine No.	Dominant habitat	% Bare peat cover	Main species in vegetation	Additional species present	Comments
				Campylopus introflexus.	
20	Cutover Bog (PB4)	90	*Juncus effusus, Juncus bulbosus*	*Polytrichum commune, Pinus contorta, Eriophorum angustifolium, Dryopteris dilatata.*	*Open water close*
21	Cutover Bog (PB4)	80	*Eriophorum angustifolium, Juncus effusus*	*Juncus bulbosus, Polytrichum commune, Campylopus introflexus*	
22	Cutover Bog (PB4)	90	*Juncus effusus, Juncus bulbosus*	*Polytrichum commune, Campylopus introflexus, Eriophorum angustifolium*	
23	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Dryopteris dilatata, Agrostis* sp., *Molinia caerulea, Salix aurita, Sphagnum palustre.*	
24	Cutover Bog (PB4)	20	*Juncus effusus, Eriophorum angustifolium*	*Campylopus introflexus, Polytrichum commune, Pinus contorta, Hypnum jutlandicum.*	
25	Cutover Bog (PB4)	50	*Juncus effusus*	*Eriophorum angustifolium, Campylopus introflexus, Juncus bulbosus, Hypnum jutlandicum*	*Close to track*
27	Cutover Bog (PB4)	80	*Eriophorum angustifolium, Campylopus introflexus*	*Juncus effusus, Juncus bulbosus, Polytrichum commune*	
28	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Dryopteris dilatata, Hypnum jutlandicum, Rhytidiadelphus squarrosus, Plagiothecium undulatum, Rubus fruticosus.*	
29	Cutover Bog (PB4)	50	*Juncus effusus, Eriophorum angustifolium*	*Agrostis sp., Polytrichum commune, Molinia caerulea, Eriophorum vaginatum, Campylopus introflexus*	
30	Cutover Bog (PB4)	<5	*Juncus effusus*	*Eriophorum angustifolium, Hypnum jutlandicum, Sphagnum subnitens, Calluna vulgaris, Sphagnum cuspidatum.*	
31	Cutover Bog (PB4)	60	*Eriophorum angustifolium, Juncus effusus*	*Polytrichum commune*	
33	Cutover Bog (PB4)	95	*Eriophorum angustifolium*	*Juncus effusus, Juncus bulbosus, Eriophorum vaginatum*	
34	Cutover Bog (PB4)	<5	*Juncus effusus*	*Senecio jacobea, Rubus fruticosus, Holcus lanatus, Calliergonella cuspidata, Cirsium palustre, Anthoxanthum odoratum*	
35	Cutover Bog (PB4)	95	*Juncus effusus, Juncus bulbosus*	*Campylopus introflexus, Polytrichum commune, Dryopteris dilatata*	

Turbine No.	Dominant habitat	% Bare peat cover	Main species in vegetation	Additional species present	Comments
36	Cutover Bog (PB4)	60	*Juncus effusus*	*Salix aurita, Dryopteris dilatata, Eriophorum angustifolium, Holcus lanatus*	*Bog remnant close*
37	Cutover Bog (PB4)	10	*Molinia caerulea*	*Calluna vulgaris, Succisa pratensis, Salix aurita, Erica tetralix*	
39	Cutover Bog (PB4)	80	*Juncus effusus*	*Juncus bulbosus, Polytrichum commune, Campylopus introflexus*	
40	Cutover Bog (PB4)	70	*Juncus effusus, Campylopus introflexus*	*Polytrichum commune, Salix cinerea, Juncus bulbosus, Eriophorum angustifolium*	
41	Cutover Bog (PB4)	<5	*Juncus effusus, Polytrichum commune*	*Sphagnum fallax, Sphagnum cuspidatum, Carex nigra, Hypnum jutlandicum, Aulocomium palustris*	
42	Cutover Bog (PB4)	<3	*Juncus effusus, Polytrichum commune*	*Salix aurita, Dryopteris dilatata, Sphagnum fallax, Epilobium angustifolium, Calluna vulgaris*	*Bog remnant close*
44	Cutover Bog (PB4)	40	*Juncus effusus, Eriophorum angustifolium*	*Polytrichum commune, Calluna vulgaris, Juncus bulbosus, Campylopus introflexus*	
45	Cutover Bog (PB4)	<3	*Juncus effusus, Polytrichum commune*	*Hypnum jutlandicum, Holcus lanatus, Dryopteris dilatata.*	
46	Cutover Bog (PB4)	20	*Juncus effusus, Polytrichum commune*	*Eriophorum angustifolium, Calluna vulgaris, Sphagnum cuspidatum, Molinia caerulea, Aulocomium palustris*	
51	Cutover Bog (PB4)	95	*Juncus bulbosus*	*Campylopus introflexus, Eriophorum angustifolium*	
52	Cutover Bog (PB4)	80	*Juncus effusus, Polytrichum commune*	*Juncus bulbosus, Molinia caerulea, Holcus lanatus*	
53	Cutover Bog (PB4)	65	*Juncus effusus, Campylopus introflexus*	*Polytrichum commune, Juncus bulbosus, Holcus lanatus*	
54	Cutover Bog (PB4)	10	*Juncus bulbosus, Sphagnum cuspidatum*	*Juncus effusus, Eriophorum angustifolium*	
55	Cutover Bog (PB4)	70	*Polytrichum commune, Juncus bulbosus*	*Juncus effusus, Eriophorum angustifolium, Carex echinata*	
56	Cutover Bog (PB4)	<3	*Juncus effusus*	*Eriophorum angustifolium, Typha latifolia, Sphagnum cuspidatum, Juncus bulbosus*	
64	Cutover Bog (PB4)	98	*Eriophorum angustifolium*	*Juncus effusus, Molinia caerulea*	*Bog remnant close*
65	Cutover Bog (PB4)	10	*Eriophorum angustifolium, Calluna vulgaris*	*Molinia caerulea, Hypnum jutlandicum, Juncus effusus, Sphagnum capillifolium*	*Bog remnant close*
66	Cutover Bog (PB4)	<3	*Juncus effusus, Polytrichum commune*	*Hylocomium splendens, Dryopteris dilatata, Holcus lanatus, Rumex acetosa, Agrostis* sp.,	

Turbine No.	Dominant habitat	% Bare peat cover	Main species in vegetation	Additional species present	Comments
				Aulocomium palustris	
67	Cutover Bog (PB4)	80	*Eriophorum angustifolium*	*Juncus effusus, Juncus bulbosus, Campylopus introflexus, Polytrichum commune*	
68	Cutover Bog (PB4)	10	*Juncus effusus, Polytrichum commune*	*Juncus bulbosus, Pinus contorta, Salix* sp., *Cladonia portentosa*	
69	Cutover Bog (PB4)	60	*Calluna vulgaris, Polytrichum commune*	*Juncus effusus, Juncus squarrosus, Agrostis* sp., *Holcus lanatus*	
79	Cutover Bog (PB4)	98	*Eriophorum angustifolium*	*Juncus bulbosus, Molinia caerulea*	*Bog remnant close*
80	Cutover Bog (PB4)	60	*Juncus effusus, Eriophorum angustifolium*	*Juncus bulbosus, Campylopus introflexus, Calluna vulgaris, Polytrichum commune*	
81	Cutover Bog (PB4)	75	*Juncus effusus, Polytrichum commune*	*Eriophorum angustifolium, Pinus contorta, Dryopteris dilatata, Calluna vulgaris, Epilobium angustifolium*	
82	Cutover Bog (PB4)	<3	*Juncus effusus, Eriophorum angustifolium*	*Polytrichum commune, Dryopteris dilatata, Campylopus introflexus, Holcus lanatus, Juncus bulbosus*	
87	Cutover Bog (PB4)	90	*Juncus effusus*	*Juncus bulbosus, Eriophorum angustifolium, Campylopus introflexus, Polytrichum commune*	
88	Cutover Bog (PB4)	20	*Juncus effusus, Eriophorum angustifolium*	*Calluna vulgaris, Campylopus introflexus, Juncus squarrosus, Polytrichum commune, Dryopteris dilitata*	
89	Cutover Bog (PB4)	20	*Juncus effusus, Sphagnum cuspidatum*	*Eriophorum angustifolium, Campylopus atrovirens, Calluna vulgaris, Juncus bulbosus*	
90	Cutover Bog (PB4)	90	*Calluna vulgaris*	*Eriophorum angustifolium, Molinia caerulea*	
91	Cutover Bog (PB4)	60	*Juncus effusus, Polytrichum commune*	*Juncus bulbosus, Eriophorum angustifolium, Campylopus introflexus, Dryopteris dilatata*	
Substation 1	Cutover Bog (PB4)	10	*Juncus effusus, Polytrichum commune*	*Eriophorum angustifolium, Calluna vulgaris, Juncus bulbosus, Agrostis* sp., *Juncus squarrosus, Holcus lanatus*	*Area generally dominated by surface gravels*
Substation 2	Cutover Bog (PB4)	15	*Juncus effusus, Polytrichum commune*	*Campylopus introflexus, Holcus lanatus, Aira praecox, Dryopteris dilatata*	*Area generally dominated by surface gravels*
Visitor centre	Cutover Bog (PB4)	20	*Juncus effusus, Eriophorum angustifolium*	*Polytrichum commune, Sphagnum cuspidatum, Juncus bulbosus, Pinus contorta*	

Turbine No.	Dominant habitat	% Bare peat cover	Main species in vegetation	Additional species present	Comments
O & M building	Cutover Bog (PB4)	20	*Juncus effusus, Polytrichum commune*	*Eriophorum angustifolium, Calluna vulgaris, Juncus squarrosus, Agrostis sp., Rumex acetosella*	
Borrow pit	Cutover Bog (PB4)				
Peat storage area	Cutover Bog (PB4)				

10 WATER QUALITY, FISHERIES AND AQUATIC ECOLOGY

10.1 INTRODUCTION

The rivers of North Mayo, particularly the Moy and its tributaries, are a major tourist attraction for both domestic and foreign anglers. In their own rights, the Owenmore and Oweninny River systems are important fishery rivers in the area. This is clearly set out in the Northwestern Regional Fisheries Board (now subsumed into the Inland Fisheries Ireland (IFI)) publication “Towards a New Era for the Owenmore”. This is a specific catchment management plan for this river with a main objective:

“To ensure that the Owenmore fisheries are effectively managed for today’s generation and conserved for future generations”

The south-easterly flowing River Deel is a tributary of the Moy and also hosts an important population of the protected species of the Freshwater Pearl Mussel (*Margaritifera margaritifera*). The north-easterly flowing Owenmore River or Cloonaghmore River is also an important local fisheries resource. Maintaining the water quality and fisheries habitat of these rivers is paramount during the development, operation and decommissioning phases of the project.

Historically, the peat harvesting operations at Oweninny had a significant impact on the aquatic ecology of the receiving waters in the catchments draining the area. This arose from loss of some peat silt material from bare peat areas within the site, which sedimented in river beds. In response to this problem and following consultation with the Fisheries Board and the Environmental Protection Agency, Bord na Móna developed a comprehensive system of drainage control using settlement ponds to trap sediment in surface runoff and a bog rehabilitation programme to rewet bare peat areas and encourage vegetative re-growth. Reduction of bare peat areas is effective at reducing loss of peat material to the aquatic environment. These measures, developed in conjunction with the North-western Regional Fisheries Board and the Environmental Protection Agency (EPA), have proved successful in significantly reducing peat particle loss to the aquatic environment with a consequent major improvement in water clarity, ecology and fish habitat. This was evidenced by a major study undertaken by IFI and funded by Bord na Móna between 2005 and 2008. As the bog rehabilitation programme effectiveness continues, further reductions in peat material loss from the site will result as the extent of bare peat areas reduces.

In terms of potential impact on the aquatic environment the proposed Phase 1 and Phase 2 of the wind farm development has the potential to cause sediment material loss from construction areas and pollution due to oil spills and waste material management. These impacts could potentially occur only to the Oweninny and Owenmore rivers flowing westwards and their tributaries, as there are no proposed elements of the development in Phase 1 and Phase 2 which could impact on the Deel- Moy river system or the eastwardly flowing Owenmore river system. However, unlike the peat harvesting operations of the past, only a small fraction of the site will be disturbed by construction and potential sediment and other polluting substances will be controlled by good engineering construction practice and through implementation of a site specific drainage and sediment control plan. This plan integrates the new proposed control measures into the existing peat control measures and will ensure no significant impact on water quality and the aquatic environment.

The Oweninny site is located within the Western River Basin District established under the Water Framework Directive[99] which sets the objectives for water quality in the district. The Water Framework Directive rationalises and updates existing water legislation by setting common EU-wide objectives for water quality. It provides for a new, strengthened system for the protection and improvement of water quality and dependent ecosystems. In brief, the legislation provides for:

- The protection of the status of all waters (surface water and groundwater)
- The establishment of 'river basin districts' (RBDs)
- The coordination of actions by all relevant public authorities for water quality management in an RBD, including cross-border RBDs
- The characterisation of each RBD
- The establishment of environmental objectives
- The development of programmes of measures and river basin management plans (RBMP).

Galway County Council is the coordinating local authority for the Western RBD set out in the legislation and Mayo County Council is a designated authority for it.

The Western River Basin District – River Basin Management Plan 2009–2015 (published 2009) has been adopted for the river basin district (see www.wfdireland.ie/docs). It establishes four core environmental objectives to be achieved generally by 2015, as follows:

- Prevent deterioration: maintain the status of waters classified as High or Good
- Restore all waters to at least Good status
- Reduce chemical pollution
- Achieve water-related protected areas objectives.

[99] "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy"

10.1.1 Relevant legislation

The Surface Waters Environmental Objectives Regulations (S.I. No. 272/2009) and the Groundwater Environmental Objectives Regulations (S.I. No. 9/2010) set out the measures needed to achieve the environmental objectives established in river basin management plans for surface water and groundwater. The regulations place a legal obligation on public authorities to aim to achieve those objectives in the context of their statutory functions.

For the river water bodies draining the Oweninny site the Western River Basin Management Plan objectives will be to achieve at least good status, and prevent deterioration of existing good and high water quality status.

As part of the assessment of the potential impacts discussions took place with IFI and NPWS to review the assessment needs of the aquatic ecology arising from the development. Resulting from this, electrofishing on the Sheskin Stream, Oweninny River and Owenmore River (by AQUAFACT) were undertaken and biological quality assessment made at a number of locations on rivers draining the general site to update the baseline conditions. This coupled with extensive data available from the IFI fish surveillance monitoring programme and the EPA national water quality assessment programme collected under the Water Framework Directive has been used to establish the baseline and to assess the potential for impact and recommend mitigation as required.

The Deel River, a tributary of the Moy, is designated as a salmonid river under the European Communities (Quality of Salmonid Waters) Regulations 1988 which enables the requirements of the European Directive of 18th July, 1978 (No. 78/659/EEC), the Freshwater Fish Directive. This Directive is scheduled to be repealed in July 2013 with its requirements for salmonid water quality being subsumed into the Water Framework Directive where designated waters will become protected areas.

The Deel River also hosts an important population of the Freshwater Pearl Mussel (*Margaratifera margaritifera*). Ecological quality objectives for the Freshwater Pearl Mussel Habitat have been set out in the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. These are generally more stringent for FPM catchments requiring high Environmental Quality Ratios equating to High status waters under the WFD. In essence the requirements are at the highest level of water quality.

10.1.2 Hydrology of the site

The Oweninny wind farm site lies within three main river catchments – Owenmore (Oweninny) flowing westwards to Tullaghan Bay on the west coast, Cloonaghmore (a different Owenmore) flowing north east to Killala Bay on the north Mayo coast and the Deel (Shanvolahan) flowing to Lough Conn in the Moy River Catchment. The main rivers draining the site area are shown on Figure 10-1 and the river catchments are shown on Figure 10-2. The Phase 1 and Phase 2 elements of the development are situated within the westerly flowing Owenmore catchment.

The Oweninny site has been comprehensively drained in the past by a series of parallel open ditches to facilitate peat production. Large areas of the site have been stripped to the subsoil layer resulting from harvesting operations. The ditch drains installed in the worked bog discharge to the natural drainage of the area. Bord na Móna has undertaken a bog rehabilitation programme as part of the requirements of the IPPC Licence for the peat harvesting operations which have now ceased. The rehabilitation works are completed and included the blocking of bog drains to allow re-wetting of areas. This has facilitated re-growth of surface vegetation, significantly reducing the loss of peat material from the site to the aquatic environment.

10.2 Approach and Methodology

No significant limitations were encountered in field surveys or data collection. The assessment was undertaken with reference to the following.

- Western River Basin District River Basin Management Plan 2009 – 2015 (www.wfdireland.ie)
- Mayo West and Conn Water Management Unit Action Plans, (www.wfdireland.ie)
- EPA ENVision environmental mapping system
- (http://maps.epa.ie/InternetMapViewer/MapViewer.aspx)
- Towards a New Era for the Owenmore. A Fisheries Catchment Management Plan for the Owenmore River System, County Mayo, North Western Regional Fisheries Board (now Inland Fisheries Ireland Western River Basin District)
- A physical, chemical and biological assessment of fluvial habitat draining the Oweninny Peatlands, North Mayo with reference to peat siltation, Inland Fisheries Ireland, December 2012
- Mapping of the Distribution of Margaritifera margaritifera. in the River Deel (Moy Catchment), Co. Mayo. October 2009, A report for Department of the Environment, Heritage & Local Government by Moorkens and McKellen
- A Fisheries Survey of the Upper Owenmore River, Co. Mayo, in the vicinity of a the proposed wind farm, AQUAFACT, September 2012
- Aquatic ecological assessment of streams in the proposed wind farm area, Aquafact, April 2013

Each of the project components have been assessed for potential impact on water quality and mitigation identified.

10.2.1 Electrofishing

The requirement for electrofishing of waters which could be affected by the proposed wind farm development was discussed on site with Inland Fisheries Ireland. Following on from this discussion a semi-quantitative electric fishing survey of the locally named Sheskin Stream, upper Oweninny river and on the Owenmore River, Co. Mayo, was carried out on the 29th and 30th July 2012. A total of four sites were electrofished using generator powered equipment energising a single anode. The locations of the fish assessment sites are shown in Figure 10-3 and coordinates are provided in Table 10.1.

Site 1: (30th July 2012) was a river section on the Sheskin Stream immediately downstream from a Bord na Móna access bridge. The river width averaged 8m and the study section was 45m long. Water depth varied from 10-70cm and the reach was a mixture of riffle, glide and pool habitat. The river substrate comprised stones, gravel and some silt and there was also some submerged vegetation at this site.

Plate 10-1: Electrofishing Site 1

Site 2: (30th July 2012) was a river section 18m wide and 22m long. The river banks were relatively high and the electrofishing equipment was positioned on the left bank. Water depths varied from 20-60cm and the substrate comprised stones and boulders with some gravel. The site was mainly a glide with a limited amount of riffle habitat. The site was located about 100m upstream from a Bord na Móna access bridge on the Oweninny River.

Plate 10-2: Electrofishing Site 2

Site 3: (29th July 2012) was a river section with riffle habitat on the Oweninny River which was 15-25m wide. A 45m long by 5m wide section along the right bank was electrofished. Water depth varied from 10-40cm and the substrate was predominantly gravel with some boulders covered in moss. The channel was open and there was also cattle access to the river at this site.

Plate 10-3: Electrofishing Site 3

Site 4: (29th July 2012) was a 30m wide riffle section on the Owenmore River where the presence of an island made survey work possible. Water depth was 10-40cm and the substrate comprised gravel and stones. A 50m long and 5m wide corridor along the right bank (looking downstream) was selected for study.

Plate 10-4: Electrofishing Site 4

Table 10.1: Location co-ordinates semi quantitative electrofishing.

Site	ITM	
	Easting	Northing
1	497599	824026
2	497674	822766
3	497405	829700
4	494262	821035

A portable generator powered bankside electric fishing machine (ELPB2 manufactured by Smith-Root Europe (www.smith-root.com) in Ireland), was used to capture fish. This equipment was powered by a Honda EU20i generator modified for electric fishing and produced an output of 0-400v, square wave pulsed direct current and smooth direct current. On 29th July 2012, water conductivity at site 4 was measured at 123 µS cm-1. In this instance the peak output voltage was set at approximately 380v and the peak output current was approximately 3amps. Pulsed DC was used at 40Hz (40 pulses per second) and at a 20% duty cycle. Electric fishing was carried out in an upstream direction using a 1.7m long anode pole with a 30cm diameter stainless steel anode (positive electrode) ring. There was 50m of cable on the anode. The cathode (negative electrode) had 5m cable and 3m tinned copper braid which was deployed in the stream adjacent to the generator / control box and transformer. Fish attracted to the anode were removed from the water by a second operator using a dip net with a non-conductive handle. The second operator also carried a bucket for holding fish. It was not possible to deploy stop nets because of water conditions. At sites 2, 3 and 4 two timed fishing runs were carried out while at site 1 only a single timed fishing run was carried out due to the occurrence of heavy rainfall. The catch was then related to the area fished and the duration of fishing. This semi-quantitative approach to electric fishing is now favoured by many fishery workers who regard electric fishing as a relative method of describing fish populations rather than an absolute method. For example, the Scottish Fisheries Coordination Centre (SFCC) now bases its information on fish populations on electric fishing first run data. Captured fish were anaesthetised using 2-phenoxyethanol and fork lengths were measured to the nearest millimetre. All fish were released back into the river after recovery from anesthesia.

Table 10.2 details the duration of run 1 and run 2 fishing times at each site studied.

Table 10.2: Duration of electrofishing times at each site studied

Site	Length m	Width m	Area m^2	Fishing Time (min) Run 1	Run 2	Combined
1	45	8	360	35	0	35
2	22	18	396	27	23	50
3	45	5	225	35	30	65
4	50	5	250	30	30	60

Site	Length m	Width m	Area m^2	Fishing Time (min) Run 1	Run 2	Combined
Totals			1,231	127	83	210

10.2.2 Stream Invertebrate Sampling

Sampling was carried out on the 22nd January 2013. Seven sites were selected for this assessment in the Sruffaunnamuingabatia River (Station 1), Muing River (Station 2), Eskeragh Bridge (Fiddauntooghaun River which is a tributary of the Shanvolahan River), (Station 3), Shanvolahan River (Station 4), the Fiddaunmuing River (Stations 5 and 6) and the Fiddaunoran River (Station 7). The last two streams are tributaries of the Owenmore/Cloonaghmore River which enters the sea northwest of Killala.

The two-minute kick sampling method was employed to collect samples of macroinvertebrates for analysis. This involved placing a standard hand net of pore size 500µm in the river, facing upstream and disturbing the river bed in front of the net mouth. The sampler then moved in a diagonal direction upstream to ensure that different micro-habitats were included in the sample. The kick method dislodges macroinvertebrates from the substrates and submerged plant material. This was continued for approximately two minutes and the resulting sample was transferred from the net to a plastic bucket and fixed using a 70% ethanol solution.

The samples were then transported to the AQUAFACT laboratories where the macro invertebrates were removed and identified using stereoscopic microscopes and the appropriate keys (see references) by a qualified freshwater taxonomist. The resulting species list was then used to assign a Biotic Index value (Q-Value) to the sampled streams.

One sample was also taken at Lough Dahybaun for water chemistry analysis. Table *10.3* shows the location co-ordinates of where the kick-sampling was carried out, along with the Lough Dahybaun site.

Table 10.3: Location co-ordinates for kick-sampling stations and water sampling site in Lough Dahybaun.

Station	Water body	ITM Easting	ITM Northing
1	Sruffaunnamuinggabatia	499690	823850
2	Muing	497752	819841
3	Fiddaunatooghaun	503870	818876
4	Shanvolahan	504275	819821
5	Fiddaunnamuing	505035	821364
6	Fiddaunnamuing	507466	822041
7	Fiddaunoran	507361	823853

Station	Water body	ITM Easting	ITM Northing
L. Dahybaun	Lough Dahybaun	500346	819458

Fast flowing stretches of the river or riffles were selected as these are typically the best aerated and contain the most pollution-sensitive macroinvertebrates. Where riffle zones were not available, a steady-flowing and sometimes deeper glide section of the stream was sampled.

10.2.3 Biological Water Quality Assessment Criteria

The Biological River Quality Classification System (Q-Scheme) has been in use in Ireland since 1971. It has undergone a number of modifications since then and has been included in the Water Framework Directive river surveillance and operational monitoring programme.

For the purpose of this assessment, now carried out routinely by the EPA, benthic invertebrates have been divided into five indicator groups according to tolerance of pollution, particularly organic pollution. In order to determine the biological quality of the river, the Q-scheme index is used whereby the analyst assigns a Biotic Index value (Q-Value) based on macro invertebrate results. The Biotic Index is a quality measurement for freshwater bodies that range from Q1 - Q5 with Q1 being of poorest quality and Q5 being pristine/ unpolluted. The criteria presented in Table 10.4 were used in the assessment of ecological water quality.

Table 10.4: Biotic Index of Water Quality

Biotic Index	EPA Water Quality	WFD Ecological Status
Q5	Good	High
Q4-5	Fair - Good	High
Q4	Fair	Good
Q3-4	Doubtful - Fair	Moderate
Q3	Doubtful	Poor
Q2-3	Poor - Doubtful	Poor
Q2	Poor	Bad
Q1-2	Bad - Poor	Bad
Q1	Bad	Bad

10.3 RECEIVING ENVIRONMENT

10.3.1 General Catchment Information

Tributary rivers, the Inagh, Alterderg, Fiddaunfrankagh and Glenora Rivers rise on the southern slopes of the Maumkeogh Mountains and drain southwards, joining to become the Oweninny River which gives the site its name. The Oweninny River drains the central part of the site. The Oweninny River is fed by the Srahmeen River and Knockmoyle Stream from the west and by numerous small tributary streams from the east (Fiddaungal, Fiddaunnaglogh, Fiddaunnameenabane, Fiddauncam and the Fiddaunnamuinggeery) before entering the Oweninny wind farm site. The Oweninny is joined by the Sheskin Steam which drains the forested south-eastern slopes of Slieve Fyagh and also forms the site's internal boundary with the O'Boyles Bog area. The Oweninny and the Fiddaunnamuingeery form part of the site boundary. The Sruffaunnamuingabatia, which drains the Bellacorick Iron Flush SAC area within the site, flows westwards and joins the Oweninny River. The Oweninny is also joined by the Muing River which drains Lough Dahybaun within the site. The Owenmore drains a catchment of approximately 332 km^2 before entering the sea at Tullaghan Bay. The Oweninny flows southwards, externally to the site and effectively dividing the site in two before joining the Owenmore turning westwards after Bellacorick Bridge and paralleling the N59. The Owenmore is joined at this location by the Altnabrocky River flowing northwards from the Nephin Mountains. Phase 1 and Phase 2 of the proposed development are situated within this Owenmore (Oweninny) catchment.

The north-eastern part of the site is drained by small tributaries (Fiddaunfura) which rise in Shanvodinnaun and flow eastwards to the main easterly flowing river, also named the Owenmore. This river rises in the townlands of Cluddaun and Shanetra to the north of the site before flowing eastwards becoming the Cloonaghmore River before entering the sea at Rathfran Bay which is within Killala Bay. It is also referred to as the Palmerstown River. The Cloonaghmore River drains a catchment of approximately 132 km^2 before entering the sea at Rathfran Bay.

The south-eastern part of the site drains to tributaries of the Shanvolahan River (Fiddaunagosty, Shanvolahan and Fiddauntooghaun) before entering the Deel River which drains to Lough Conn and eventually joins the River Moy at Ballina before entering the sea at Killala Bay. The River Moy drains a catchment of approximately 1,966 km^2 before entering the sea at Killala Bay. The area of the Shavolahan catchment before it enters the Deel River is approximately 23.7 km^2.

The upper catchments of these rivers could potentially be impacted by the wind farm development through loss of materials leading to increased suspended solids and sedimentation on river beds and entry of pollutants such as oils and waste debris entering watercourses.

10.3.2 Inland Fisheries Ireland – Oweninny Report 2012

In response to the historic impact of peat silt loss to the rivers draining the Oweninny bog area following more than 40 years of industrial milled peat production and the control measures introduced by Bord na Móna, a comprehensive study of the impacts and effectiveness of these measures was undertaken by staff of the former North Western

Regional and Central Fisheries Board (now Inland Fisheries Ireland (IFI)) between 2005 and 2008. The study, funded by Bord na Móna, assessed the freshwater fisheries habitat in the Owenmore, Deel and Cloonaghmore upper catchments[100].

Biological investigations included fish stock assessment, salmon ova mortality studies and floral and invertebrate analyses. Water chemistry was also reviewed and an assessment of the degree of peat siltation on salmonid spawning habitat due to peat harvesting activities made. The study also endeavoured to validate and monitor the anticipated reduction in peat silt export due to the peatland rehabilitation efforts undertaken by Bord na Móna. This latter objective was considered important for stakeholder confidence in the Bord na Móna rehabilitation plan, including the proposal to decommission the silt pond network servicing the worked bog area over time.

The key conclusions of the study were as follows:

- Peat silt discharges from the Oweninny catchment in the last decade of active peat production were generally recognised as being substantially reduced relative to the quantities that were historically observed prior to and during the 1980s. This is attributed to a programme of staff training, improvements in the number and type of peat settlement ponds installed by Bord na Móna and investment in equipment to enable more effective and timely management of these.
- Additional sediment control was introduced by Bord na Móna on foot of the Integrated Pollution Prevention Control Licence (IPPC Licence) granted by the Environmental Protection Agency (EPA) up to the time that peat harvesting ceased on the site, which led to further reductions in sediment loss from the site.
- The major rehabilitation of the bog production fields initiated in 2003 and substantially completed by 2005 included drain blocking or plugging, effectively reducing water table fluctuations and rewetting the production area. This led to an observed substantial visual reduction in the sedimentation of peat silt deposits during the 2006 angling season in the Owenmore River.
- Statistically significant and large reductions in sedimented peat were recorded at two of the historically most heavily impacted sites, at Sheskin and in the

[100] Kennedy Bryan, McLoughlin Derek and Caffrey Joe, A physical, chemical and biological assessment of fluvial habitat draining the Oweninny Peatlands, North Mayo with reference to peat siltation, Inland Fisheries Ireland, Swords Business Campus, Swords, Co. Dublin, 2012

upper Cloonaghmore River at Doobehy which have been attributed to the Bord na Móna rehabilitation plans. Further reductions at other sites were observed including the Oweninny (Junction) and at Cloonaghmore (Correens).

- Decommissioning of the silt pond network over the peatland area has continued, in consultation with NWRFB Inspectors, since 2008.

The study clearly indicated the effectiveness of the control measures introduced for sediment loss from the site and stated that;

> *"The rehabilitation plan implemented by Bord na Mona must be acknowledged for its overall effectiveness and for the relatively short interval before large reductions in the export of peat silt to adjacent watercourses was evident".*

The report also recommended actions going forward to build on the success to date and ensure continued reduction in sediment loss from the site as follows:

- an annual inspection of silt ponds should be undertaken where the competence or stability of the pond is suspected, or where ponds are susceptible to erosion due to their proximity to watercourses.
- the possibility of creating vegetation buffer zones under the Native Woodland Scheme at natural low points should be examined.
- Sections of the riparian area along the Muing River bank have also been periodically maintained, or cleared, by Bord na Móna from the silt pond to several hundred metres upstream of it. This involves removal of the bankside material and vegetation leading to a loss of overhanging cover for fish. A review of the bank clearing exercises along the Muing River should be undertaken.
- The proposed Oweninny wind farm development will not lead to any significant increase in the level of existing peat silt loss to the rivers draining the site. A drainage and sediment control plan will be implemented for the site which integrates into the existing Bord na Móna sediment control measures (see Chapter 19). Settlement lagoons followed by overland flow will be provided at each turbine and substation building and also at the batching plant, borrow pit , Visitor Centre and O&M building locations. There will be no direct discharge to the existing river system within the site from construction activities associated with the wind farm development.

10.3.3 Fishery Value

The importance of the fisheries in the Oweninny catchment to Inland Fisheries Ireland – Western River Basin District is described in a number of publications including in their report discussed in Section 10.3.2 above which states as follows:

> *"The rivers are important salmon and trout fisheries for both local and tourist anglers and are also valuable property rights. The Owenmore River is a renowned salmon and sea-trout fishery, mostly in private ownership. Bord na Mona is the fishery owners on the Oweninny River, its principal tributary, and the Central Fisheries Board has a minor interest in this river and in Lough Dahybaun whose*

rights are also vested, in part, in Bord na Mona. A comprehensive breakdown of the ownership rights on the Owenmore is contained in the fisheries catchment management plan (NWRFB 2003[101]). The fishery rights on the Cloonaghmore River are vested in the State and traditionally this was a prized river for sea trout, with a late summer grilse run in September. The Shanvolahan River was, at one stage, an important spawning and nursery area for salmon and trout. It drains into the Deel River which is a spring salmon, grilse and brown trout fishery, and is the most significant tributary of Lough Conn and of the wider Moy catchment."

The fisheries value of the Owenmore River flowing through Bangor Erris is also highlighted in the Fisheries Catchment Management Plan prepared by the Northwestern Regional Fisheries Board in 2003 which indicated that:

"Native Irish fish species recorded in the catchment included the Atlantic Salmon (Salmo salar), the Brown trout and Sea trout (Salmo trutta), the Three-spined stickleback (Gasterosteus aculeatus) and the European Eel (Anguilla anguilla). Unconfirmed reports of migratory lampreys, from a lower section of the Owenmore River, predate the 1950's. Recent electro fishing operations have recorded the presence of another lamprey species in various locations Introduced species are limited to the Minnow (Phoxinus phoxinus) and the catchment is ecologically significant due to the absence of any of the other exotic introductions e.g. Pike, Perch, Loaches or Cyprinids that are now widespread elsewhere."

The Mayo Angling Guide 2012[102], published by Inland Fisheries Ireland provides a brief description of the Owenmore, Oweninny, Deel and Cloonaghmore (Palmerstown) River fisheries which are summarised as follows:

- **Owenmore:** Much of the water is held by various syndicates with about 6.5 km near Bangor Erris leased by the Bangor Angling Club. The river is characteristically wild, with riffles glides and deep pools providing good fishing with generally clear banks to facilitate angling. The Owenmore tends to fish best during the run-off of a spate event. It receives a small run of spring salmon with a prolific run of grilse in mid-summer and fishes well from July on to end September. It receives a good run of sea trout from mid-summer also.
- Oweninny: The major tributary of the Owenmore is the Oweninny, which is a small wild spate river only producing good angling on a dropping spate. Ownership of the lower section is very fragmented but fishing rights are state

[101] Towards a New Era for the Owenmore, North Western Regional Fisheries Board, 2003

[102] County Mayo Game Angling Guide, published by Inland Fisheries Ireland, 2012

owned in the townlands of Srahmeen, Knockmoyle and Laghtanvack from an area 300m upstream of the confluence of the Oweninny and Sheskin Streams for around 8.5 km to its confluence with the Srahmeen River. This section is described as rugged and wild and suitable only for the more adventurous anglers.

- River Deel: The River Deel rises high in the Nephin Beg mountains before flowing 45km through moorland and pastures, through the town of Crossmolina, before entering the northern end of Lough Conn. It is the largest of the Moy tributaries and offers a wide variety of angling experiences ranging from dry fly fishing for trout to salmon fishing in the lower reaches.
- Cloonaghmore (Palmerstown) River: Once famed for its sea trout fishery it now receives only a moderate run which is more prolific towards the end of the season (October). It holds a resident stock of small brown trout, and is currently closed for salmon angling as a conservation measure.
- The game fishery associated with the rivers draining Oweninny is an important local resource used by angling clubs and by fishing tourists attracted to the area. It is important that this fishery resource be protected during all phases of the Oweninny wind farm development.

10.3.4 Electrofishing surveys

10.3.4.1 Inland Fisheries Ireland Surveys

Inland Fisheries Ireland undertake fish stock surveys on river sites throughout Ireland as part of the fish sampling programme for the Water Framework Directive (WFD). Fish sampling is required by both national and European law, with Annex V of the WFD stipulating that rivers are included within the monitoring programme and that the composition, abundance and age structure of fish fauna are examined. IFI fish assessments are reported on http://wfdfish.ie/. As part of this surveillance monitoring programme fish monitoring has been undertaken on the Deel River at Crossmolina in the past, 2008[103] and 2012[104]. In 2008, six fish species were recorded of which roach was the most common. Species included salmon *Salmo salar,* brown trout *Salmo trutta*, eel *Anguilla anguilla,* lamprey*,* roach *Rutilus rutilus,* perch *Perca fluviatilis* and pike *Esox lucius.* In 2012 the preliminary report indicates the presence of salmon, eel, lamprey,

103 Central and Regional Fisheries Board, Sampling Fish for the Water Framework Directive 2008,

104 Inland Fisheries Ireland, Preliminary Synopsis of WFD Surveillance Monitoring Fish Stock Surveys at River Sites in the Western River Basin District, May/July 2012

roach and pike. Brown trout was not recorded. Roach and Perch were again abundant at the site.

10.3.4.2 Electrofishing survey

The project aquatic ecologists AQUAFACT carried out an electrofishing survey at sites agreed with IFI in 2012. The fish species detected during the electrofishing survey are similar to those described in IFI reports and are presented in Table 10-5

Salmon predominated in the catch. Very low numbers of brown trout (Salmo *trutta* L.) were recorded during the survey and only at sites 1 and 4. Brook lamprey (*Lampetra planeri* Bloch) were recorded at three of the four sites studied. A solitary European eel (*Anguilla anguilla* (L.)) was recorded at site 2. A solitary Minnow (*Phoxinus phoxinus L.*) and several Three-spined stickleback (*Gasterosteus aculeata L.*) were also recorded.

While this was essentially a semi-quantitative survey, first and second run fishings were attempted at sites 2, 3 and 4. This was done for two reasons. The river was wide for single anode electrofishing and the opportunity was taken to increase the catch and also see if depletion could be achieved. The overall catch of salmon at sites 2, 3 and 4 was increased but significant depletion was not achieved suggesting that capture efficiency was under 50% at each site where a second run was attempted see Table 10.6.

Table 10.5: Results of the electrofishing survey – Sheskin, Oweninny and Owenmore River.

Site	Salmon		Trout		Minnow		Brook lamprey		Eel		Three spined stickleback	
	Run		Run		Run		Run		Run		Run	
	1	2	1	2	1	2	1	2	1	2	1	2
1*	191	-	9	-	-	-	2	-	1	-	7	-
2	72	83	0	0	0	0	5	5	0	0	2	2
3	165	115	0	0	0	1	1	1	0	0	0	0
4	102	75	3	2	0	0	0	0	0	0	0	0
Totals	530	273	12	2	0	1	8	6	1	0	9	2

** Second fishing run not undertaken at Location 1 as a single fishing run in this narrow river was deemed sufficient for evaluation purposes.*

Table 10.6: Salmon capture rates, minimum density estimates and capture rates per m² per min, separate calculations for first run and second run fishings.

Site	Run 1			Run 2		
	Salmon/min	Salmon/m^2	Salmon/^{m2}/min	Salmon/min	Salmon/m^2	Salmon/m^2/min
1	5.46	0.53	0.10	-	-	-
2	2.67	0.18	0.07	3.61	0.21	0.06
3	4.71	0.73	0.16	3.83	0.51	0.13
4	3.40	0.41	0.12	2.50	0.30	0.12

The length frequency distributions of salmon captured during the survey are shown in Plate 10-5 and Table 10.7.

.At sites 3 and 4, there was no clear fork length demarcation between 0+ and older salmon parr. At sites 1 and 2 there was a clear fork length demarcation. Based on fork length measurement alone there are only two fish in the 6.5-6.9cm length group that could be assigned to either the 0+ or older salmon groups and both these fish were captured at site 4.

Table 10.7: Length frequency distributions of salmon captured at each site (>0+ salmon highlighted in red).

Forklength (cm)	Site 1	Site 2		Site 3		Site 4		All sites
	Run 1	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	
3	1	-	-	-	1	1	1	4
3.5	11	6	7	6	8	3	4	45
4	41	18	15	28	23	18	14	157
4.5	49	10	19	51	30	26	26	211
5	40	24	26	37	26	28	20	201
5.5	7	2	6	17	13	2	2	49
6	2	-	-	3	2	1	1	9
6.5	-	-	-	1	-	1	-	2
7	2	-	-	1	-	1	1	5
7.5	4	2	2	3	1	3	-	15
8	5	3	2	3	1	5	-	19
8.5	9	5	5	6	2	2	4	33
9	5	-	-	4	3	6	-	18
9.5	7	2	-	2	1	4	-	16
10	4	-	-	-	3	1	-	8
10.5	1	-	1	1	-	-	-	3
11	1	-	-	1	-	-	1	3
11.5	2	-	-	-	1	-	1	4
12	-	-	-	-	-	-	-	0
12.5	-	-	-	1	-	-	-	1
Totals	191	72	83	165	115	102	75	803

Note: Blank cells indicates no fork length of that size recorded

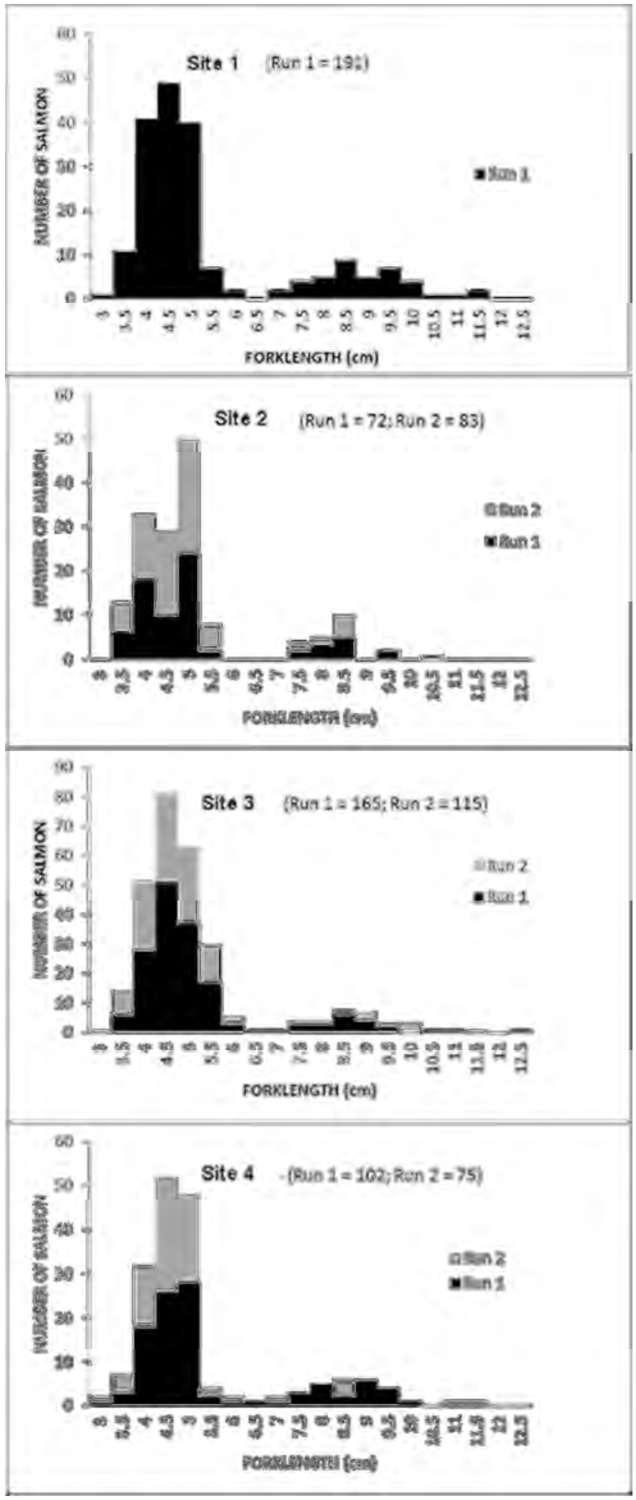

Plate 10-5: Length frequency distributions of salmon captured at each site and during each fishing run in the case of sites 2, 3 and 4.

The length frequency distributions of salmon captured during runs 1 and 2 at sites 2, 3 and 4 were similar and there is no evidence that larger salmon were captured during the first run. The attempt to achieve a significant depletion at sites 3 and 4, where 5m wide corridors along the right bank were electrofished was unsuccessful. When the salmon catches from the first and second runs are combined for sites 2, 3 and 4 the minimum estimated densities of salmon per square metre at these sites are 0.71, 1.24 and 0.39, respectively.

These statistics are quite high for semi-quantitative electrofishing. It should be noted that the survey work was carried out at the end of July in a particularly wet and therefore favourable year for 0+ salmon survival. Had the survey work been carried out at the end of September the estimated density of salmon (particularly 0+ fish) would have been much lower.

A very small number of brown trout (n=14) were encountered during the survey. Table 10.8 details the length frequency of trout captured. The three fish in the 6cm length groups are 0+ fish and the remainder are probably 1+ fish, though no scale samples were collected to verify this.

Table 10.8: Length frequency distribution of brown trout captured at all sites during the survey.

Forklength (cm)	Number	Forklength (cm)	Number
6	2	12	2
6.5	1	12.5	1
7		13	
7.5		13.5	2
8		14	
8.5		14.5	
9		15	1
9.5		15.5	1
10		16	1
10.5		16.5	

Forklength (cm)	Number	Forklength (cm)	Number
11	1	17	1
11.5	1	17.5	
		Total	14

10.3.5 Electrofishing Summary

In the context of fisheries survey work, catch - effort sampling is standard practice as the costs associated with the determination of absolute densities of fish are significantly higher in terms of manpower and time spent surveying when compared with the semi-quantitative approach taken during this survey. Other workers (Strange *et al*. 1989[105]; Crozier & Kennedy 1994[106]) have compared the results of semi-quantitative electric fishing results with those obtained using quantitative methods and found that the results of the semi-quantitative approach were meaningful in the context of results obtained by using quantitative methods.

The results of the survey show that juvenile Atlantic salmon are abundant at all sites studied and this finding is in keeping with the catchment-wide assessment of the conservation status of salmon in the Owenmore River made by the Standing Scientific Committee (Anon., 2010)[107].

The widespread occurrence of brook lamprey recorded during the survey suggests that, had lamprey habitat been targeted during the survey, high densities may have been recorded.

The paucity of juvenile brown trout at the sites studied is not easily explained. Sites 3 and 4 were riffle habitat which was particularly suited to salmon. However, sites 1 and 2 would have been expected to support more trout as these sites contained glide and some pool habitat. It is possible that the success of salmon in the catchment may be at

[105] Strange, C.D., Aprahamian, M.W. & Winstone, A.J. (1989). Assessment of a semi-quantitative electric fishing sampling technique for juvenile Atlantic salmon, *Salmo salar* L., and trout, *Salmo trutta* L., in small streams. *Aquaculture and Fisheries*

[106] Crozier, W.W. & Kennedy, G.J.A. (1994). Application of semi-quantitative electrofishing to juvenile salmonid stock surveys. *Journal of Fish Biology*, 45, 159-164.

[107] Report of the Standing Scientific Committee on the status of Irish salmon stocks in 2009 and precautionary catch advice for 2010 & Appendix VI – Owenmore River p160.

the expense of brown trout at those locations where both species are competing for spawning and nursery habitat.

10.3.6 EPA Biological analyses.

The Environmental Protection Agency carries out biological water quality assessments on a rolling three year basis at river sites in Ireland as part of the Water Framework Directive river monitoring programme. The biological quality data collected is used in the status assignment of river water bodies in conjunction with other water quality parameters. EPA biological monitoring data for the rivers draining the Oweninny site were obtained from the EPA geoportal website (http://gis.epa.ie/DataDownload.aspx) and is presented in Table 10.9. The EPA site locations are shown on Figure 10-4.

The EPA assessment indicates that water quality in the rivers draining the Oweninny site is generally of good to high status. The more recent EPA survey (2011) of the Owenmore River flowing through Bangor Erris indicates the status as high at most locations with one location at good (south east of Srahnakilly). The Muing River is rated as Moderate (2008) indicating some anthropogenic impact on this river. This has been attributed to peat harvesting impacts by the EPA [108]. The north-easterly flowing Owenmore (Cloonaghmore/Palmerstown) River is also assessed as being at good status (2010) along its length. The Deel River was also assessed as good to high at locations along its length. Tributaries of the main rivers such as the Duvowen on the Cloonaghmore and the Fiddauntooghaun and Shanvolahan on the Deel are also generally of good to high water quality status with the exception of one location just above the confluence of the Shanvolahan and Deel rivers.

[108] EPA, Integrated water Quality Report, Galway , Mayo and Sligo 2011, published 2012

Table 10.9: EPA Biological Monitoring Data

Site Code	Station name	River	LAST Year EPA Q value recorded	Q VALUE	River Water Body Status	River Water Body Code
RS33M010100	Just u/s Owenmore River	Muing	2008	4	Good	IE_WE_33_2157
RS33O040050	Br SE Srahnakilly	Owenmore (Oweninny)	2011	4	Good	IE_WE_33_3204
RS33O040090	300 m u/s Bellacorick Bridge	Owenmore (Oweninny)	1990	4-5	High	IE_WE_33_3204
RS33O040100	Bellacorick Bridge	Owenmore (Oweninny)	1990	5	High	IE_WE_33_3204
RS33O040150	1.1 km d/s Bellacorick Br	Owenmore	2005	4-5	High	IE_WE_33_3204
RS33O040250	S. of Tawnaghmore (nr School)	Owenmore	2011	4-5	High	IE_WE_33_3204
RS33O040270	W. of Largan	Owenmore	2011	4-5	High	IE_WE_33_3204
RS33S030150	Bridge 1 km u/s Oweninny R	Owenmore (Sheskin Stream)	2011	4-5	High	IE_WE_33_3204
RS34C030060	Bridge near Lecarrownwaddy	Owenmore/Cloonaghmore	1989	5	High	IE_WE_34_397
RS34C030100	Bridge near Belville	Owenmore/Cloonaghmore	2013	4	Good	IE_WE_34_397
RS34C030150	Ballintober Bridge	Owenmore/Cloonaghmore	2013	4-5	High	IE_WE_34_397
RS34C030200	Tonrehown Bridge	Owenmore/Cloonaghmore	2013	4	Good	IE_WE_34_3976
RS34C030270	1.2 km u/s Palmerstown Br	Cloonaghmore	2013	4	Good	IE_WE_34_3976
RS34C030280	200 m u/s Palmerstown Bridge	Cloonaghmore	1989	4	Good	IE_WE_34_3976
RS34C030310	Palmerstown Bridge (RH side)	Cloonaghmore	1989	4	Good	IBAS_ID WE 291
RS34D010025	Ford S.W. of Knockbrack	Deel	2013	4	Good	IE_WE_34_3896_1
RS34D010050	Ford at Ballymulty	Deel	1984	5	High	IE_WE_34_3896_2

Site Code	Station name	River	LAST Year EPA Q value recorded	Q VALUE	River Water Body Status	River Water Body Code
RS34D010100	Ford E. of Ballycarroon House	Deel	2013	4-5	High	IE_WE_34_3896_3
RS34D010120	Crossmolina Bridge	Deel	2013	4	Good	IE_WE_34_3896_3
RS34D010150	S.E. of Crossmolina	Deel	1993	4	Good	IE_WE_34_3896_3
RS34D010200	800 m d/s Crossmolina Bridge	Deel	2005	4-5	High	IE_WE_34_3896_3
RS34D010250	NW Rectory near old Abbey	Deel	2005	4	Good	IE_WE_34_3896_3
RS34D010300	Knockadangan Bridge	Deel	2013	4-5	High	IE_WE_34_3896_3
RS34D010400	Bridge at Castle Gore	Deel	2013	4-5	High	IE_WE_34_3896_3
RS34D030800	Br u/s Cloonaghmore River	Duvowen River	2013	4	Good	IE_WE_34_2800
RS34F060100	Eskeragh Bridge	Fiddauntooghaun (Deel)	2013	4	Good	IE_WE_34_3820
RS34S010200	E. of Shanvolahan	Shanvolahan	1989	4-5	High	IE_WE_34_228
RS34S010300	Bridge S.W. of Coolturk	Shanvolahan	2010	4	Good	IE_WE_34_448
RS34S010400	Just u/s Deel River confl	Shanvolahan	2013	4	Good	IE_WE_34_1254

10.3.7 Aquafact Biological analyses.

The results of the biological quality Q assessments at seven sites assessed by AQUAFACT are provided in Table 10.10, see Figure 10-5.

When analysed, Stations 1, 2, 5 and 6 were given a biotic index score of Q3-4, indicating that the stretches of river at those locations are slightly polluted. A biotic index score of Q4 to Q3-4 was assigned to stations 3, 4 and 7 indicating that pollution levels were lower.

Table 10.10: Q-value result for each station

Station	Location	Biotic Index Assigned	Quality Status	Approximate Status
1	Sruffaubnnamuigabatia	Q3-4	Slightly Polluted	Moderate
2	Muing River (just upstream Owenmore River)	Q3-4	Slightly Polluted	Moderate
3	Fiddaunnatooghaun (Eskeragh Bridge)	Q4 to Q3-4	Unpolluted/Slightly Polluted	Good
4	Shanvolahan River (east of Shanvolahan)	Q4 to Q3-4	Unpolluted/Slightly Polluted	Good
5	Fiddaunmuing (headwaters)	Q3-4	Slightly Polluted	Moderate
6	Fiddaunmuing (Gortnahurra Lower)	Q3-4	Slightly Polluted	Moderate
7	Fiddaunoran upstream of confluence with the Owenmore	Q4 to Q3-4	Unpolluted/Slightly Polluted	Good

10.3.8 Ecological Importance and Designated areas

As described in detail in Chapter 9, the site abuts the Bellacorick Bog Complex Special Area of Conservation (also a proposed Natural Heritage Area). The potential for impact on the ecology of these areas arising from the wind farm development is discussed in detail in Chapter 9. The rivers draining the eastern (Owenmore/Cloonaghmore) and southeastern (Shanvolahan and Fiddaunatooghaun) parts of the site also flow through the Bellacorick Bog Complex designated areas in these locations. The Shanvolahan is a tributary of the Deel River which supports an important population of *Margaratifera*

margaratifera the freshwater pearl mussel. The population of this protected species was mapped in 2009 by Moorkens and Killeen[109] for the Department of Environment Heritage and Local Government.

The nearest recorded freshwater pearl mussel population is located some 8 km downstream of the Oweninny site boundary, see Figure 10-6. However, there is no hydraulic connectivity between the Phase 1 and Phase 2 part of the Oweninny wind farm development and the Deel River hence there is no potential from impact on the freshwater pearl mussel population located there.

Lough Dahybaun is a special area of conservation partly located within the Oweninny site. It is drained by the Muing River. Results of the analyses on the water sample collected in Lough Dahybaun are shown in

[109] Moorkens E. and Killeen I. Mapping of the distribution of Margaritifera margaratifers in the River Deel (Moy Catchment),Co. Mayo. October 2009, A report for Department of the Environment, Heritage & Local Government

Table 10.11 below. With the exception of ammonium all parameters were less than detectable limits and would comply fully with the high status requirements of chemical parameters set out in the European Communities Environmental Objectives (Surface Waters) Regulations 2009 and the Salmonid water quality standards set out in the regulations of 1988. This is indicative of the pristine nature of this water body. Again, there is no hydraulic connectivity between the proposed works in Phase 1 and Phase 2 of Oweninny wind farm and hence no potential impact on Lough Dahybaun is possible.

Table 10.11. Results of analyses on a sample collected in L. Dahybaun, January, 2013. All values as mg/l.

Parameter	Suspended soils mg/l	Phosphorus	Ammonia	Nitrate	Nitrite
Lough Dahybaun	< 2	<0.01 as PO_4 (<0.003 as mg P/l)	0.022 MG/L as (NH_4) (0.017 mgN/l)	<0.44 MG/L as NO_3 (<0.099 mg N/L)	<0.017 MG/L as NO_2 (<0.005 MG n/L)
European Communities Environmental Objectives (Surface Waters) Regulations 2009	-	High Status < or = to 0.025 mg P/l (mean) Good Status < or = to 0.035 mg P/l (mean)	Total Ammonia High Status < or = to 0.04 mg N/l (mean) Good Status < or = to 0.065 mg N/l (mean)	Dissolved Inorganic Nitrogen High Status (37.5 psu) < or = to 0.17 mgN/l Dissolved Inorganic Nitrogen Good Status (37.5 psu) < or = to 0.25 mgN/l	
Salmonid Water Quality Standards – S.I. No. 293 of 1988	< or = to 25 mg/l	-	< or = to 1 mg/l NH_4	-	< or = to 0.05 mg/l NO_2

Construction within the Lough Dahybaun catchment is limited to one wind turbine, crane hardstand and access tracks, see Figure 10-7.

10.4 POTENTIAL IMPACT OF THE DEVELOPMENT

The potential significant impacts on aquatic ecology are as follows:

- Pollution with suspended solids due to runoff of soil from construction areas.
- Pollution with nutrients due to ground disturbance during construction and impacts of clearfelling c. 36 hectares of the forest plantation.
- Pollution with nutrients due to decomposition of brash after forest clearfelling and from repository area.
- Pollution during construction phase with substances such as fuels, lubricants, waste concrete, waste water from site toilet and wash facilities, etc.
- Pollution with surface drainage water from paved areas and track surfaces during operation.
- Hydrological impact due to changes in the flow rates of streams/rivers
- Pollution with suspended solids through surface drainage water from peat repository.

- Permanent loss of habitat due to culverting or bank/stream alteration.
- Obstruction to upstream movement of aquatic fauna due to culverting.

10.4.1 Construction Phase Impacts Pollution of Streams with Suspended Solids

In the absence of adequate mitigation, suspended sediment due to runoff of soil from construction areas, forestry clearance operations or due to disturbance of fine sub-surface sediments can have negative impacts on invertebrate and plant life and on all life stages of salmonid fish.

The proposed development site has varying levels of peat cover ranging from 0.0 m to 3.0 m over glacial deposits which are also evident across the site. The possibility of erosion and loss of sediment to the aquatic environment during construction arising from the disturbance of these areas or removal of vegetation could generate suspended solids giving rise to the following potential impacts:

- Suspended sediment can settle on spawning areas, infill the intra-gravel voids and smother the eggs and alevins (newly hatched fish) in the gravel.
- Bed load (coarse material transported along the bottom of a stream) and settled sediments can infill pools and riffles, reducing the availability and quality of rearing habitat for fish.
- Suspended sediment can reduce water clarity and visibility in a stream, impairing the ability of fish to find food items.
- Settled sediments can smother and displace aquatic organisms such as macroinvertebrates, reducing the amount of food items available to fish.
- Increased levels of sediment can displace fish from prime habitat into less suitable areas.
- Suspended solids can abrade or clog the gills of salmonid fish. It takes a high concentration of solid wastes to clog a fish gill and cause asphyxiation, but only a little to cause abrasions and thus permit the possibility of infections.
- Bog failure/slippage, which could result in a major impact on the receiving waters, including extensive fish kills and loss of other aquatic flora and fauna, is addressed in the peat stability risk assessment report in Appendix 4.

Therefore, the contamination of water courses with suspended solids is a potentially significant impact of the proposed development and would be classified as a moderate/major potential impact on all potentially affected streams should the impact manifest.

10.4.2 Pollution with Nutrients Decomposition of Brash after Forestry Clearfelling

Decaying brash, generated from forest plantation clearfell has the potential to release nutrients such as phosphorous into surface runoff where felling occurs on peat soils which have limited absorption capacity for phosphorous.

> *"Any organic matter (particularly recently dead material such as brash or roots) that is left on site to rot will release phosphorus and nitrogen. The*

breakdown of brash, roots and other organic matter takes a number of years. Potentially, therefore, a clearfell site may continue to release phosphorus to the aquatic zone for at least three years after clearfelling. The rate of decomposition is influenced by temperature, moisture and humidity. Consequently, phosphorus loss tends to be greatest during the warmer months and may be particularly problematic during a flood event following a prolonged hot and dry period." (Forest Service 2008[110]).

Felling of the commercial forest plantation within the Oweninny site boundary is planned in a scheduled manner over a number of years (see Chapter 15), regardless of whether the wind farm is developed or not. The required clearfelling for Oweninny wind farm Phase1 and Phase 2 will require a clearfell of 1.05ha which will add insignificantly to the environmental impact that would arise from the normal forestry operations on the commercial plantations within the site.

In Ireland, it is now recognised that a significant potential source of nutrient leaching to receiving waters from forestry on peat comes via decaying organic matter, including the foliage and branches, unwanted stems, stumps and dead roots, left on site after crop thinning or felling which are added to the soil at the same time that nutrient uptake is reduced. (Hutton et al 2008[111]; Kennedy 2005[112]; Campbell & Foy 2008[113]; Rogers *et al*., 2008[114]). Dr Martin McGarrigle of EPA indicates that standing crop of 20 kg/ha phosphorus in brash may have loss rates "similar to intensive farmland with just 10% loss per annum" (McGarrigle, 2008[115]).

[110] Forest Service (2008) Forestry and Freshwater Pearl Mussel Requirements Site Assessment and Mitigation Measures. Department of Agriculture, Fisheries and Food

[111] Hutton S.A., Harrison S.S.C.& O'Halloran J. (2008) An evaluation of the role of forests and forest practices in the eutrophication and sedimentation of receiving waters. Western River Basin District Project

[112] Kennedy, N. (2005) An examination of the causes and factors related to the recent eutrophication of Carrowmore Lake. North Western Regional Fisheries Board.

[113] Campbell, E. & Foy, B. (2008) Lough Melvin Catchment Management Plan. Northern Regional Fisheries Board

[114] Rogers *et al* (2008) EPA STRIVE Programme 2007–2013 Quantification of Erosion and Phosphorus Release from a Peat Soil Forest Catchment (2000-LS-3.2.4-M2)

[115] McGarrigle, M. (2008) Agricultural Phosphorus Losses to Water – A Review. EPA, Castlebar National Water Conference, Galway, 11-12 June 2008 www.epa.ie

In a study of a peat soil forest catchment in the Burrishoole River system Rodgers *et al.* (2008[114]) stated that: "*Significant increases in P concentrations and loads were observed at the downstream station after clearfelling and harvesting compared with the P concentrations and loads at the upstream station. Phosphorus load release rates were 2,243.9 g TRP/ha per year in the harvested catchment and 20 g TRP/ha per year in the undisturbed forest catchment*." Whereas the study did not quantify the contribution that different aspects of the forestry operation made to the elevated phosphorus figures, it is clear that decomposition of brash was regarded as a significant contributor in the Burrishoole study.

In contrast the PEnrich study prepared for the EPA for COFORD which focused on the Ballinagee forest plantation and nutrient losses post clearfelling, found low levels of phosphorous in the receiving waters despite the forest plantation being located on blanket peat. "The most striking result of the study was the absence of any significant detrimental influence of forestry or forest operations on phosphorus concentrations or transported phosphorus in surface waters in the Ballinagee River catchment." (Machava *et al.,* 2007[116]) It was believed that this may have been due to a lowering of the water table due to improved drainage and reduced surface runoff, so much so that the water table was below the zone of P in the soil and hence resulted in no leaching of P.

Clearfelling of 1.05 ha of commercial forests will be carried out to facilitate Phase 1 and Phase 2 of the wind farm construction. This felling will occur as a linear section to facilitate access track development. A full description of forestry at Oweninny is provided in Chapter 15.

Due to the small area of forest plantation to be felled there will be no significant predicted impact on water quality. Pollution with Nutrients Decomposition of Brash in Repository Areas

As a very small area of forest plantation will be felled for the development of Phase 1 and Phase 2 only a small quantity of brash will be deposited in the peat depository.

The repository is located in the general catchment area of the Sruffaunnamuingabatia River and Oweninny River. Drainage from the repository area will be directed to settlement ponds with subsequent overland flow. There will be no direct hydraulic connectivity to any receiving waters. The repository is founded on mineral soil beneath

[116] Machava Ján, McCabe Olive, O'Dea,Philip, Cabral Raquel and Farrell, Edward P, Forest Ecosystems Research Group, University College Dublin, Forestry Operations and Eutrophication – PEnrich. (2000-LS-3.2.2-M2), Synthesis Report,

the thin peat layer. Boreholes, to a depth of 20m, undertaken in the repository area as part of the development of the existing Bellacorick wind farm development indicate very shallow peat (either zero or less than 0.3m) with a minimum of approximately 3m of silty sand and gravel below the peat layer and then boulder clay. No bedrock was encountered.

In contrast to peat, mineral soil has a higher absorption capacity for phosphorus due principally to the naturally high concentrations of free iron and aluminium oxides and hydrous oxides in the soil (Sharpley 1995[117], Morgan, 1997[118]; Daly *et al.,* 2000[119]). In a literature review on forest and water eutrophication undertaken for the Water Framework Directive Programme of Measures[120], the authors indicated that

> *"In general, acid mineral soils will tend to immobilise P, while peaty soils, with their very low concentrations of Fe and Al, will tend to leach P"*

The literature survey also states that

> *"…… phosphorus transport in groundwater is generally ignored in catchment studies and monitoring programmes, due to the high P-retention properties of mineral soil."*

It also references a study of forest harvesting on mineral soil (Renou & Cummins, 2002[121]) which indicated that

> *"…. phosphorus leached through the low-sorption organic forest litter layer but was retained by the upper layers of the mineral soil and did not leave the site."*

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[117] Sharpley, A.N. 1995. Identifying sites vulnerable to phosphorus losses in agricultural runoff. *Journal of Environmental Quality*, **24**: 947–951.

[118] Morgan, M.A. 1997. The behaviour of soil and fertiliser phosphorus. In H. Tunney, O.T. Carton, P.C. Brookes and A.E. Johnston (eds.) *Phosphorus Loss from Soil to Water*. CAB International, Wallingford, UK, pp. 137–149.

[119] Daly, K., Jeffrey, D. and Tunney, H., (2001). The effect of soil type on phosphorus sorption capacity and desorption dynamics in Irish grassland soils. Soil Use and Management 17: 12–20.

[120] Hutton SA, Harrison SSC and O'Halloran J Department of Zoology, Ecology and Plant Science, Environmental Research Institute University College Cork, Water Framework Directive, Western River Basin District, Programme of Measures, Forest and Water National Study Forest and Surface Water, Eutrophication and Sedimentation Literature Review 2008.

http://www.wfdireland.ie/docs/22_ForestAndWater/Forest%20and%20water%20Eutrophication_Sedimentation%20Literature%20review%20.pdf

[121] Renou, F. and Cummins, T. 2002. *Soil as a key to sustainable forest management*. In F., Convery, and J., Feehan, (eds.), Achievement and Challenge, Rio + 10 and Ireland. The Environmental Institute, University College Dublin, Dublin, pp 85-90.

The adsorption capacity of phosphorus was further evidenced in related field studies undertaken by UCC[122] which reported on clearfell forest catchments on a variety of soils.

Phosphorus released by the decomposition of the brash in the repository would have high potential for adsorption by the mineral soils in the repository base and in the drainage channels and settlement ponds which will be excavated into the mineral soil stratum also in this area.

Phosphorus loss by erosion of the mineral soils could still occur and this is assessed in Section 10.4.4 below.

10.4.3 Construction - Pollution with Nutrients due to Ground Disturbance and Clearfelling Operations

10.4.3.1 Nutrients Adsorbed or Chemically Bound to Eroded Suspended Solids

Several studies in the USA have found increases in both nitrogen and phosphorus export into streams following forestry felling, particularly in association with organic particles (Golladay & Webster 1988[123]; Likens *et al*.,1970[124]). Giller *et al.,* (2002[125]). These studies concluded that phosphates released into streams after clear-felling are mainly attached to small soil particles and are carried into watercourses if there is sediment input and increased erosion following clear-felling.

A range of studies in Ireland and abroad have indicated that peat cannot 'store' significant amounts of phosphorus, therefore phosphorus applied to these soils are not retained for long but leach to surface and ground waters. The potential for loss of added phosphorus from peatland soils with low levels of iron and aluminium has been

122 Hutton SA, Harrison SSC and O'Halloran J Forests and Surface Water Eutrophication and Sedimentation FORWATER, Final Report

http://www.wfdireland.ie/docs/22_ForestAndWater/Forest%20and%20Water_UCC_Draft%20Final%20Report.pdf

123 Golladay, S.W. and Webster, J.R. (1988) Effects of clear-cut logging on wood breakdown in Appalachian mountain streams. American Midland Naturalist 119(1): 143-155.

124 Likens, G.E., Borman, F.H., Johnson, N.M., Fisher, D.W. and Pierce, R.S. (1970) Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed ecosystem. Ecological Monographs 40: 23-47

125 Giller, P.S., Johnson, M. and O'Halloran, J. (2002) Managing the impacts of forest clearfelling on stream environments. COFORD, Dublin.

recognised for at least three decades, (Cummins & Farrell 2003[126]). In the Irish context Daly *et al*., (2001[127]) and Styles (2004[128]) concluded that peat soils have limited capacity to chemically bind phosphorus and create any phosphorus reserves. Daly & Styles (2005[129]) found that "*peat soils and high organic matter soils did not chemically adsorb P in the same way that mineral soils do. … The concept of P "build-up" cannot be applied to peat soils in the agronomic sense. … These soils are vulnerable to P loss through a lack of sorbtion capacity and binding energy rather than high rates of desorption to solution."*

With regard to the Oweninny site, the disturbed soil will consist of both peat with low adsorption capacity for phosphorous and mineral soil which has a high adsorption capacity. However, the site consisted of blanket bog subsequently commercially harvested and phosphorus fertiliser would only have been applied to forest plantation locations in the past. Phosphorous from rainfall would traditionally have been taken up by bog vegetation prior to harvesting. An increase in phosphorus loss associated with rainfall on bare peat has been suggested by Inland Fisheries Ireland however this would be at very low levels and would decrease further as bare peat areas become revegetated. The main potential source of phosphorus loss is associated with erosion of mineral soils with adsorbed phosphorus. Peat particles will have little or no adsorbed phosphorus. The drainage control system has been designed to settle out soil particles and therefore, phosphorous loss associated with mineral soil particle loss is considered to be low at this site.

10.4.4 Construction - Pollution with Other Substances

The potential exists for a range of construction related pollutants to enter watercourses during construction. Any of the following will have deleterious effects on fish, plants and

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[126] Cummins, T & Farrell, E. P. (2003) Biogeochemical impacts of clearfelling and reforestation on blanket peatland streams I. phosphorus. Forest Ecology and Management 180 545–555

[127] Daly, K., Jeffrey, D. and Tunney, H., (2001). The effect of soil type on phosphorus sorption capacity and desorption dynamics in Irish grassland soils. Soil Use and Management 17: 12–20.

[128] Styles, D., (2004). Phosphorus dynamics in some Irish soils: the influence of laboratory drying, soil characteristics and season. Ph.D. Thesis, Dublin University.

[129] Daly, K and Styles, D. (2005) Environmental RTDI Programme 2000–2006. Eutrophication from Agricultural Sources – Phosphorus Chemistry of Mineral and Peat Soils in Ireland. (2000-LS-2.1.1b-M2) Final Report Prepared for the Environmental Protection Agency by Teagasc, Johnstown Castle, Wexford

http://www.epa.ie/downloads/pubs/research/water/epa_eutrophication_agricultural_ertdi38_final.pdf invertebrates if allowed to enter watercourses in an untreated and/or uncontrolled manner.

- Raw or uncured concrete and grouts associated with the batching plant operations or deliveries of concrete to the site
- Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks.
- Fuels, lubricants and hydraulic fluids for equipment used on the development site.
- Waste from on-site toilet and wash facilities.

10.4.5 Potential Operational Impacts Long-Term Aquatic Effects

10.4.5.1 Pollution with Surface Runoff from Completed Development

Wind farm operation produces no discharges and, other than lubricants, uses no chemicals. The risk of significant pollution from paved areas after construction is minimal. Nevertheless, due care and best practice will be required to prevent any contamination of surface waters with hydrocarbons.

The wind farm will have the potential for pollution of watercourses with suspended solids due to eroding of track surfaces and drains.

There will be some potential for impact to occur associated with the maintenance operations carried out on the turbines and the electrical substations and from the use of the O&M facility and Visitor Centre. These include:

- Leakage or spillage of fuels, lubricants and hydraulic fluids from equipment used on the development site.
- Waste from on-site toilet and wash facilities contaminating surface and groundwater through failure of the waste water treatment systems serving the electrical substations, O&M building and Visitor Centre.

10.4.5.2 Permanent Loss of Habitat and Obstruction to Upstream Movement of Aquatic Fauna Due to Culverting, Track Construction & Upgrading

The network of wind farm access tracks in Phase 1 and Phase 2 intersects streams shown on EPA stream mapping (www.epa.ie) at a number of locations on the Sruffaunnamuingabatia stream (2). The habitat loss due to widening of tracks will be insignificant as simple box culvert bridging is proposed on the Sruffaunnamuingabatia and all crossings will be in accordance with the Inland Fisheries Ireland Requirement for

Protection of Fisheries Habitat during Construction and Development Works[130]. The upgrading of the site tracks will not have a significant negative impact on fish movement.

10.4.6 Hydrological impacts

Hydrological impacts are assessed in Chapter 19. Approximately 3.9% of the Muing River catchment and less than 2% of the other river sub-catchments will be affected by the development. Additionally, settling ponds constructed as part of the erosion and sediment control plan for the site will provide a further degree of flow attenuation. No significant impact from changes to hydrology arising from development on the site is predicted.

10.4.7 Decommissioning phase

The decommissioning phase would be expected to have similar potential impacts to water quality mainly arising from soil disturbance during decommissioning and with the potential for pollutants such as fuels, oils and greases to enter water courses. However, by this stage surface re-vegetation resulting from the bog rehabilitation programme will be well established and this will act as a silt trapping mechanism on the site reducing the potential from soil run off impact to occur.

10.5 MITIGATION

Detailed mitigation measures are also presented elsewhere in the EIS. The following recommendations are made from the aquatic ecological and water quality perspective.

10.5.1 Construction Phase Mitigation - Reduction and Prevention of Suspended Solids Pollution

10.5.1.1 General Recommendations

Release of suspended solids to all watercourses will be minimised. The specific means by which suspended solids in discharges to streams will be prevented from exceeding 25 mg/l (salmonid water quality standard[131]) is set out in the Erosion and Sediment Control Plan Chapter 19.

[130] Murphy D, Eastern Regional Fisheries Board Fisheries Protection Guidelines, Requirement for Protection of Fisheries Habitat during Construction and Development Works

[131] European Communities (Quality of Salmonid Waters) Regulations, 1988

Works will comply with the Inland Fisheries Ireland Requirement for the Protection of Fisheries Habitat during Construction and Development at River Sites.

The key factors in erosion and sediment control are to intercept and manage runoff and maximise the separation between construction areas and sensitive watercourses, thereby limiting the potential for soils to be eroded and enter streams in runoff. Erosion control (preventing runoff) is much more effective than sediment control in preventing water pollution. Erosion control is less subject to failure from high rainfall and requires less maintenance.

Erosion control measures to prevent runoff flowing across exposed or excavated ground and becoming polluted with sediments are provided for in the design through the following:

- Provision of diversion drains, or clean water cut off drains, to channel runoff from up slope portions of a catchment around any construction areas or areas disturbed as a result of construction works.
- Design of access tracks with falls which do not exceed 15%.

Measures which will be included in the construction management plan include:

- Minimising the area of exposed ground.
- Minimising runoff velocities and erosive energy by maximising the lengths of flow paths for precipitation runoff, constructing interceptor ditches and channels with low gradients to minimise secondary erosion and transport.
- Restricting vehicular and equipment access or providing working surfaces/pads.
- Backfilling and construction of access tracks will occur in conjunction with excavation, and will not proceed faster than rate of excavation.
- Retaining existing vegetation where possible and physically demarking the construction clearance areas on site.
- Revegetating bare areas, particularly cut and fill slopes and disturbed slopes, as soon as possible. Non-development site vegetation should not be introduced on semi-natural sites such as peatlands (DOEHLG 2006).
- Diverting runoff away from bare areas.
- Retaining eroded sediments on site with erosion and sediment control structures such as sediment traps (mobile or constructed), silt fences and sediment control ponds.
- In the case of temporary watercourse diversions, where this is required the diversion should be excavated in isolation of stream flow, starting from the lower end of the diversion channel and working upstream to minimise sediment production. The temporary channel will be constructed in such a way as to minimise suspended solids released when the watercourse is rerouted. Upon completion the bank will be stabilised around the temporary diversion.
- Stream crossings to be in accordance with the Inland Fisheries Ireland Fisheries Protection Guidance130 except with the prior agreement of IFI.
- Prohibiting entry of machinery to a watercourse to cross it.

- Locating site facilities such as site offices and contractors' compounds away from watercourses.
- Monitoring of the weather forecast prior to planning excavation works. To the extent possible, construction activities close to watercourses will be scheduled for drier months, avoiding construction during periods of heavy precipitation and run-off.
- Providing impermeable mats (plastic sheeting} as covers to mounded excavated material and open excavations during periods of heavy rainfall where this proves necessary and where a threat to water quality is identified.
- Providing silt fences at the toe of any significant areas where excavated material is stored.

Settlement ponds are an integral part of the sediment control and containment measures on site and the protection of watercourses. Settlement ponds will be provided adjacent to the areas of the site where the most excavation or earthworks are planned, i.e. the turbine locations, substation sites, O&M building site, Visitor Centre site, batching plant site, borrow pit and associated aggregate storage site and peat repository area. These ponds will be installed before starting site clearance. Ponds have been designed in accordance with assessed risk to water courses as described in Chapter 19. There is a large factor of safety built into these calculations through the runoff coefficients used and the high rainfall intensity covered. Additional ponds developed for the project will discharge to overland flow and not directly to any watercourse thereby providing additional settlement of any suspended solids leaving the pond. This should ensure minimisation of suspended solids entering watercourses post settlement.

The site specific hydrology and sediment control plan (see Chapter 19 and Appendix 13) incorporating individual settlement ponds with subsequent overland flow will minimise the level of silt loss to ensure that no significant impact will occur.

10.5.2 Construction Phase Mitigation - Forestry Clearfelling

Based on the Forest Service Guidance and Codes of practice and taking into account additional mitigation identified through research (Giller *et al*., (2002)), the following will be applied to all watercourses including drains:

- Forest clearfelling will be undertaken in accordance with the Forest Service's Guidelines and Codes of Practice:
    - The Code of Best Forest Practice – Ireland.
    - Forestry and Archaeology Guidelines.
    - Forestry and Water Quality Guidelines.
    - Forest Harvesting and the Environment Guidelines.
    - Forest Biodiversity Guidelines.
    - Forestry and the Landscape Guidelines.
- Where they exist, vegetated riparian buffer zones will be maintained and where possible left undisturbed.
- Drainage channels will never form a direct connection between the clearfell area and a watercourse, i.e. no bypassing of buffer strips will occur. If it is not possible for machinery to gain access to block all drains discharging directly to a stream, straw bales will be placed in these drains to act as filters to

reduce the input of sediment, taking care to prevent release of trapped sediment when the bales are removed.

- Silt traps will be installed at locations that will intercept run-off to streams.
- Where silt traps have been put in place, a regime of checking and emptying them will accompany the felling schedule, to prevent them from overflowing. Inspection of silt traps will be logged.
- Where possible machinery roads/tracks should be kept away from watercourses to avoid them becoming a direct route of sediment input.
- A water quality monitoring programme will be established on key drainage discharge points leaving the site. This will include daily visual inspection of selected watercourses, silt traps and silt ponds.
- A contingency plan will be established which will allow for the temporary cessation of works where routine inspections or spot monitoring indicates suspended solids at levels above 25 mg/l is entering the drains downstream of silt traps and ponds. Mitigation measures will be reviewed should this occur with additional measures such as increased cleaning of ponds or additional settlement structures being provided.

10.5.3 Construction Phase Mitigation - Pollution of Watercourses with Nutrients

There is only limited potential for nutrient input to watercourses during peatland and glacial till disturbance associated with suspended soil particles and the very limited forest clearfelling, hence the measures outlined earlier apply equally to prevention of nutrient inputs to streams. The settlement ponds will further reduce loss of nutrients bound to soil particles with additional nutrient uptake by vegetative growth in the drainage channels and by overland flow across vegetated areas post settlement occurring.

To ensure minimisation of nutrient loss the clearfell activities on site will be undertaken strictly in accordance with the Forest Service Codes of Practice and published Guidelines.

In order to minimize enrichment of watercourses by nutrients leaching from decomposing brash, all forest activities will be carried out in accordance with the Forest Service Guidelines.

10.5.4 Construction Phase Mitigation - Pollution of Watercourses with nutrient from Repository areas.

The following measure swill be implemented

- Drainage from this repository will be directed to settlement ponds followed by overland flow to trap phosphorus bound to soil particles and promote uptake by vegetative growth.
- Where the gradient allows, drainage and settlement ponds will be constructed on the overburden layer below the peat layer to ensure any water percolating through comes into contact with the underlying mineral soil.
- Repositories will be filled in cells and allowed to re-vegetate naturally. This will facilitate nutrient uptake and also reduce surface water flow from the repositories.

10.5.5 Construction Phase Mitigation - Turbine Foundations, Cable Trenches and Upgrade of Tracks

The following measure swill be implemented

- The site specific hydrology and sediment control plan incorporating drainage system with settlement ponds, soak-aways and interceptor drains will be installed in a coordinated manner prior to any excavation work along new access tracks.
- Settlement ponds / silt traps will be installed towards the end of drainage channels. Where practicable, these will not be within 100 m of the receiving watercourse.
- Machinery and vehicles used in track construction will be operated from the track as it is constructed. Excavation machinery will be operated from access tracks and trench digging machinery will be operated from bog mats where appropriate.
- Surface vegetation layers will be excavated and stored separately from other excavated material. This surface material will be used to reinstate turbine foundations and repository following construction.
- At locations where excavated materials are stored, interceptor drains will be installed to distribute runoff to the controlled drainage system.
- Any water pumped from trenches will be passed through a suitable silt removal facility before discharge to surface waters.
- The excavated material will be laid alongside the trench for use in reinstatement following the laying of the cables. Silt runoff from excavated material to surface waters will be prevented using methods outlined above.

10.5.6 Construction Phase Mitigation – General Management of Pollution

The following guidelines will be followed:

- Concrete washout will be strictly controlled and will occur at the concrete batching plant in the area sloped to the three bay water recycler and at selected locations across the site.
- Concrete washout areas outside the batching plant will comprise an excavated area lined with a high density polyethylene (HDPE) liner. These will be located away from any watercourse and will act as settlement for concrete solids.
- The outlet from the concrete washout area will be directed to an appropriate settlement pond with subsequent overland flow.
- There will no direct discharge of concrete washout to any watercourse.
- Only the chute of the concrete delivery truck will be cleaned on site, using the smallest volume of water necessary.
- All concrete used in the construction of turbine bases will be pumped directly into the shuttered formwork from the delivery truck. Concrete will not be transported around the site in open trailers or dumpers.
- Clearly visible signs will be placed in prominent locations close to concrete pour areas, indicating the location of concrete washout areas.

- Large concrete pours will be avoided where prolonged periods of heavy rain are forecast and covers will be available for freshly placed concrete to avoid the surface washing away in heavy rain.
- Wash down water from exposed aggregate surfaces and cast-in-place concrete will be trapped on-site to allow sediment to settle out before clarified water is released to overland flow via the drainage control system.
- Fuels, lubricants and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage and will be properly secured against unauthorised access or vandalism.
- Fuelling and lubrication of equipment will be carried out in specially bunded areas. Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained and the contaminated soil removed from the site and disposed of properly.
- Runoff from crane hard standings serving as storage areas for material, e.g. reinforcing steel, and machinery will be directed to the drainage system which includes silt removal.
- All pumps using fuel or containing oil will be locally and securely bunded when situated within 25 m of waters or when sited such that taking account of gradient and ground conditions there is the possibility of discharge to waters.
- Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction site to deal with any accidental spillage. Emergency response procedures will also be put in place.
- Foul water from the Visitor Centre, O&M building and substations will be directed to appropriate proprietary treatment systems as described in Chapter 2. These shall be regularly inspected and maintained on an annual basis.
- Foul waste from portable toilets or holding tanks, etc. will be removed to a suitable treatment facility by a licensed waste contractor.

10.5.7 Operational Phase Mitigation - Wastewater treatment system

Foul water from the Visitor Centre, O&M building and substations will be directed to appropriate proprietary treatment systems as described in Chapter 2. These shall be regularly inspected and maintained on an annual basis.

10.5.8 Operational Phase Mitigation - Habitat Loss

Where development is to take place close to rivers/streams, a riparian leave strip will be clearly marked and its significance explained to machinery operators.

10.5.9 Operational Phase Mitigation - Obstruction to Movement of Aquatic Fauna

In general water course crossings will comply with the existing Guidance issued by the IFI. It is understood that new guidance is in preparation and that it includes the following measures for watercourse crossings:

- Design and choice of temporary crossing structures must provide for passage of fish and macroinvertebrates, the requirement to protect important fish habitats e.g. spawning and over wintering areas, as well as preventing erosion and sedimentation.
- No temporary crossing on any watercourse shall be installed without the approval of IFI as regards sizing, location and timing.
- Where circumstances such as space or access difficulties preclude use of clear span structures, temporary crossings structures shall:
- Comprise one or more metal or concrete pipes, prefabricated culverts or such other material as IFI may permit of minimum diameter 900 mm. Pipes or culverts may be vertically stacked.
- Be laid in such a manner as to maintain existing stream profile.
- Ensure no significant alteration in current speed or hydraulic characteristics, in particular not result in scouring, deposition or erosion upstream or downstream of the temporary crossing location.
- Have capacity to convey the full range of flows including flood flows likely to be encountered without the crossing being overtopped.
- Be covered with clean inert material such as to allow for the safe crossing of the widest items of plant and equipment without cover material being dislodged and entering waters.

Tracks will be designed and constructed in such a way as to ensure that watercourses remain passable for aquatic fauna. The development will involve the culverting or replacement of culverts on sections of drain at proposed / existing track crossings. The following additional guidelines will be taken into consideration when designing permanent culverts:

- To avoid a change in velocity that could alter the sediment transportation capacity of the watercourse, culverts will be designed so as not to change the hydrological conditions that existed prior to installation. The cross-sectional area will not be restricted by the culvert and the gradient and the roughness coefficients will remain unchanged, where practicable.
- Culverts will not be aligned so that culvert outflows are directed into a watercourse bank.
- Culverts will be constructed without a bottom or installed well below the stream grade in order to assist the safe passage of aquatic fauna.
- If concrete bottoms are used, they will be at least 300 mm below the stream grade with cross walls not less than 80 mm to collect natural streambed material.
- If pipe culverts are used, the culvert diameter will be at least 1.2 times the bank full width of the stream + 0.5 m and culverts should be embedded to a depth of at least 25% of the pipe diameter.
- If box culverts are used they will be embedded at least 300 mm below the existing stream bed with cross walls not less than 80 mm to collect natural streambed material.

10.5.10 Operational Phase Mitigation - Hydrological Impacts

Measures will be put in place if necessary to ensure that no significant increase in peak stream/river flows is caused by the proposed development.

Natural drainage patterns will be restored after the completion of road construction by allowing surface drainage to pass under or over the proposed new road at intervals, corresponding with existing natural drainage lines.

Water abstraction from watercourses for any purpose will only take place at locations, in a manner and during a time period agreed with Inland Fisheries Ireland.

10.5.11 Procedures, Monitoring and Maintenance

Liaison with IFI will be established prior to commencement of the works and will be ongoing throughout the construction period.

Contractors will be provided with the guidance document "*Control of water pollution from construction sites - Guidance for consultants and contractors*" published by the Construction Industry Research and Information Association (CIRIA 2001) and be familiar with its contents.

Contractors will be provided with the IFI guidance document "*Requirement for the Protection of Fisheries Habitat during Construction and Development Works*) and be familiar with its contents. Contractors will also be provided with any updated Guidance when published.

Contractors will be provided with the mitigation set out in the EIS and the requirements of the planning authority, NPWS and IFI with respect to mitigation to be carried out during project construction.

A visual inspection programme of the site will be carried during construction to monitor integrity and general performance of silt traps, settlement ponds and erosion control measures. The frequency of this inspection programme will be agreed with Inland Fisheries Ireland. A log of visual inspections will be maintained and any identified issues will be brought to the contractor's attention for immediate action.

A biological and chemical monitoring system will be put in place on potentially affected streams including, the Sheskin Stream, Sruffaunnamuingabatia River,. As a minimum, the monitoring system will measure Q-value, suspended solids, ammonia, molybdate reactive phosphorus, temperature, dissolved oxygen and pH. The programme will be agreed with both IFI and NPWS.

It will be necessary to establish a statistically meaningful baseline of conditions for an extensive period immediately prior to the commencement of construction works. The details of the monitoring system, including frequency of sampling, monitoring locations and parameters to be monitored will be agreed in advance with both IFI and NPWS.

As virtually all treatment options require proper maintenance in order to function correctly and as some can become a source of pollution if not properly maintained, a programme of regular cleaning, maintenance and inspection of the track runoff treatment systems will be adopted to ensure that they function correctly.

10.5.12 Residual Impacts post mitigation

Good construction practice coupled with the implementation of the hydrology and sediment control plan for the site will ensure that any residual impacts will not be significant.

10.6 CUMULATIVE IMPACTS

Cumulative impacts could potentially arise from the construction activities of other wind farms located near the site and with the construction of the proposed gas peaking plant near the Oweninny River on lands running through the centre of the site. Cumulative impacts could also occur due to the upgrade works associated with the proposed meteorological mast at Sheskin, Bellacorick to Castlebar 110kV OHL uprate, the Bellacorick to Moy 110kVOHL uprate, the Bellacorick to Bangor Erris 38kV uprate, the proposed modification of the existing Bellacorick substation, proposed peaking plants and, the proposed meteorological mast at Sheskin and the Grid West project. These are discussed below.

10.6.1 Wind Farms

10.6.1.1 Corvoderry Wind Farm Development

The Corvoderry site is located within the Oweninny site and will comprise construction of 10 wind turbines, access tracks and substation. The site is drained westwards by the Muing River and eastwards by the Fiddaunagosty Stream. There is potential for cumulative impacts to arise from loss of suspended solids and other pollutants to the Muing from part of Corvoderry and then to the Owenmore flowing west arising from the construction activities associated with both developments. Additionally development of Corvoderry will require the clearfelling of 19.3 hectares of forest plantation. There will therefore be potential for cumulative nutrient enrichment impact of the Muing River. Detailed mitigation has been set out in the environmental impact statement which accompanied the planning application for Corvoderry Wind Farm which when fully implemented will ensure that any cumulative impact will not be significant.

The Natura Impact Statement for the development identified potential (in absence of mitigation) for adverse impacts on Lough Dahybaun SAC as a result of possible changes in water quality entering the lake during the construction and operation phases. As there are no elements of the Phase 1 and Phase 2 Oweninny development hydraulically linked to the Dahybaun catchment there is no potential for cumulative impact to occur.

10.6.1.2 Dooleeg, Bellacorick Wind Farm

This wind farm has permission to construct a single one 2 MW turbine at Dooleeg, Bellacorick). The location is a few hundred metres south of the Oweninny site and again the Phase 1 and Phase 2 of the Oweninny development has no hydraulic link with this area and no cumulative impact on water and aquatic ecology can occur.

10.6.1.3 Tawnanasool Wind Farm

The Tawnanasool proposed wind farm is located to the about 10km to west southwest of the Oweninny site in the Croaghaun river catchment, a coastal catchment which drains directly to Tullaghan Bay. The Owenmore River into which the Oweninny flows also drains to Tullaghan Bay. Hence, there is very limited potential for cumulative impact on Tullaghan Bay to occur given both the distance and the extensive mitigation measures set out in the Tawnanasool proposal and the Oweninny Phase 1 and Phase 2 proposal if implemented properly.

A request for further information had been issued by Mayo County Council to the developer (dated 23rd February 2015) which related to the correct hydrology of the catchment being a coastal catchment entering Tullaghan Bay and detail on the mitigation methods for site rehabilitation and site drainage control. This was subsequently provided by the developer on the 21st July 2015.

However, a notification of refusal was issued by the Planning Authority on the 14th August on the grounds of impact on visual amenity and natural character of the landscape and also due to the creation of a traffic hazard at the access point to the windfarm on the N59. This refusal was at the appeal stage to An Bord Pleanála at the time of writing.

10.6.1.4 Potential future development of Oweninny Phase 3

The potential impact with respect to aquatic ecology, fisheries and water quality of all three phases of Oweninny acting in combination formed the basis for assessment of the original wind farm application made to An Bord Pleanála in 2013. The main areas that could potentially be affected by Phase 3 and which were assessed fully in that application were Lough Dahybaun and the rivers draining the site to the Cloonaghmore and Deel/Moy catchment. The original assessment concluded that there would be no significant impact once all mitigation measures were fully implemented.

10.6.2 Meteorological Mast

ABO Wind Ireland Limited have applied (22nd July 2015) for permission to install a temporary (3 yrs) meteorological mast at Sheskin Townland, Bellacorick, Co Mayo. The mast comprises a 100 m high steel lattice tower, supported by cable stays. The site for the proposed mast is within conifer forest plantation. This site is located within the catchment of the Oweninny River and hence there is some potential for cumulative water pollution effects during construction. However, the application was accompanied by a Screening for Appropriate Assessment which concluded that there will be no adverse effects as a result of the installation and operation of the meteorological mast.

10.6.3 Overhead Power Lines

Planning permission has been granted for the following overhead power line projects in the Bellacorick area:

Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410) – granted to EirGrid plc by An Bord Pleanála on 11th August 2015.

Comprising the uprating of approximately 100 structures over a distance of 19.5 km of power line between Bellacorick and Castlebar a portion of this project, structures 1 – 18, are located within the Owenmore river catchment. There is therefore potential for water quality impacts in terms of pollution to occur in a cumulative manner with the Oweninny Phase 1 and Phase 2. However, a detailed Stage 2 appropriate assessment was prepared which demonstrate that there would no adverse impact from this uprate works and no cumulative impact is foreseen. The Board granted permission for the project on 11th August 2015 subject to 11 conditions.

Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45) – granted to EirGrid plc by Mayo County Council on 4th August 2015 comprising the uprating of approximately 27 km of power line between Bellacorick and Gorteen. Part of the existing line uprate occurs in the Owenmore catchment and hence there is some potential from impact of pollutants during the construction phase. A detailed Stage 2 appropriate assessment was carried out which indicated that no adverse effect would occur should all the identified mitigation be implemented.

Proposed uprate of the existing Bellacorick to Bangor 38kV Overhead Line comprising the uprating of approximately 12.3km of power line between Bellacorick and Bangor Erris. The catchment in the vicinity of the proposed project drains into the Owenmore River which meanders through a low lying valley to the south of the proposed line route hence there is some potential from impact of pollutants during the construction phase. The project Natura Impact Statement was carried out which indicated that no adverse effect would occur should all the identified mitigation be implemented.

No significant cumulative impact is predicted to occur between the Oweninny project and the planning approved a proposed line uprates

10.6.4 Substation Project

EirGrid have made a planning application to Mayo County Council (22/07/2015, Planning Reference 15/456) for a minor modification of the existing Bellacorick 110kV Substation. The works, all within the existing substation. As the substation site is within the westerly flowing Owenmore catchment some potential for cumulative water quality impacts exists. The mitigation measures to protect water quality set out for the proposed works will ensure no potential cumulative impact will occur. This project has received a notification of grant of permission from Mayo County Council in September 2015.

10.6.5 Power Plants

Planning permission has been granted for the following power plants:

- 68 MW gas turbine peaking plant at Bellacorick – Bellacorick Power Plant (Planning reference 01/1250).
- Conventional 200 MW natural gas fired peaking plant along the Srahnakilla road (Planning permission 09/286 granted to Constant Energy on 16/11/2001). Site located between the eastern and western parts of the Oweninny site.

As the planning documentation for the above projects did not identify significant adverse impacts on water quality, it can be assumed that there would be no cumulative effects with Phase 1 and Phase 2 of the Oweninny development..

10.6.6 Grid 25/Grid West

The proposed EirGrid Grid West Project is located to the east of the Oweninny wind farms site. There is no hydraulic connectivity between Phase 1 and Phase of Oweninny and the river systems through which the Grid West OHL or cable route would pass. Hence, there is no potential for cumulative impact on aquatic ecology or water quality of Oweninny Phase 1 and Phase 2 and Grid West.

The proposed EirGrid Grid West Project is located to the east of the Oweninny wind farms site. With respect to potential cumulative impacts with the Oweninny project these could potentially occur within the Moy catchment as the Grid west project is located largely within the Moy catchment area.

The Government-appointed Independent Expert Panel (IEP) Report published by EirGrid in July 2015, sets out, in detail, the technical, environmental and cost aspects of three technology options:

- a fully underground direct current cable;
- a 400kV overhead line and;
- a 220kV overhead line with partial use of underground cable

The project will include a substation/converter station in north Mayo and a substation/converter station near Flagford, Co. Roscommon. Converter stations, to convert the direct current to alternating current would be required if a direct current underground cable is provided

The Constraints Report prepared for the Grid West Project (Tobin, August 2012) identified two key potential impacts that could constrain the Grid West Project

- Potential impact on river crossings and
- Potential impact on lakes

The environmental assessment of the underground cable route and overhead line routes and the substation/converter station sites/zones was completed as part of the UGC and OHL reports and a further appraisal based on public feedback and consultation as well as specialist studies.

The Grid West UGC and OHL routes and the converter station in north Mayo are located in the Clonaghmore river catchment (predominantly good or High water quality status and the Moy catchment which again has predominantly Good or High water quality status. As the Oweninny Phase 1 and Phase 2 development area catchment drains westwards and is outside the Cloonaghmore and Moy catchment no cumulative impact on water quality with Grid West is possible.

10.6.7 Forestry

Forestry operations are widespread in the vicinity of the Oweninny development site. Forestry is identified as an ongoing threat to the following designated sites: Lough Dahybaun SAC, Bellacorick Bog SAC and the River Moy SAC (source NPWS).

Forestry activities can affect water quality and associated aquatic interests in a number of ways, as follows:

- Leaching of fertilisers, especially phosphorus, to local watercourses
- Disturbance of soils during clearfelling operations and subsequent runoff of nutrients and suspended solids to local watercourses
- Decomposition of brash after clearfelling and subsequent runoff of nutrients to local watercourses

While Phase 1 and Phase 2 of the Oweninny project will require the removal of 1.05 ha of commercial forest, this will result in very limited loss of nutrient and solids particularly with the implementation of the mitigation detailed in the EIS for sediment control and nutrient loss. It is also not within the catchment of the Moy river system or Lough Dahybaun and no cumulative impacts are expected..

10.7 CONCLUSION

The rivers draining the Oweninny site are important salmonid fishery rivers and a key angling tourist attraction to the general area. The commercial peat harvesting impacts that occurred in the past have been largely mitigated by the sediment control system introduced by Bord na Móna and the extensive bog rehabilitation programme the effects of which are increasingly being observed. The development of the Oweninny wind farm has potential to cause impacts on the water quality and aquatic ecology of the receiving waters. The key potential impacts on water and aquatic ecology have been identified as sediment material loss to the aquatic environment, pollution from oils, fuel and waste materials and nutrient enrichment from brash decay associated with forest clearfelling. Good construction practice coupled with the implementation of the hydrology and sediment control measures set out in Chapter 19, the geotechnical mitigation measures set out in Appendix 4 and the mitigation measures specified in this chapter will ensure that no significant impact will occur from the construction of Oweninny wind farm.

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Oweninny Power Ltd.

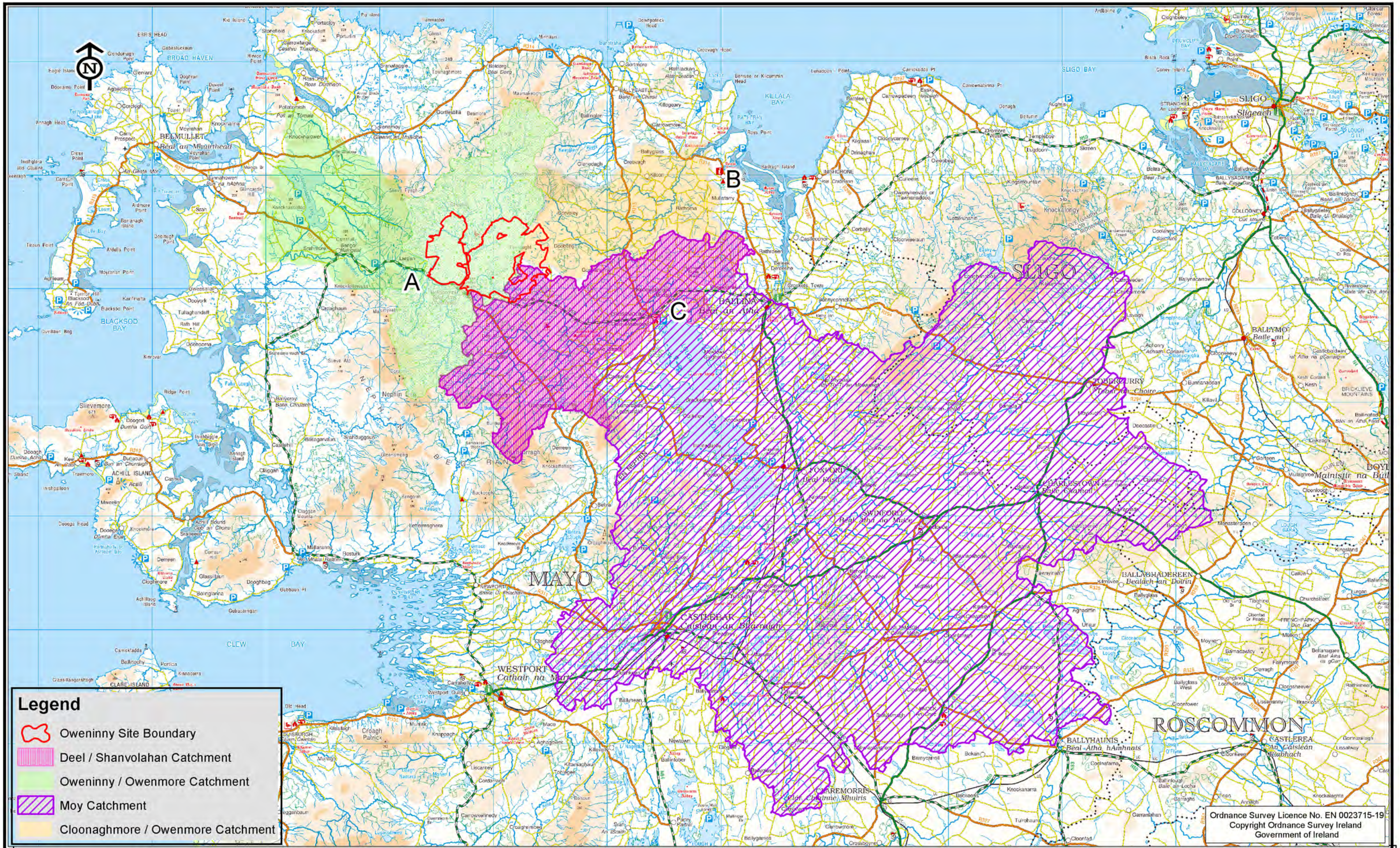
Client	Oweninny Power Ltd.
Title	Oweninny Rivers
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
C.F	C.F	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
	00-00	A3	1:45,000

MAP REFERENCE

FIGURE 10.1



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Project	Wind Farm at Oweninny, Co. Mayo
Title	Oweninny Site & Main River Catchments
Production Unit	Civil, Building & Environment Group

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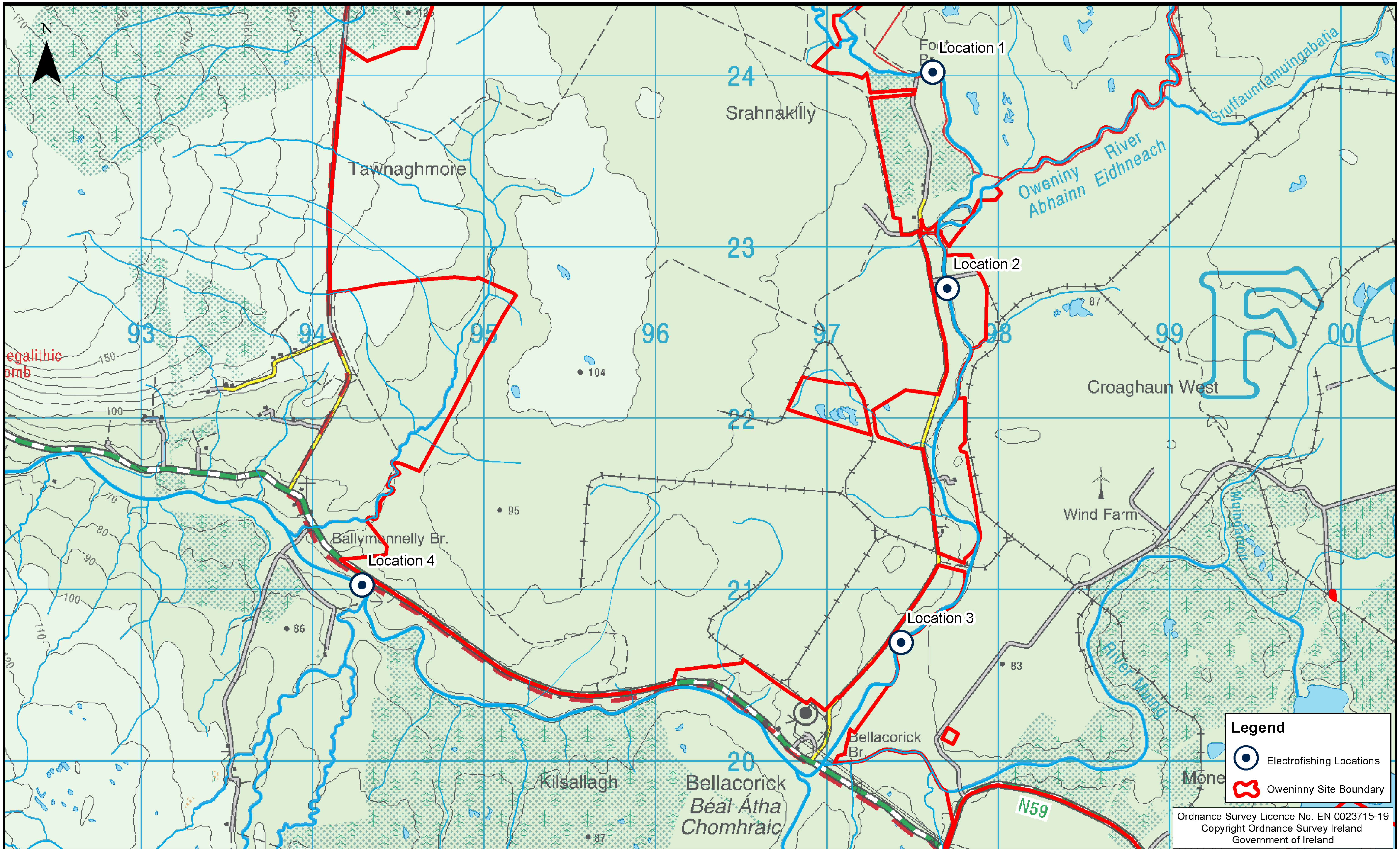
MAP REFERENCE

Figure 10.2



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Electrofishing Survey Assesment Locations

Project	Production Unit
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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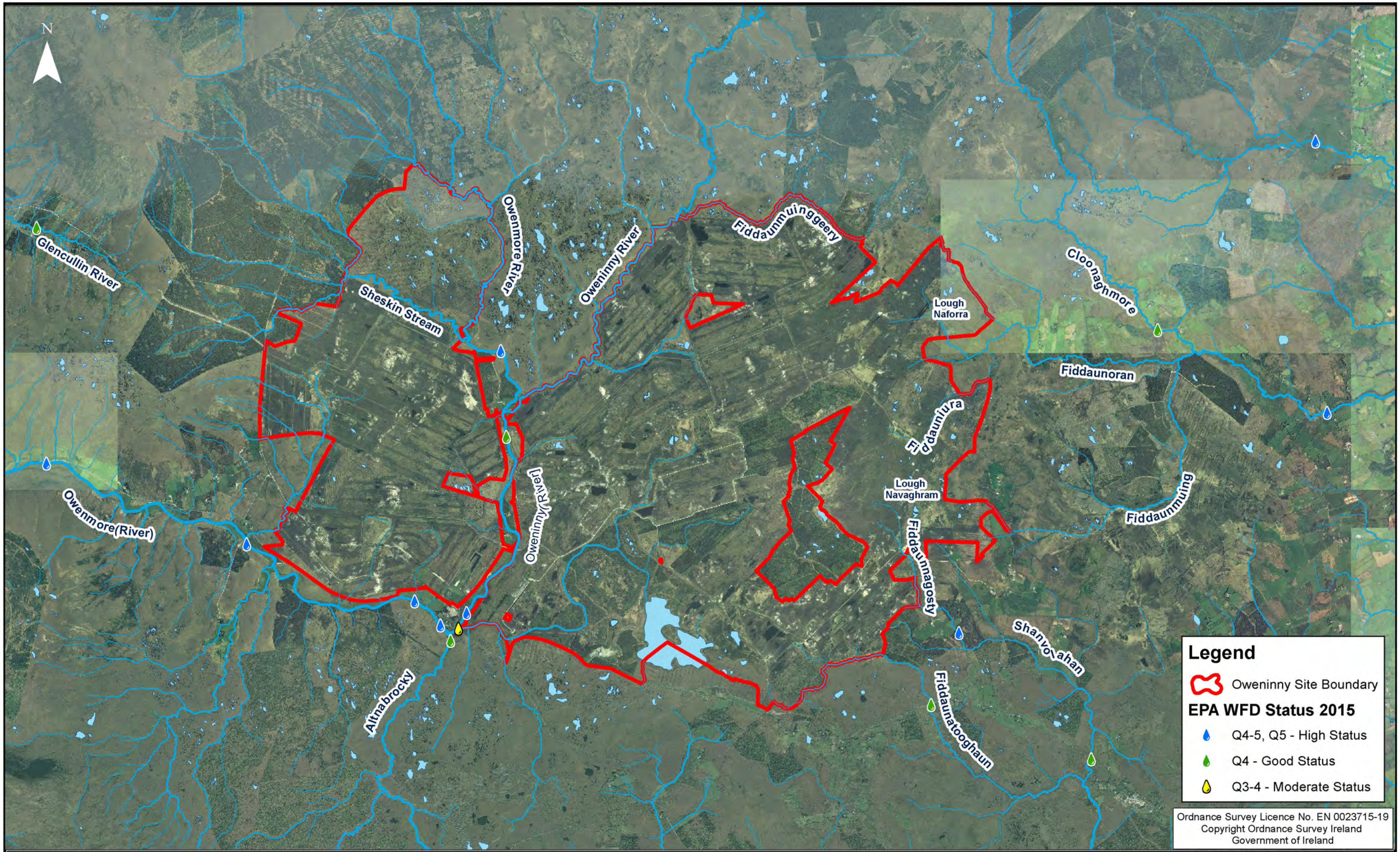
MAP REFERENCE

FIGURE 10.3



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	EPA Biological Assesment Sites
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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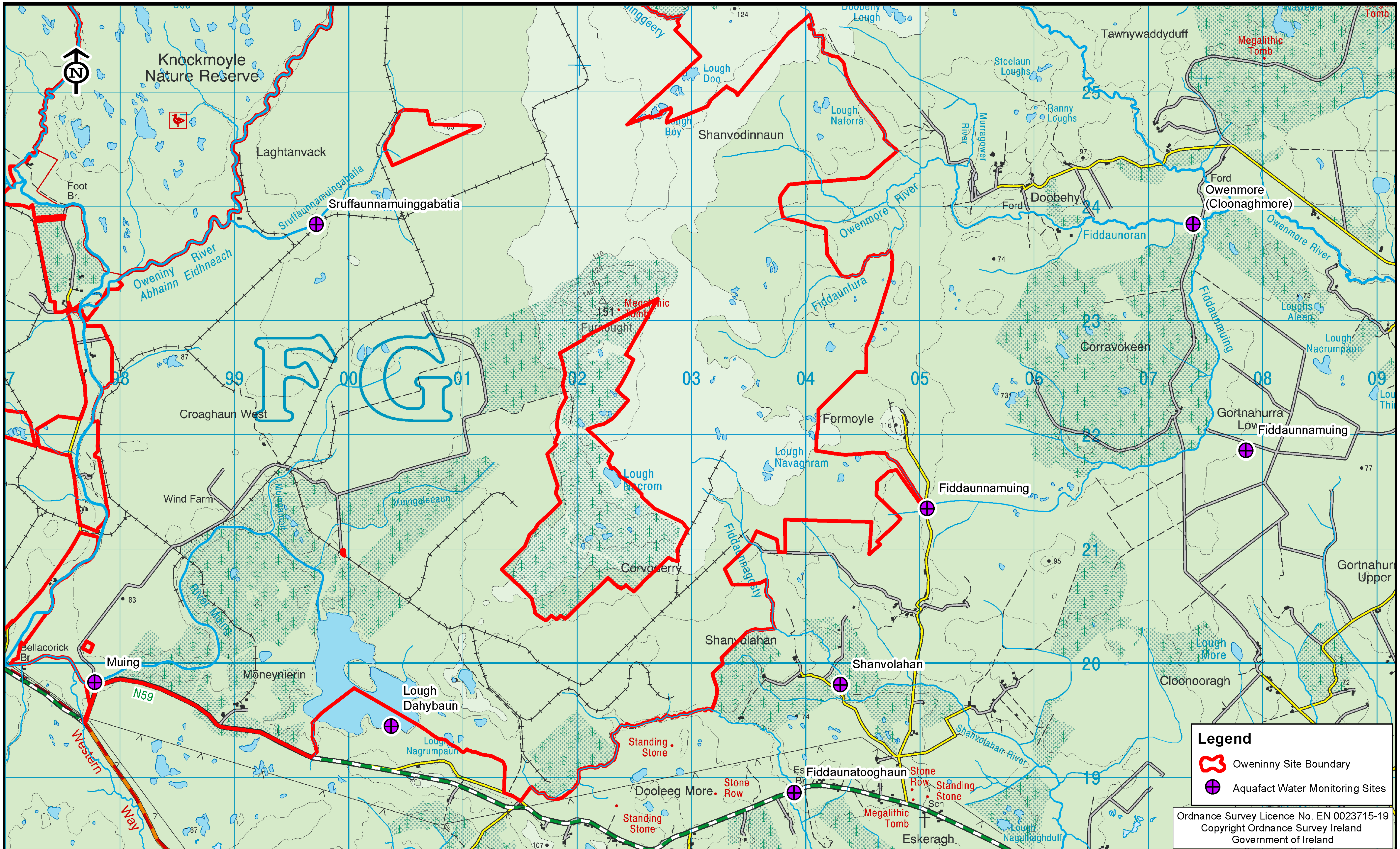
MAP REFERENCE

FIGURE 10.4



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Aquafact Water Monitoring Sites
Project	**Production Unit**
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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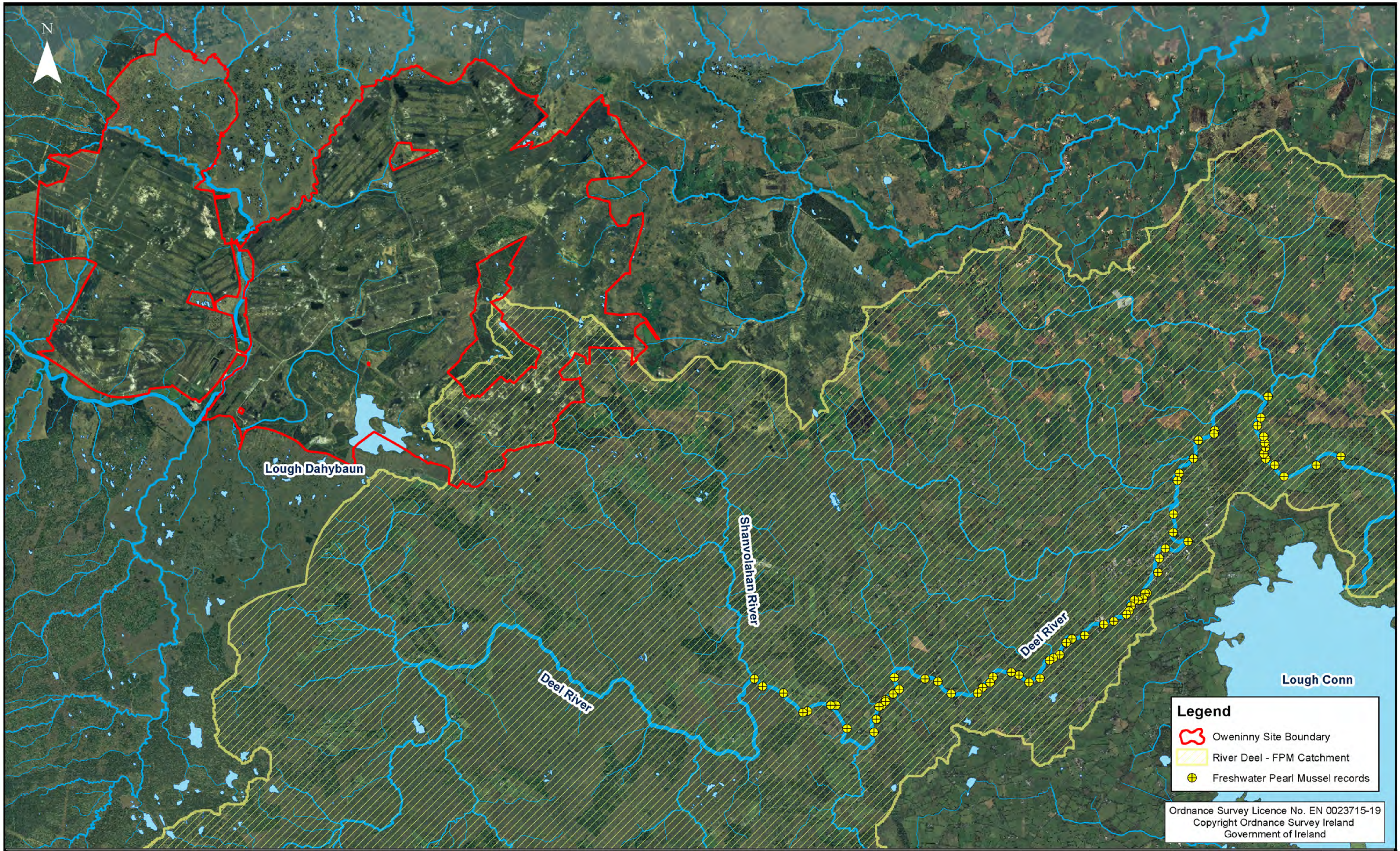
MAP REFERENCE

FIGURE 10.5



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Relationship of Oweninny wind farm site to Freshwater Pearl Mussel Records on the Deel River

Project	Production Unit
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

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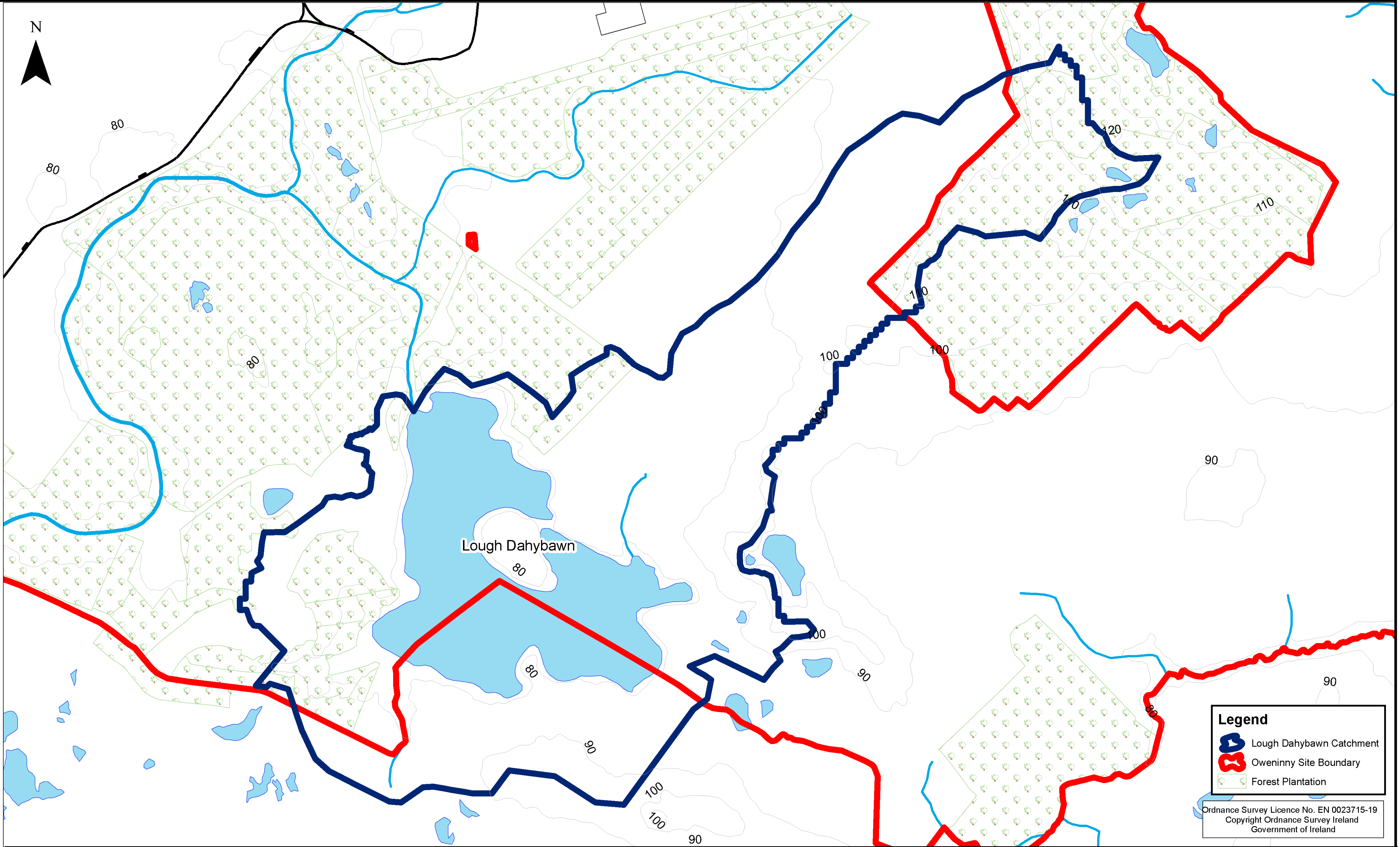
	00-00	A3	1:60,000

MAP REFERENCE

FIGURE 10.6



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Lough Dahybaun Catchment

Project	Production Unit
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	PK	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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MAP REFERENCE

Figure 10.7

11 LANDSCAPE

11.1 BASIS OF VISUAL IMPACT ASSESSMENT

This section of the E.I.S. describes the landscape and visual effects of the proposed Oweninny Wind Farm comprising of 61 up to 176 m high turbines, including ancillary development, located at Bellacorick, County Mayo

11.1.1 Introduction

Where installed, wind turbines modify the traditionally perceived image of the countryside and as they become part of the rural landscape they influence the character of the surrounding area.

It is a common conception that a significant impact of wind farms is caused by the dominance of their visual characteristics. So it is desirable, when feasible, to decrease that effect. However, wind farms like all developments should not be judged solely on their visual properties but should also be valued for other qualities such as what they symbolise.

A wind farm obviously indicates human impact within the landscape and as a consequence reduces the perception of remoteness, but when wind farms are related to the landscape characteristics then their sculptural image as well as their functional role may be seen as an enrichment of the local landscape character.

11.2 METHODOLOGY

11.2.1 Introduction

In April 2013, the third edition of the guidelines for Landscape and Visual Impact Assessment (GLVIA3) was published by the Landscape Institute. Following this publication, the Landscape Institute provided the following advice regarding its adoption for LVIA projects which commenced prior to the 2013 adoption date. It states that:

"*An assessment started using GLVIA2 should be completed using that edition. However, if in the view of the professional a comparison should be undertaken with GLVIA3, and subsequently if necessary a re-assessment undertaken according to GLVIA3, then this should be discussed and agreed with the client in the first instance*"; it further states that: "*In general terms the approach and methodologies in the new edition are the same. The* *main difference is that GLVIA3 places greater emphasis on professional judgment and less emphasis on formulaic approach.*" (Source: Landscape Institute website[132]).

GLVIA3 was published and came into force on 17th April 2013, long after work on the LVIA for Oweninny Wind Farm had commenced. The adoption of GLVIA 2, for the duration of the assessment, is therefore considered to be consistent with the guidance from the Landscape Institute's Technical Committee.

A full list of references is provided at section 11.79 of this LVIA, and has been updated for the purposes of this report. Although some of these reference documents have since been superseded by more recent guidance, for the reasons stated above, this means that the original LVIA and this new report remain able to be compared.

11.2.2 Zone of Visual Influence

The function of wind turbines and their utilisation of optimum wind speeds result in a wind farm being highly visible. However, this also relates to a number of other variables such as meteorological conditions, the mode and speed of viewing, and the nature of the surrounding landscape.

The description of the nature of visibility from the following viewing distances informs the assessment of the visual effects.

- 0 - 2.5 km (radius) - Turbines typically form the dominant landscape element in good visibility.
- 2.5 – 5.0 km (radius) - Turbines are perceived as one element of many within the landscape in good visibility.
- 5 - 10 km (radius) - Turbines are perceived within the wider landscape setting in good visibility.

The human eye can detect movement at great distances because the natural landscape is motionless. At 2.5 km motion, rather than size, draws the eye. At 8 km it highlights the turbines' location within the wider landscape.

11.2.2.1 Visibility

The *extent of visibility*, meaning how many turbines will be visible and from where, can be accurately measured. The way that wind turbines appear in the landscape, described as *nature of visibility,* depends on the observer's perception of wind turbines and the landscape as well as involving a degree of subjective judgement.

Visibility of wind turbines is described in relation to the following:

[132] http://www.landscapeinstitute.co.uk/knowledge/GLVIA.php (accessed 01/09/15)

- Climatic conditions; views from roads; significant viewpoints; topography; vegetation; movement; and position of the viewer.
- The nature of visibility is then described in the context of the wind farm as follows:
- Relation to skyline; relation to landform and relationship to landscape character
- For any particular viewpoint, the assessment would also include a description of the following:
- Visual composition of a view; the nature of visibility in the surrounding area; and the cumulative effects of existing wind farms.

Widely accepted design principles that are practised within the design professions were used in order to limit the boundaries of subjective judgement about the nature of the wind farm's visibility. A summary of these principles is as follows:

Harmony and Clarity: The eye seeks clarity in a visual pattern and must be able to tell what a design is trying to say. Harmony creates balance and feelings of restfulness.

Rhythm and Repetition: Rhythm relates to the regular or harmonious recurrences of lines and shapes. Repetition is one of the most effective ways to create unity in a composition, organising forms and spaces.

Scale: Scale signifies importance. The description of scale can refer to how a structure is perceived and its relation to its surroundings as much as its actual size.

11.2.3 Design Guidelines

The following design guidelines on the location and design of wind farms, gained through reference and research, have been used in the assessment process, against which to measure the impact of the development.

- The location and design of a wind farm should relate to the key characteristics of a landscape.
- The landscape comprises physical, social, experiential and visual characteristics for each potential wind farm site. These and their relative dominance must be assessed and the processes acting upon them.
- A wind farm possesses visual relationships between each turbine, in addition to the landscape as a collective group. This relationship must appear clear and simple in order for a development to seem rational.
- Turbines and the landscape need to form a coherent unit and avoid visual confusion.
- The size of wind turbines should relate to the scale of the surrounding landscape, as well as to the design of the wind farm group.
- The spacing of turbines should be relatively regular.
- Wind turbines should be perceived in a clear, unambiguous way.

11.2.4 Survey Methods

The survey methods used consisted of:

- A desktop study of the current Mayo and Sligo County Development Plans and other relevant published literature.

- Mapping of key landscape characteristics such as vegetation, topography, major and minor ridgelines, vegetation, land use, visual quality and settlement areas. This was achieved using OSi mapping, Lidar surveys and on site visual assessment.
- Site survey to assess key features of the landscape and critical view corridors. The significance of the site and visual dominance within the landscape were recorded.
- Zones of Theoretical Visibility (ZTV) maps were prepared for a range of turbine heights, 120 m hub height and 176m blade tip height and 100 m hub height and 150 m tip height. The ZTVs were based over a 30 km radius and were used to check visibility from surrounding areas. The ZTV maps were used as one tool in the assessment process and their limitations, such as accuracy at a 30km distance and using contour intervals of 10m, are acknowledged. The maps also represent visibility within a bare earth landscape and so depict a `worst case' scenario with none of the screening effects of vegetation being taken into account. Hence the maps were used as a general guide to visibility, as one tool in the assessment process, and on site surveys were used to back up or confirm the findings of the ZTV mapping.
- Wire Frame Models - three dimensional wire frame models were constructed from key viewpoints within a 30km radius. These were used to assess the visual relationship of the wind farm to the existing topography and the visual relationships between each turbine.

11.2.5 Definition of Visual Impact

The visual effects of a wind farm will depend upon the distance of the observer from the wind farm, with visibility decreasing significantly over 5 to 20km. With other forms of development, low visibility correlates to low visual effects and the less a development is seen, the more positive the impact. With respect to wind farms however, of greater importance than the extent of visibility in determining visual effects, is the nature of the visibility (i.e. how a wind farm is seen within the landscape). For example whether it appears balanced within the visual composition of a view, whether it creates a focal point or if it blends into the background.

Hence visual effects will be assessed using the following criteria:

- How the wind farm is perceived within the visibility zone with respect to scale, landform and skyline.
- Relationship to land use and human settlements.
- Impact of ancillary development - access roads, buildings, and connection to the national electricity grid.
- Landscape Character - the effects on the landscape character will be assessed in terms of the relationship of the development to the landscape character and landscape characteristics.

The following definitions are used to determine landscape or visual effects. These effects may be adverse (negative), neutral or positive.

Table 11.1: Definition[133] of magnitude / degrees of visual effects resulting from the proposal

Magnitude	Effect
None	No part of the development, or work or activity associated with it, is discernible.
Negligible	Only small parts of the proposal are discernible and / or they are at such a distance that they are scarcely appreciated. Consequently they have very little effect on the scene.
Slight	The proposal constitutes only a minor component of the wider view, which might be missed by the casual observer or receptor. Awareness of the proposal does not have a marked effect on the overall quality of the scene.
Moderate	The proposal may form a visible and recognisable new element within the overall scene and may be readily noticed by the observer or receptor.
Substantial	The proposal forms a significant and immediately apparent part of the scene that affects and changes its overall character.
Severe	The proposal becomes the dominant feature of the scene to which other elements become subordinate and it significantly affects and changes its character.

Table 11.2: Criteria[134] for the assessment of magnitude of effects on landscape character

Magnitude	Typical Criteria
Negligible	Very minor loss or alteration to one or more key elements / features / characteristics of the baseline, i.e. pre-development landscape or view and / or introduction of elements that are not uncharacteristic with the surrounding landscape – approximating the 'no change' situation.
Low	Minor loss of or alteration to one or more key elements / features / characteristics of the baseline, i.e. pre-development landscape or view and / or introduction of elements that may

133 Based on criteria set out on Page 145, Option 2, in the "*Guidelines for Landscape and Visual Assessment, 2nd Edition* by The Landscape Institute with the Institute of Environmental Management and Assessment, published by *Spon Press 2002,*[ISBN 0-415-23185-X]

134 Based on criteria set out on Page 138, Appendix 6, Example 1, in the "*Guidelines for Landscape and Visual Assessment, 2nd Edition* by The Landscape Institute with the Institute of Environmental Management and Assessment, published by *Spon Press 2002,*[ISBN 0-415-23185-X]

Magnitude	Typical Criteria
	not be uncharacteristic when set within the attributes of the receiving landscape.
Medium	Partial loss of or alteration to one or more key elements / features / characteristics of the baseline, i.e. pre-development landscape or view and / or introduction of elements that may be prominent but may not necessarily be considered to be substantially uncharacteristic when set within the attributes of the receiving landscape.
High	Total loss of / or major alteration to key elements / features / characteristics of the baseline, i.e. pre-development landscape or view and / or introduction of elements considered to be totally uncharacteristic when set within the attributes of the receiving environment.

11.2.6 Location of photomontages

Photomontages have been produced from viewpoints, which are representative of the nature of visibility at various distances and in various contexts. It is not feasible to produce photomontages from every possible viewpoint in the study area. Photomontages are used as a tool to come to understand the nature of the residual effects. The selection process of viewpoint locations is as follows:

- The location of viewpoints within the study area is informed by site survey, mapping and predicted Zones of Theoretical Visibility (ZTV);
- Visual impact mapping of open and intermittent views during site surveys assess the potential visibility of the proposed development from settlements, national, regional and main local roads including scenic roads, scenic viewpoints as well as from cycling and walking routes, relevant mountain tops and other landscape designations such as national parks etc.;
- Identification and selection of representative viewpoints showing typical open or intermittent views within a local area, which will be frequently experienced by a range of viewers;
- Identification and selection of specific viewpoints from key viewpoints in the landscape such as routes or locations valued for their scenic amenity, main settlements etc.;
- Confirmation of viewpoint locations to be used for photomontages by the client and relevant planning authorities consulted during the preparation of the EIS.
- Viewpoint selection has been carried out according to the best practice standards and industry guidelines as used for the original EIS; this means that the original LVIA and this new report remain able to be compared:
- Visual Representation of Windfarms - Good Practice Guidance, Scottish Natural Heritage, 29 March 2006
- Photography and Photomontage in Landscape and Visual Impact Assessment, Landscape Institute Advice Note 01/2011
- Planning Guidelines for Wind Energy Development, Department of Environment, Heritage and Local Government, 2006

11.2.7 Summary

An understanding of both the landscape character and key landscape characteristics forms the basis for an assessment of the visual impact of a wind farm development. The assessment is largely based on objective criteria. However, an element of subjective judgement is also involved.

11.3 RECEIVING ENVIRONMENT

11.3.1 Site Context

The proposed wind farm site is located within a large landscape basin on generally flat terrain. It is surrounded by mountains of the Nephin Beg Range to the south and southwest, Slieve Fyagh to the northwest and Maumakeogh with associated hills to the north. The application site is mainly located on a former industrial peat harvesting area, which was formerly used to supply the adjacent, now demolished, Bellacorick power station. There is an existing operating wind farm located within the proposed wind farm site comprising 21 turbines. The site has planning permission for a wind farm development comprising 180 wind turbines with a maximum tip height of 100m.

Bellacorick borders the southern wind farm site boundary. Crossmolina lies approximately 9.7 km and Ballina 18km to the east boundary of the site, Bangor Erris 8km to the western site boundary, Belmullet 25 km to the west and Newport 23km to the south.

The N59 runs to the south of the application site in close proximity to the development site boundary. The R315 runs approximately 7km to the east at its closest. The R312 approaches the site from the southwest before joining the N59. The R314 runs through the northern study area arching from west to north to east at an approximate 9.5km distance to the nearest turbine.

11.3.2 Landscape Character

The landscape consists of the following four key characteristics - physical, social, experiential and visual. These can be defined in terms of topography, landform, land use, scale, exposure and visual quality.

11.3.3 Physical characteristics (Topography, Landform)

The exposed generally flat basin is located at an altitude of an average of 100m AoD, rising gently from south to north. The nearest prominent mountains are Slieve Fyagh (331m AoD) to the northwest and Maumakeogh (379m AoD) and several foothills (ranging between 226 – 351m AoD) to the north, northeast. The Nephin Beg Range frames the basin with Nephin (806m AoD) to the southeast, Birreencorragh (698m AoD) to the south, Nephin Beg (627m AoD) and Slieve Carr (721m AoD) to the southwest. The very gently undulating landform within the wind farm site continues to the east and changes quite abruptly to gentle drumlin topography. The proposed wind farm site contains many small loughs and a number of small streams, which are tributaries of the Oweninny, Owenmore (west and northeast) and Shanvolahan Rivers. The Oweninny and River separate the wind farm site into to a western and eastern section.

The majority of the proposed wind farm site is part of the former peat harvesting area and comprises predominantly low vegetation consisting of different regenerating bog grass types and moorland grasses resulting in wide open and relatively uniform landscape. Patches of coniferous forest provide isolated clusters of recognisable vertical vegetation. The wider surrounding area comprises of further large areas of grassland, of pastureland to the south and east and large plantations of commercial coniferous forest along hill and mountain slopes to the north, west and south.

11.3.4 Social (Land use)

The majority of the land within the proposed wind farm site has been left open for regeneration after the cessation of industrial peat harvesting. An existing 21 turbine wind farm is located in the south-eastern part of the site. The site also holds planning permission for a wind farm layout comprising 180 wind turbines, (see Chapter 2). The wider landscape includes areas of blanket bog, large plantations of commercial forest as well as a number of overhead transmission lines carried on timber pole-sets. The land use changes, when travelling to the east towards Crossmolina and beyond, where extensive areas of pasture and fields divided by hedgerows, clusters of scrub, woodland and pockets of peat bog dominate the overall pattern.

The Western Way passes along sections of the southern and western site boundary approaching the proposed wind farm site from the south and continuing north, northeast. Other walking and cycling routes are located outside of the landscape basin containing the wind farm site. The wider area contains the Céide Fields and Visitor Centre located on the northern slopes of Maumakeogh, north of the proposed wind farm site, and facing the Atlantic Ocean. The Ballycroy National Park and the proposed Nephin Wild Project are located to the south and southwest across sections of the Nephin Beg Range and are separated from the wind farm by large coniferous plantations. A number of scenic viewpoints and scenic roads are located within the vicinity of the development site and in the wider study area.

11.3.5 Experiential (Scale and exposure)

The field of vision of a potential observer on site is wide and open to all directions. The absence of significant vertical vegetation, generally flat landscape and the size of the basin containing the proposed wind farm site lead to a sense of openness and remoteness. High mountain ridges to the southwest, south and southeast (refer to Photomontages 9A, 10B and 20) line the horizon and contribute to the sense of a large scale landscape.

11.3.6 Visual

The open, windswept, smooth and remote nature of the landscape basin containing the proposed wind farm site and the lack of any significant landmarks contributes to a particular visual quality, which is different to the more common agricultural landscape pattern to the east and the coastal landscape to the west. The visual quality is high due to uninterrupted views covering large perceptibly empty areas.

11.3.7 Planning Context (Refer to Figure 11.1)

The Mayo County Development Plan 2008-2014 and Sligo County Development Plan 2011-2017 contain the statutory plans controlling development in the study area. The plans have been consulted with regard to visual amenity policies and landscape designations. Special Areas of Conservation (SACs), proposed Natural Heritage Areas (pNHAs), Natural Heritage Sites (NHAs), and Special Protection Areas (SPAs) produced by the NPWS for County Mayo and Sligo were taken into consideration in relation to landscape designations at national level.

11.3.8 Landscape Character County Mayo

The Landscape Appraisal of County Mayo contained in the current development plan subdivides the County into 16 Landscape Character Units. Units with similar landscape types have been grouped into 4 Principle Policy Areas. The proposed Oweninny Wind Farm is located within the following character unit/policy area:

Landscape Character Unit:

F – North Mayo Inland Bog Basin

11.3.9 Principle[135] Policy Area:

Policy Area 3 – Uplands, moors, heath or bogs

The Landscape Appraisal sets out indicative policies for each Policy Area, which should be read in conjunction with the relevant landscape factors of each landscape character unit. The Landscape Appraisal sets out the following indicative policies for Policy Area 3:

"Policy 12: Recognise the occurrence of areas of highly valued scenic vistas, uninterrupted by shelter vegetation or undulating topography, which can cover vast areas and are abundant.

Policy 13: Encourage development that will not have a disproportionate visual impact (due to excessive bulk, scale or inappropriate siting) and will not significantly interfere or detract from scenic upland vistas, as identified in the Development Plan, when viewed from areas of the public realm.

Policy 14: Encourage development that will not interrupt or penetrate distinct linear sections of primary ridge lines when viewed from areas of the public realm.

[135] As ststed in the Landscape Appraisal of County Mayo, Mayo County Council, 2008

Policy 15: Facilitate developments that have a locational requirement to be situated on elevated sites (e.g. telecommunications and wind energy structures). It is necessary however to ensure that adverse visual impacts are avoided or mitigated wherever possible.

Policy 16: Preserve from development any areas that have not already been subject to development, which have retained a dominantly undisturbed upland/moorland character.

Policy 17: Consider development on steep slopes, ensuring that it will not have a disproportionate or dominating visual impact on the surrounding environment as seen from areas of the public realm."

The Landscape Appraisal also evaluates different development types in different policy areas in a Development Impact – Landscape Sensitivity Matrix. For Policy Area 3, wind farm and ancillary development has been identified as having "High potential to create adverse impacts on the existing landscape character. Having regard to the intrinsic physical and visual characteristics of the landscape area, it is unlikely that such impacts can be reduced to a widely acceptable level."

The Landscape Appraisal zones the county into areas designated as vulnerable and sensitive.

The proposed wind farm site includes the following Areas Designated as Vulnerable - Shorelines of Oweninny River, River Muing and Lake Dahybaun.

The majority of the proposed wind farm site is located within the following Areas Designated as Sensitive - Peat Bogs.

Relevant detailed information as stated in the Renewable Energy Strategy for County Mayo 2011-2020 is described in Section 11.3.16 – Renewable Energy Development.

A summary of relevant Landscape Character Units and Principle Policy Areas which are either fully or partially contained within the 30km study area is shown in Table 11.3 & 11.4 below and mapped in Figure 11-2 – Landscape Character. Section 11.5 – Landscape and Visual Effects describes the resultant impact on these areas.

Table 11.3 – List of Landscape Character Units (LCU) fully or partially contained within the study area

LCU	Name
A	Achill, Clare and Island Complex
B	North West Coastal Moorland
C	North West Coastal Bog
D	North Coastal Plateaux
E	North Mayo Mountain Moorland
F	North Mayo Inland Bog Basin (contains the proposed Oweninny Wind Farm site)
G	North Mayo Drumlins

LCU	Name
H	East Mayo Uplands
J	Clew Bay Drumlins

Table 11.4 – List of Principle Policy Areas (PPA) fully or partially contained within the study area

PPA	Name
1	Montaine Coastal
2	Lowland Coastal
3	Uplands, moors, heath or bogs (contains the proposed Oweninny Wind Farm site)
3A	Lakeland Sub-policy Area
4	Drumlins and lowlands
4A	Lakeland Sub-policy Area

<u>County Sligo</u>

Objective O-LCAP-1 contained in the current Sligo County Development Plan 2011-2017 states that Sligo County Council plans to "undertake a Landscape Character Assessment for County Sligo within the principles of the European Landscape Convention and best practice guidance."

Current landscape policy is based on a detailed landscape characterisation and appraisal study which was carried out in 1997 resulting in a Development Control Policy Map. The map classifies the county according to its visual sensitivity and ability to absorb new development without compromising the scenic character of an area.

The following designated areas have been identified within the study area:

- River Moy and its Estuary - 'Sensitive Rural Landscape' These are areas that "tend to be open in character, with intrinsic scenic quality and a low capacity to absorb new development."
- Eastern shores of the River Moy - 'Visually Vulnerable Areas'. These are areas which contain "Distinctive and conspicuous natural features of significant natural beauty or interest, which have extremely low capacity to absorb new development."

11.3.10 Areas designated for ecological importance

The Development Plans for County Mayo and Sligo indicate a number of Natural Heritage Areas and Natura 2000 sites within the study area. However, the online map viewer of the National Parks and Wildlife Service (NPWS) contains the most up to date information on these sites and was therefore solely used to identify relevant areas within the study area as listed below. While these designations are primarily concerned with ecological issues, their potential amenity value warrants assessment in terms of landscape value. An overview of the location of relevant Natural Heritage Areas and Natura 2000 sites is mapped in Figure 11-3 – Designated ecological sites and Natura 2000 sites.

Table 11.5 – List of Natura 2000 (cSAC and SPA) sites within the 30km study area

Site Code	Site Name	Site Code	Site Name
County Mayo Special Areas of Conservation (SAC)			
000458	Killala Bay/Moy Estuary	000534	Owenduff/Nephin Complex
000466	Bellacorick Iron Flush	000542	Slieve Fyagh Bog
000470	Mullet/Blacksod Bay Complex	001482	Clew Bay Complex
000472	Broadhaven Bay	001922	Bellacorick Bog Complex
000476	Carrowmore Lake Complex	002005	Bellacragher Saltmarsh
000500	Glenamoy Bog Complex	002144	Newport River
000516	Lackan Saltmarsh and Kilcummin Head	002177	Lough Dahybaun
000522	Lough Gall Bog	002298	River Moy
County Sligo Special Areas of Conservation (SAC)			
000458	Killala Bay/Moy Estuary		
County Mayo Special Protection Areas (SPA)			
Site Code	***Site Name***	***Site Code***	***Site Name***
004036	Killala Bay/Moy Estuary	0004037	Blacksod Bay/Broadhaven
004228	Lough Conn and Lough Cullin	004052	Carrowmore Lake
004074	Illanmaster	004098	Owenduff/Nephin Complex
County Sligo Special Protection Areas (SPA)			
Site Code	*Site Name*		
004036	Killala Bay/Moy Estuary		

Table 11.6 – List of Natural Heritage Areas within the 30km study area

Site Code	Site Name	Site Code	Site Name
County Mayo Natural Heritage Areas (NHA)			

Site Code	Site Name	Site Code	Site Name
001473	Bangor Erris Bog		
001548	Pollatomish Bog	000494	Downpatrick Head
001566	Tristia Bog	000500	Glenamoy Bog Complex
001567	Tullaghan Bay and Bog	000516	Lackan Saltmarsh and Kilcummin Head
001570	Ummerantarry Bog	000519	Lough Conn and Lough Cullin
002383	Croaghmoyle Mountain	000522	Lough Gall Bog
002391	Inagh Bog	000534	Owenduff/Nephin Complex
002419	Glenturk More Bog	000542	Slieve Fyagh Bog
002420	Cunnagher More Bog	001485	Cloonagh Lough (Mayo)
002432	Forrew Bog	001488	Corraun Point Machair/Dooreel Creek
002446	Ederglen Bog	001499	Drumleen Lough
000458	Killala Bay/Moy Estuary	001517	Killala Esker
000459	Altaconey Bog	001527	Lough Alick
000466	Bellacorick Iron Flush	001922	Bellacorick Bog Complex
000467	Benaderreen Cliffs	002005	Bellacragher Saltmarsh
000470	Blacksod Bay complex	002078	Moy Valley
000472	Broadhaven Bay	000482	Creevagh Head
000476	Carrowmore Lake Complex		
County Sligo Proposed Natural Heritage Areas (pNHA)			
Site Code	***Site Name***		
000458	Killala Bay/Moy Estuary		

11.3.11 Protected views and prospects

County Mayo

The Landscape Appraisal accompanying Mayo County Development Plan 2008-2014 identifies

- Scenic Routes, and
- Areas with Highly Scenic Views

It sets out the following policies for these designations:

> *"Scenic routes indicate public roads from which views and prospects of areas of natural beauty and interest can be enjoyed. Sightseeing visitors are more likely to be concentrated along these routes." Applications for permission "to develop in the environs of a scenic route" should "demonstrate that there will be no obstruction or degradation of the views towards visually vulnerable features nor significant alterations to the appearance or character of sensitive areas."*
>
> *"Highly scenic views or vistas indicate areas along public roads from which views and prospects of areas of high natural beauty and interest can be enjoyed. Sightseeing visitors are more likely to be concentrated along these areas. Development located between the public road and the seashore, lakeshore or riverside should be subject to strict visual criteria. New development should only be considered where it can be demonstrated that it does not obstruct of designated highly scenic vistas nor alters or degrades the character of the surrounding landscape."*

Map 10 of Mayo County Development Plan 2008-2014 identifies Highly Scenic Views, Scenic Views, Scenic Viewpoints and Scenic Routes. There are slight differences in relevant designations when comparing the County Development Plan 2008-2014 and the Landscape Appraisal. However, for the purpose of this assessment, data contained in both documents have been combined, and designated scenic routes & views which are located fully or partially within the study area and are mapped on Figure 11.1 – Landscape Designations and Photomontage Locations. Individual relevant Scenic Routes for Counties Mayo and Sligo have also been numbered for the purpose of this assessment and mapped accordingly in Figure 11.1 as listed in Table 11.7 and 11.8 below.

***Table 11.7* County Mayo - List of Scenic Routes and Highly Scenic Views within the study area**

No.	Scenic Routes
SR 1	N59 from Bangor to east of Rosturk
SR 2	R297 from Castleconor (border to County Sligo) to Crockets Town (Ballina)
SR 3	R312 from Derreen to Beltra Lough
SR 4	R313 Barnatra to Blacksod Point
SR 5	R314 from Belderg to Bunatrahir Bay and from Glenamoy to Barnatra
SR 6	R315 from Lahardaun to Pontoon (west of Lough Conn)
SR 7	R319 from Mulranny to south of Bunacurry (northern part of Achill Island)

No.	Scenic Routes
SR 8	L134 from Knockmore to north of Ross West (between Lough Conn and Lough Cullin)
SR 9	Local road from Rathlackan west to Gortmore, south of Downpatrick Head
SR 10	Local road from south of Pollatomish to Barnatra
SR 11	Local road along the west shores of Carrowmore Lake, from Barnatra to the R313 junction
SR 12	Local road from Gweesalia and around the peninsula
SR 13	Local road from Beltra to the R315 junction at Lough Conn
SR 14	Local road from Killala to Moyne Abbey
SR 15	Local road east of Lough Conn, from Garrycloonagh to Brackwanshagh
SR 16	Local road west of Lough Conn, from the R312 junction north of Keenagh to Newport
SR 17	Local road from Srahmore, running east of Furnace Lough, to Newport
SR 18	Local road from Srahmore, running north joining the R312 to Bellacorick
Highly Scenic Vistas	
R310 south of Lough Conn and north of Lough Cullin (looking to both lakes)	
R314 at Céide Fields (looking towards the Atlantic Ocean)	
R315 from Cuilkillew to Pontoon (looking towards Lough Conn)	
Local road north of Pollamish (looking towards Broad Haven)	
Local road west of Carrowmore Lake, from Barnatra to the R313 junction (looking towards Carrowmore Lake)	
Local road at Dooyork (looking towards Blacksod Bay)	
Local road from the R312 junction north of Keenagh running to the west of Furnace Lough to Newport (looking towards the Nephin Beg Range, Lough Feeagh and Furnace Lough)	

Table 11.8 County Sligo - List of Scenic Routes within the study area

No.	Scenic Route
SR 19	R297 from Enniscrone running southwest and diverting to a local road continuing south along the east side of River Moy towards Ballina

11.3.12 Walking routes

The current Mayo and Sligo County Development Plans do not identify specific existing walking routes within the study area. However, relevant existing walking routes have been laid out in OSi Discovery Series (4th Edition) as well as on the following websites:

- Irishtrails; http://www.irishtrails.ie/

- Mayo Walks, http://www.mayowalks.ie

- Erris Beo, http://www.errisbeo.ie

- Discover Ireland, http://www.discoverireland.ie

The most relevant and clearly mapped routes within the study area have been included in Figure 11.1, 11.4 & 11.5 and are listed below:

Western Way

This long distance walking route enters the study area in the south at Newport and continues north across the Nephin Beg Range passing close to the southern and western proposed wind farm site boundary. It continues northeast to Ballycastle, then southeast via Killala to Ballina, leaving the study area east of Ballina. Large sections of the walking route within a 17km radius of the proposed wind farm site are located within coniferous forestry.

Bangor Trail

This approximately 29km linear walking route stretches between Bangor Erris, along the western and southern slopes of the Nephin Beg Range to Newport, coinciding with the Western Way route from Srahmore to Newport. At its nearest, it is located approximately 8.5km west of the nearest proposed wind turbine.

Burrishoole Loops

The Burrishoole Loop Walks comprise a number of looped walks located along the southern slopes of the Nephin Beg Range between Newport and Mulranny. The walks are grouped into the following four main walking areas:

- Newport (comprising 4 looped walks)
- Derradda (comprising 3 looped walks)
- Tiernaur (comprising 3 looped walks)
- Mulranny (comprising 2 looped walks outside of the study area)

The walks are located between approximately 23km and 29km nearest proposed wind turbine and face Clew Bay.

Crossmolina Loop Walks

A series of three interconnecting looped walks are located along side roads and country lanes east and northeast of Crossmolina. The walking routes consist of the following walks:

- White Walk (Gortnoor Abbey), 4km
- Blue Walk (Grange), 6km
- Red Walk (Deel Castle), 11km

The walking routes are located approximately 13km east, southeast from the proposed wind farm site at their closest (distances based on nearest turbine).

Achill Spur

This approximately 17km long walking route between Mulranny and Newport runs along the southern slopes of the Nephin Beg Range and coincides with sections of the

Burrishoole Loop Walks. The walking route is located approximately 23km south of the nearest proposed wind turbine.

Enniscoe House Loop

This 3km looped walk approximately 2.5km south of Crossmolina is located within the former demesne of the same name and travels through woodlands near the shore of Lough Conn. The walk is located approximately 15km southeast of the proposed wind farm site.

Keenagh Loop

The approximately 11.5km Kenagh Loop is located on the eastern and southern slopes of Knockaffertagh Mountain and approximately 17km southeast of the nearest proposed wind turbine. It offers scenic views of the south-eastern section of the Nephin Beg Range.

Letterkeen, Bothy, Lough Aroher Loops

These 3 looped walks are located on the lower south-eastern slopes of Nephin Beg within mountainous valleys and coincide along several sections. The majority of the walks are located within coniferous forestry approximately 13km south of the nearest proposed wind turbine.

Ceathrú Thaidhg Loop Walks

The walks starting at Caethrú Thaidhg and comprise the following two looped walks:

- Children of Lir Loop (10km),
- The Black Ditch Loop (13km)

The loop walks are located on the south-western slopes of hills rising to Benwee Head and are located approximately 21.5km northwest of the proposed wind farm site.

Belleek Nature Trail

This walking route is located north of Ballina and within the forestry along the western shores of the River Moy. The site is located approximately 21km from the eastern proposed wind farm boundary.

Sralagagh Loop Walk

This 9.5km looped walk starting in Ballycastle encircles the Bellananaminnaun River valley west of Ballycastle. This walk is located approximately 13km northeast of the proposed wind farm site.

Inishbiggle Loop Walks

These walking routes comprise the following two looped walks located on the island of Inishbiggle, Blacksod Bay:

- Bull's Mouth Loop (5km)
- Gubnadoogha Loop (4km)

Both walks coincide in the centre of the island and are located approximately 24km southwest of the proposed wind farm boundary.

The Great Western Greenway

This approximately 43.5km walking and cycling route runs between Westport and Achill Sound running along the southern slopes of the Nephin Beg Range in the south of the study area. The route is located approximately 25km south of the proposed wind farm site at its closest.

Foxford Way

Older OSi Discovery Series mapping indicates the Foxford Way looping around Lough Cullin as well as stretching to the east of the town of Foxford. Up to date OSi mapping (2010) and the Mayo Walks brochure indicate the Foxford Way (subdivided into several loops) to the east of Foxford only, and therefore outside of the study area. Online independent walking websites indicate sometimes both the Lough Cullin route and the routes east of Foxford. Potential landscape and visual effects have not been assessed as the most up to date information states that this walk is outside of the study area.

'Slí na Sláinte' walking routes

The study area contains three of currently four Slí na Sláinte walking routes in County Mayo. Developed by the Irish Heart Foundation, the routes are mainly located within close proximity of towns such as Belmullet, Ballina and Carrowteige / Ceathrú Thaidhg. The following walks have been identified within the study area:

- Carrowteige, Ceathrú Thaidhg Slí (3km)

- Belmullet, Broadhaven Slí (3.1km)

- Ballina, Ballina Sli (3.2km)

11.3.13 Cycling Routes

The current Mayo and Sligo County Development Plans do not identify specific existing cycling routes within the study area. Relevant existing cycling routes have been identified on the following website:

- Mayo Walks, http://www.mayowalks.ie

Relevant and clearly mapped routes within the study area have been included in Figure 11.1, 11.4 & 11.5 and are listed below:

Belmullet Cycle Hub

As part of the North Mayo Cycle Network, the town of Belmullet is a hub of a number of marked cycling trails ranging in distance from 37km – 72km. The following cycling routes are located within the study area:

- Carrowmore Loop (37km)

- Pullathomas Loop (50km)

- Glinsk & Rossport Linear Route, Coastal Route between Belmullet and Ballycastle (72km)

- North Mayo Linear Route – Belmullet – Ballycastle (49km)

The Carrowmore Lake Loop, at an approximate 11km distance, is located closest to the proposed wind farm site.

Great Western Greenway

This approximately 43.5km walking and cycling route runs between Westport and Achill Sound running along the southern slopes of the Nephin Beg Range in the south of the study area. The route is located approximately 25km south of the wind farm site at its closest.

11.3.14 Céide Fields

The stone-walled Céide Fields network is located approximately 12km north, northeast of the proposed wind farm site boundary across the northern and north-eastern slopes of Maumakeogh Mountain and its foothills (refer to location indicated on Figures 11.1 – 11.7). This extensive Stone Age monument, the largest of its kind in the world, contains field systems, dwelling areas and megalithic tombs of 5000 years ago. It is a Candidate World Heritage Site.

11.3.15 Ballycroy National Park

Established in November 1998, Ballycroy National Park is located on the western seaboard of the Nephin Beg Range. It comprises 11,000ha of Atlantic blanket bog and mountainous terrain, covering a large uninhabited wilderness. It contains Owenduff Bog, one of the last intact active blanket bog systems in Ireland and Western Europe. The Park also protects a variety of other important habitats and species. The National Park is itself part of the Owenduff/Nephin Complex Special Area of Conservation (SAC) and Special Protection Area (SPA) as listed in Section 11.3.9 and mapped on Figure 11.2 – Natural Heritage Areas and Natura 2000 sites). The National Park is mapped on Figure 11.1 – Landscape Designations and Photomontage Locations.

11.3.16 Proposed Nephin Wild Project

This proposed project is looking at the feasibility of setting aside an extensive area in the Nephin Beg Mountains as a wilderness area. Coillte, as landowner of the area, envisages the setting aside of a large area that would be initially managed to create the conditions where natural processes will begin to prevail and where opportunities will be provided for visitors to experience challenging and adventurous wilderness recreation.

The existing forest contains two trails – the Bangor Trail, which skirts along the south-western boundary of the lands and the Western Way which traverses the site through the forest in a north south direction. The project is at concept stage and the transition period from forest to wilderness will take several years after a decision to proceed with this project has been made. The proposed area of the Nephin Wild Project is mapped on Figure 11.1 – Landscape Designations and Photomontage Locations and Figure 11.7 – Nature of Visibility.

11.3.17 Renewable Energy Development

The Mayo County Development Plan 2008 – 2014 states that the Council will have regard to the policies laid out in the DoEHLG’s Wind Energy Development Guidelines, 2006.

The Renewable Energy Strategy for County Mayo 2011-2020 accompanies the current development plan, and classifies potential areas for on-shore wind energy development. The proposed location of Oweninny Wind Farm is located within a 'Priority Area' for wind farm development. It states in Section 6.4.1 – Wind Energy, that "Priority Areas are areas which have secured planning permission and where onshore wind farms can be developed immediately."

Objective 2.4 states that "It is an objective of the Council to ensure that renewable energy developments do not interfere with, damage, remove, or impinge on the visual amenity of, existing rights of way, public walking and cycling routes, scenic routes and scenic views, architectural heritage including protected structures and Architectural Conservation Areas, archaeological heritage including recorded monuments, Ballycroy National Park and vulnerable or sensitive landscapes in the County."

Section 6.5.14 – Landscape, of the Renewable Energy Strategy also states that "Renewable energy developments shall avoid sensitive and vulnerable landscapes, listed highly scenic views, scenic views, scenic viewing points and scenic routes where detailed visual analysis demonstrates that the development will have an adverse affect on those landscapes. Renewable energy developments shall be sited and designed to minimise the visual amenity of the surrounding area."

Constraints: Landscape Sensitivity

The proposed wind farm is located within the Bellacorick Basin / Landscape Character Unit F / Policy Area 3. As stated in Section 11.3.8, the Development Impact - Landscape Sensitivity Matrix contained in the Landscape Appraisal classifies the overall landscape sensitivity as high.

11.4 CHARACTERISTICS OF THE PROPOSAL

11.4.1 The Proposal

It is proposed to locate 61 turbines on the site. All turbines will have a maximum tip height of 176m. They will be arranged into two main sections (east and west) across the often flat or gently undulating topography of the former peat harvesting areas and will be separated by the Oweninny River. Turbine rotors and nacelles will swivel to face the prevailing wind. Ancillary development such as substations, meteorological masts, 110 kV overhead transmission lines, an Operation and Maintenance facility and a proposed visitor centre will be located within the proposed wind farm site.

11.4.2 Spatial Layout Characteristics

11.4.2.1 Relationship to Site, Topography and Landscape

The site is located across the former peat harvesting areas of Bellacorick, north of the N59. The proposed wind farm site is located within a large basin of generally flat terrain and it is surrounded by mountains of the Nephin Beg Range to the south and southwest, Slieve Fyagh to the northwest and Maumakeogh with associated hills to the north. Views from within the basin are open, panoramic and often unrestricted for long distances due to the lack of significant vegetation or other landmarks. The surrounding landscape appears remote. Despite the large scale of the landscape, human influence is recognisable in the form of a number of overhead transmission lines in the vicinity of public roads and commercial forest plantation. The former industrial character created by the Bellacorick peat burning Power Station has been significantly reduced due to the removal of all vertical power station structures and the commencing rehabilitation of the large peat harvesting areas.

The spatial arrangement of the turbines relates to the contours of the large basin and to the surrounding mountain ranges. The siting of the wind farm also relates to the existing wind resource and the exposure of the open and exposed basin.

The landscape setting is large in scale and lends itself to the possibility of a large number of turbines rather than a smaller wind farm. The proposed development comprising 61 turbines would constitute a large wind farm.

11.5 IMPACT OF THE DEVELOPMENT

11.5.1 Introduction

The main parameters defining Visual Effects (as described in Section 11.2.1) are:

- Extent of visibility
- Nature of visibility

In areas where visual effects are significant there is also an effect on the landscape character. The effects on landscape character are assessed in Section 11.3.8.

The assessment of the visual character is based on widely accepted design principles, practised within the design professions as described in Section 11.2.1. The Zones of Theoretical Visibility are presented separately for hub and blade tip height on the ZTV maps – Figures 11.4 and Figure 11.5. The extent of visibility is described in the Visual Impact Map, Figure 11.6. Areas from where the wind farm is visible are mapped in Figure 11.7 – Nature of Visibility.

Thirty two photomontages illustrate the landscape and visual effects of the wind turbines within the Zones of Theoretical Visibility.

In this section the following issues will be discussed in detail:

- Zones of Theoretical Visibility
- Effects on Landscape Character
- Cumulative Effects
- Effects on Designated Areas
- Impact on built-up areas
- Impact on roads
- Connection to National Electricity Grid

A visual survey of the study area was made during the following four separate site visits:

- 13-14 March 2012, weather conditions generally overcast with short to middle distance visibility;

- 18-22 September 2012, mixed weather conditions ranging from cloudy with good middle distance visibility to clear and sunny with long distance visibility;
- 23 October 2012, cloudy conditions with good long distance visibility;
- 20-21 February 2013, weather conditions good with sunny spells and good middle distance visibility
- 13-15 May 2013, good sunny spells and long distance visibility mixed with occasional showers

The site survey also included an assessment of views from the summit of Nephin Beg and Maumakeogh representing views from the mountain ranges to the north and south of the proposed wind farm site. The visual survey was carried out as part of the four main site visits but on the following dates:

- 20 September 2012 – Maumakeogh, cloudy weather conditions with sunny spells, good long distance visibility from summit with slight haze across the Bellacorick basin containing the proposed Oweninny Wind Farm site
- 21 September 2012 – Nephin Beg, good sunny spells with some cloudy patches and clear long distance visibility

11.5.2 Zones of Theoretical Visibility (Refer to Figures 11.4 & 11.5)

The Zones of Theoretical Visibility at hub and blade tip height have been mapped for a 30km radius. These maps indicate areas where turbines are visible and where they are not visible, and the number of turbines that would be viewed from certain areas. This mapping does not, however, take account of vegetative screening or the built environment and hence reflects a ‘bare earth’ landscape, which for the visual impact assessment process represents ‘’the worst case scenario’’.

However, vegetative screening was mapped during the site survey and is taken into account in the visual analysis. In areas where the definition of the precise amount of visibility was critical, photomontages are used. The results are presented in the Visual Impact Map, Figure 11.6, which shows the principal views and sections of roads where there are open or intermittent views of the proposed Oweninny Wind Farm.

11.5.3 Principal Views (Refer to Figure 11.6)

Views of the proposed Oweninny Wind Farm can generally be classified into the following four visual zones:

- Primary Principal Visual Zone, core visual zone within up to 14km of the wind farm site;
- Secondary Principal Visual Zone, west of the wind farm site between approximately 11-29km distance;
- Northern Mayo Drumlin Zone, east and southeast of the wind farm between approximately 12 – 30km distance;
- Mountain Range Zone, from elevated areas, summits or slopes facing the wind farm site to the northwest, north, south and east as well as relevant river valleys within this zone between approximately 8 – 30km of the centre of proposed wind farm site.

The extent of the Principal Visual Zones within the study has been mapped on Figure 11.6.

Primary Principal Visual Zone - Comprises views primarily from within the wind farm site, areas to the north, east and south of the site within up to 14km radius of the centre of the wind farm site. This zone is shaped by the surrounding topography and large scale commercial forestry. Large sections of this zone consist of unpopulated or sparsely inhabited land and forestry plantations. Within much of this area, visibility of the wind farm will often be open and unrestricted due to generally flat topography and the absence of significant vertical intervening vegetation. Wind turbines will be seen either fully or partially, with the lower part of the tower being screened by topography or clusters of existing commercial forestry. Landscape and Visual effects are illustrated in Photomontages A and B, 2 – 11 & 21 – 23.

Secondary Principal Visual Zone - Comprises views from middle to long distances between approximately 11km and 29km of the centre of the wind farm site. Areas with views are located west and northwest of the wind farm on the western side of the Nephin Beg Range and Slieve Fyagh and along the shores of Carrowmore Lake. The availability of views is due to the Glencullin River valley between Slieve Fyagh and Carrafull mountains as well as the Owenmore River valley between the mountains of Carrafull and Knocklettercuss. This Principal Visual Zone is again sparsely populated but it contains a higher density of residential dwellings than the Primary Principal Visual Zone, particularly when moving west towards the coastal areas. Views are open and panoramic with little obstruction by intervening significant vegetation but become increasingly dependent on weather conditions the further away the observer is located from the wind farm. The intervening mountain range to the west of the wind farm will limit the turbine visibility to blades or blade tips. Landscape and Visual effects are illustrated in Photomontages 16 – 18.

The **Northern Mayo Drumlin Zone** - Comprises areas to the east, southeast and northeast between approximately 12km and 30 km distance from the centre of the proposed wind farm site. These will experience open and intermittent middle and long distance visibility from public roads. Views become increasingly intermittent owing to local undulating North Mayo drumlin topography, vegetative screening and the effects of distance. Similar to the Secondary Principal Visual Zone, longer distance views between 20 and 30km will depend highly on weather conditions but also on the extent of intervening topography and vegetation. The density of residential habitations increases to the east, northeast and southeast. Landscape and Visual effects are shown in Photomontages 1, 24, 26 & 27.

The **Mountain Range Zone** - comprises Mountains of the Nephin Beg Range to the south and west of the proposed wind farm area and uplands, hills and mountains to the northwest, north and northeast of the site including all relevant river valleys between 8km and 30km distance of the centre of the proposed wind farm site. The majority of elevated areas, including mountain tops are unpopulated and only accessible by foot. Lower river valleys contain some residential dwellings dotted along the main public roads. Bangor Erris, which is located in the Owenmore River valley, is the only settlement of significance. Landscape and Visual effects are shown in Photomontages 12, 13, 15, 19, 20 & 25.

Outside of the above described visual zones, the proposed wind farm is largely screened by topography and intervening vegetation when seen from public roads located to the south, southwest, northwest and north. Areas from where views of the wind farm will occur from public roads are indicated in Figure 11.6 – Visual Impact.

11.5.4 Landscape and Visual Effects (Refer to Figure 11.7)

The ZTV maps on Figures 11.4 and 11.5 indicate areas from where the turbines are theoretically either fully or partly visible. The site surveys revealed screening elements in the landscape and the areas of actual visibility are marked on Figure 11.7 in context with the ZTV mapping at 176m Blade Tip Height.

Photomontages and associated wireframes (refer to Photosheets enclosed in Appendix 10) illustrate the proposed structures of Oweninny Wind Farm from selected viewpoints located at different distances and elevations within the study area. They show the proposed Oweninny Wind Farm in different weather conditions in order to illustrate landscape and visual effects typical for County Mayo and to comply with current best practise guidelines. Detailed information on weather conditions captured has been described in Section 11.5.1. Please note that the following photomontage descriptions should be read in conjunction with Photosheets 1-27, there are a total of 32 photosheets but some are alternative views from the same location (4A and 4B, 7A and 7B, 8A and 8B, 9A and 9B and 10A and 10B). The photomontage images enclosed overleaf are of reduced resolution and for information only. The photomontages also show the proposed wind turbines at Corvoderry and Tawnanasool as well as the permitted turbine at Dooleeg. The landscape and visual effects of Oweninny Wind Farm as well as cumulative effects of other wind energy developments in the public domain in the area are described. Further details on cumulative effects and their definitions are described in detail in Section 11.5.5.

Photomontage 1: View west from the R315 at the northern outskirts of Crossmolina

Visual Zone	Northern Mayo Drumlin Zone
Description of view	Representative view from a series of short stretches with intermittent visibility of the proposed wind farm north of Crossmolina, when driving along the R315 towards Ballycastle. Similar views can be experienced from local roads within the vicinity. The wind farm will be visible along the horizon and will be partially screened by intervening topography and vegetation. The foreground and middle distance comprise an agricultural landscape with clusters of mature trees, shrubs, overgrown hedgerows, scattered residential dwellings and farm buildings as well as low voltage overhead transmission lines. Sections of the background are framed by mountains of the Nephin Beg Range.
Visual Effects	The proposed wind farm turbines will be visible individually and in small groups along the horizon, but will otherwise be screened by intervening vegetation and topography. Only the upper tower sections and their blades of the majority of visible turbines will be seen. The turbines are irregularly but generally harmoniously distributed along part of the horizon to the centre and right of the view. The turbines generally appear spaced along the horizon, however where turbine blades are overlapping this can result in visual confusion. The wind farm structures constitute recognisable, but not dominant new components in the wider view as they appear lower than intervening vegetation and smaller than other man-made and natural elements, which helps to integrate them in the overall panoramic view. The majority of the visible structures will be visible against the sky when looking west. However, given the distance of 12.77km to the nearest turbine and approximately 15km to the centre of the wind farm site, the visibility will be dependent on clear weather conditions. The visual effects are considered Slight. Cumulative effects in combination will be experienced from this viewpoint between the proposed Oweninny Wind Farm development and the permitted single turbine at Dooleeg. A small number of blade tips of the proposed Corvoderry Wind Farm will be visible. However, as demonstrated by comparison of the photomontage and wireframe image, the majority of the Corvoderry scheme will be screened by intervening vegetation and topography. Despite intervening vegetation, when seen together the wind farms will be perceived as one development due to the distribution of the turbines along the horizon.

Landscape Effects	The proposal would introduce new vertical elements along the horizon in the background of an established man-altered rural landscape character. Existing built vertical elements comprise scattered houses and low voltage overhead transmission lines. The proposed development will not be prominent and is not uncharacteristic when set within the attributes of the landscape. The landscape effects are therefore considered to be Low.

Photomontage 2: View west from the N59 at the Coolturk townland border

Visual Zone	**Primary Principal Visual Zone**
Description of view	This open view is representative of an elevated stretch of approximately 1km when driving along the N59 in the vicinity of Coolturk townland. Oweninny Wind Farm together with the Corvoderry Wind Farm will be visible in this view across the horizon. The foreground contains pasturelands and bog grass types, general low vegetation and road side vegetation, a number of overhead transmission lines and road infrastructure. Extensive coniferous plantations are located in the middle distance stretching to the horizon in this view.
Visual Effects	In this or similar open views within the vicinity, the proposed wind farm will be visible across the horizon, indistinguishable from the proposed Corvoderry Wind Farm resulting in cumulative effects in combination. The majority of the lower tower sections of visible turbines will be screened by intervening topography and coniferous plantations. The turbines are irregularly spaced with several turbines overlapping resulting in some visual stacking. The majority of turbine structures will be seen against the sky, lower tower sections will be seen against the low mountain backdrop on the horizon. The proposed wind farm will have a sustained presence in this view, framing the horizon with large artificial features and affecting and changing its overall character. The proposal will be dominant in height but the remaining elements of the scene will not become subordinate due to the distance of the proposed wind farm (c.7.27km to the nearest proposed turbine). The visual effects will therefore be Substantial.
Landscape Effects	The open and exposed landscape character, influenced by human activity, will experience the introduction of large and prominent vertical structures. This new layer of verticality in the landscape is due to the intensity and scale of the proposed wind farm and will therefore result in a partial alteration of the existing landscape character. The introduction of the development is not substantially uncharacteristic as existing vertical elements such as transmission line masts and coniferous plantations are already present. Oweninny Wind Farm will intensify this verticality significantly and introduce a new industrial character, not in a traditional sense, but with the meaning of 'sustainable energy harvesting'. The landscape effects will be Medium as the introduction of the wind farm development will not result in a total loss of key landscape characteristics of the existing landscape when set within the attributes of the receiving environment. The "empty" characteristic of the landscape will change, but the flatness or open character remains.

Photomontage 3: View northwest from the N59 at Dooleeg

Visual Zone	**Primary Principal Visual Zone**
Description of view	This view illustrates a perspective from the N59 in the vicinity of the townland of Dooleeg near the south-western border of the proposed Oweninny Wind Farm. Similar open views can be experienced from locations along the N59 and local roads in the vicinity and east within a radius of approximately 6-8km from the centre of the wind farm site. The generally flat smooth terrain is covered with low vegetation such as moorland grasses, bog grass and clusters of shrubs in the foreground. Intermittent coniferous plantations and clusters of woodland in between grassy areas shape the middle ground. The ridges of hills and low mountains northwest of the wind farm site frame the background. The proposed Oweninny Wind Farm will be visible in the middle to far distance together with parts of the proposed Corvoderry Wind Farm, and single permitted Dooleeg wind turbine on the left of this image. The majority of turbines are either fully visible or with the lower turbine parts screened by intervening topography and vegetation.
Visual Effects	The open view across the land will be altered by the introduction of the proposed wind farm considering its scale and extent. From this location the slight separation of turbines to the east and west of the wind farm site is perceptible. Overall, the turbines are irregularly spaced and overlap in several locations with their blades and towers but appear harmonious overall. Turbines will be seen partially against the sky and the mountain backdrop in clear weather conditions. The turbines will be a rominent and immediately recognisable feature in this view and interrupt previously open views towards the mountains. They will become an extensive feature but are not visually obstructive due to their nature (that is, their slim, vertical form), layout and location within a large scale and open landscape. Visual effects are considered Moderate to Substantial. Cumulative visual effects in combination will be experienced with the single permitted Dooleeg wind turbine, which located on the left in this view, as well as parts of the Corvoderry Wind Farm, which is located in the right of this view. While the Dooleeg wind turbine can be seen as a separate development in this view, the development at Corvoderry will remain indistinguishable from the Oweninny wind farm development.
Landscape Effects	The existing landscape is regenerating following large scale industrial peat extraction within the proposed wind farm site and contains the existing Bellacorick wind farm. The turbines will be prominent and introduce a new key element into the landscape due to the scale and intensity of development, but they are not totally uncharacteristic when set within the attributes of the receiving environment. The underlying landscape character and the openness will remain. The landscape effects are considered Medium.

Photomontage 4A: View northwest from the N59 across Lough Dahybaun

Visual Zone	Primary Principal Visual Zone
Description of view	This view, together with Photomontage 4B, offers a panoramic vista which will be experienced when driving westbound along the N59 in this area. Photomontages 4A & 4B will be described separately as the observer would not be able to experience the wide panoramic view of both photomontages without turning the head. This viewpoint is located at the beginning of a flat landscape with smooth terrain covered with bog grasses with some single shrubs in the foreground. Lough Dahybaun is located in the middle ground. Areas of coniferous plantations intensify towards the background where they cover most of the low mountain ridges which enclose the wide open view on the horizon. The proposed wind farm will be visible mostly without intervening topography and vegetation.
Visual Effects	The wind farm and ancillary structures will be irregularly spaced across the centre of the view in the middle distance; to the right of the view the layout is evenly spaced with a more harmonious feel. All visible turbines will be seen partially against the mountain backdrop and the sky in clear weather conditions and interrupt previously open views towards the mountains. Visual stacking arises in areas where turbines overlap. The visual effects are considered Moderate to Substantial. The proposed turbines form a clearly recognisable new element within the overall scene but do not dominate this view given their setting within a wide open landscape with low vegetation offering large scale panoramic views. There will be no cumulative effects with proposed or permitted wind farm development in this view.
Landscape Effects	Much of this open and remote landscape is shaped by human influence with roads, power infrastructure, forest plantation and cutaway bog. It however retains an “empty” characteristic that will change with the introduction of significant vertical elements. The absence of significant vertical vegetation and the homogenous appearance of bog grassland, rehabilitating bog and coniferous plantations prevent possibilities for screening the proposed development. While the development will be prominent, it is not substantially uncharacteristic when set within the attributes of the receiving environment. The landscape effects will therefore be Medium.

Photomontage 4B: View north/northeast from the N59 across Lough Dahybaun

Visual Zone	Primary Principal Visual Zone
Description of view	Similar to Photomontage 4A, this view offers a panoramic vista which will be experienced when driving eastbound along the N59 in this area. This viewpoint illustrates the transition between undulating landscape in the east becoming more and more flat towards the west. Grassy ground cover with few scattered shrubs in the foreground and around Lough Dahybaun in the middle distance is replaced by low coniferous plantations in the background. Ridges of low mountains define the horizon. The wind farm will be openly visible. The base of turbines will be partially screened by intervening topography and low coniferous vegetation.
Visual Effects	The wind farm will be openly visible and irregularly spaced across the panorama in the middle distance. The majority of turbines will be seen partially against the mountain backdrop in clear weather conditions. Some instances of visual stacking arise in areas where turbines overlap in the centre of the view. While the currently existing Bellacorick wind farm already forms a focus point in this area, the proposed Oweninny Wind Farm will introduce large vertical and prominent new elements in this scene altering the existing view due to their scale, number and distribution across the field of view. The visual effects will be Substantial. The proposed Corvoderry Wind Farm will be seen in the middle distance to the right of the view and appear as an extension to the Oweninny scheme; together the proposed developments will be perceived as one scheme to the casual observer. However, a slight differentiation between Corvoderry Wind Farm and Oweninny Wind Farm may be possible due to different turbine heights but the overall cumulative effects will be in combination.
Landscape Effects	The middle distance of this open and remote landscape is shaped by human influence and the character of the landscape is homogenous and large scale. There are no structures or natural elements against which to perceive the scale of the proposal and therefore it becomes another large scale and homogenous addition to the landscape. The existing Bellacorick Wind Farm has already altered the existing landscape character. Therefore, the introduction of the proposed development would not be uncharacteristic when set within the existing environment but it would significantly extend the ‘Energy harvesting’ character resulting in Medium landscape effects due to the scale and coverage of the proposed development. The relatively “empty” characteristic of the landscape will change, but the flatness or open character remains.

Photomontage 5: View north/northwest from the R312 (Scenic Route SR 18) in close proximity to Bellacorick

Visual Zone	Primary Principal Visual Zone
Description of view	This view is representative of similar views along an approximately 3.5km long stretch of the R312, Scenic Road SR 18, southeast of the N59. The wind farm is visible across the middle distance and the background. Lower turbine tower parts are partially screened by intervening topography and coniferous vegetation. The foreground and parts of the middle distance are covered with extensive bog grassland. The Bord na Móna compound at Oweninny is located in the middle distance and is partially surrounded by coniferous forest plantation. Low mountain ridges, partially covered with coniferous plantations, define the horizon. Significant existing vertical elements in the otherwise flat landscape are overhead transmission lines in the foreground and middle distance.
Visual Effects	The wind farm is perceived as two separate groups (east and west) of turbines from this viewpoint. The turbines are openly visible and introduce extensive new elements in this scene due to the absence of road side vegetation or any other significant intervening elements. The large scale and wide view will be altered by new tall vertical features, sometimes overlapping, which will, have a sustained presence across this view. Due to the turbine layout and location in a large scale and wide open landscape, existing landscape elements will not become subordinate. Ancillary structures including the proposed visitor centre and substations will be entirely screened by topography and / or intervening vegetation. The visual effects will be Substantial. There will be no cumulative effects with adjacent permitted or proposed wind farm development in this view.
Landscape Effects	The existing landscape character is wide open. Transmission lines and the existing Bellacorick wind farm, as the only obvious vertical features, as well as intermittent forest plantation, indicate human activity but do not take from the sense of remoteness. The introduction of a large number of vertical elements will alter the existing landscape character, reduce the sense of remoteness and add an energy harvesting character. However, the underlying landscape remains and the proposed development will not be seen as totally uncharacteristic when set within the attributes of the existing environment. The landscape effects are therefore considered Medium.

Photomontage 6: View northeast from N59 at Bellacorick Bridge (part of Western Way walking route)

Visual Zone	Primary Principal Visual Zone
Description of view	This view from the N59 at Bellacorick Bridge represents a panoramic open view across Oweninny River and Muing River. This section of the N59 is also part of the Western Way walking route. Besides the water courses, the view contains areas of moorland and bog grass as well a small areas of pasture land in the foreground. Clusters of coniferous forest plantation and an isolated residential property define the middle and background. A number of overhead transmission lines cross the vista in the foreground. The wind farm will be visible in the middle distance extending into the background. The proposed 110kV overhead transmission line structures will be visible in the background. The proposed visitor centre (as indicated in the wireframe) will be fully screened by intervening topography and vegetation.
Visual Effects	The proposed wind farm will be openly visible to the left of the view. Lower sections (bases and lower portions of towers) of some turbines will be screened by intervening vegetation and topography. The turbines will be spaced irregularly and overlapping of turbines will result in visual confusion. The majority of the turbines will be seen against the sky. The turbines will form immediately apparent features of the scene, albeit concentrated in one direction, changing its overall character due to the introduction of tall vertical elements. Despite the number and density of the development, the underlying visual landscape will not become subordinate due to the nature of the wind turbines, the open nature of the view and the lack of a defining background which the turbines can be measured against. The visual effects will be Moderate to Substantial. Cumulative effects in combination will occur with the proposed Corvoderry Wind Farm will be seen to the centre and right in the background and is partially screened by intervening vegetation. The effect of the Corvoderry wind farm will be to extend the influence of wind energy development across much of the available field of view. Cumulative effects in succession will be possible with the permitted Dooleeg wind turbine from this viewpoint, seen to the right of this view.
Landscape Effects	The majority of the existing landscape has been altered by human activity. The introduction of the proposed development will be prominent due to the scale, verticality and number of turbines and would partially alter the pre-development landscape. However, it would be not substantially uncharacteristic when set within the attributes of the receiving landscape as the underlying physical landscape features will remain. The landscape effects are considered Medium.

Photomontage 7A: View west/southwest from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint near the centre of the wind farm site is located between the eastern and western section of the development. Photomontages 7A and 7B show a panoramic view to the southwest, west and northwest. However, the observer would not be able to see the entire development in one view without turning the head. The overall view has therefore been divided into two panoramic photomontages. This view is directed to the southwest and west. The wind farm as well as the proposed 110kV transmission line structures will visible in the middle distance. The foreground is covered with bog grassland. The ridges of the foothills of Slieve Carr rise up in the background.
Visual Effects	The panoramic view is wide open across a slightly rising, smooth, open landscape lacking in any significant vertical features. The mountain ridges apply some scale to the overall view. The overall vista portrays a remote and large landscape setting. The introduction of wind turbines will introduce immediately apparent elements which will, due to their scale and number, alter the overall character of the view. The turbines will be openly visible with the bottom of turbine towers partially covered by intervening topography. The turbines are laid out harmoniously. Visual confusion due to overlapping turbines is minimal from this viewpoint location. The majority of the turbines will be seen against the sky. The bottom part of the turbines will be seen against the mountain ridges in the background. While the turbines will be dominant features in this view and some mountain ridges will be seen through the turbines, the proposal will not dominate the existing landscape features due to the distance between each turbine. The visual effects are considered Substantial. There will be no cumulative effects with adjacent proposed or permitted wind farm development.
Landscape Effects	The introduction of wind turbines will re-establish the use of this landscape as harvesting area for energy production. The vertical, extensive and built nature of the proposed wind farm will alter the existing empty character of the landscape but the new elements will not be totally uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium.

Photomontage 7B: View west/northwest from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	**Primary Principal Visual Zone**
Description of view	This photomontage represents a view west/northwest from the same location as Photomontage 7A. The wind farm as well as the upper sections of the proposed 110kV transmission line structures will be visible in the middle distance. The proposed substation (as seen on the wireframe image) will be screened by intervening topography. The foreground is covered with bog grassland. Low mountain ridges covered with extensive coniferous plantations define the background.
Visual Effects	The panoramic view is wide open across a generally flat, smooth, open landscape lacking in any significant vertical features. The vista portrays a remote and large landscape setting. The introduction of wind turbines will introduce immediately apparent elements which will, due to their scale and number, alter the overall character of the view. The turbines will be openly visible with the bottom of turbine towers partially covered by intervening topography. The turbines are laid out harmoniously. Visual confusion due to overlapping turbines is minimal from this viewpoint location. The majority of the turbines in the foreground will be seen against the sky. Turbines in the middle distance will be partially seen against the mountain ridges in the background. The mountain ridges will be seen exclusively through the turbines. While the turbine layout is harmonious overall and overlapping of turbines is minimised, the development will have a sustained presence in this view. However, due to the layout and distance of turbines to each other, the natural landscape elements in this view will not become obliterated. The visual effects are therefore considered Substantial. There will be no cumulative effects with proposed or permitted wind farm development.
Landscape Effects	The introduction of wind turbines will re-establish the use of this landscape as harvesting area for energy production. The vertical, extensive and built nature of the proposed wind farm will alter the existing empty character of the landscape but the new elements will not be totally uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium.

Photomontage 8A: View northeast/east from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	Primary Principal Visual Zone
Description of view	This view portrays a view east/northeast from the same viewpoint location as for Photomontages 7A & 8B. Photomontages 8A & 8B have been taken at the same viewpoint location but facing to the northeast, east and southeast. The overall panoramic view has been divided into two photomontages, as the observer would not be able to see the entire development in one view without turning the head. This view is directed to the northeast and east. The wind farm will be openly visible. The proposed 110kV transmission line structures and substation in the middle distance (as shown in the wireframe image) will be screened by intervening topography. The foreground comprises Oweninny River and is otherwise covered with bog grassland. Low mountain ridges can be seen in the background on the left in this image.
Visual Effects	The vista is defined by a smooth and gently undulating landscape in the foreground. The water course is visually almost entirely absorbed into the bog grassland. The rehabilitated former peat extraction areas will not be seen from this viewpoint. The introduction of the wind turbines would fill approximately two-thirds of this view with large vertical elements, which will become significant and immediately apparent features in this view. The majority of the turbines will be seen against the sky, while turbines in the background will be partially seen against the land. The turbine layout is clear and harmonious in the middle distance and increases in density as it recedes in the background. Overlapping of turbines is minimal in the middle distance but increases towards the background. The development is extensive and will have a sustained presence in this view. However, due to the layout and distance of turbines to each other, the natural landscape elements in this view will not become obliterated. The visual effects are considered Substantial. There will be cumulative effects in combination with Corvoderry Wind Farm which, as indicated in the wireframe model, will be located to the centre and right of the background of the view, although in part screened by intervening topography and / or vegetation. The schemes will be indistinguishable from each other and be perceived as one development.
Landscape Effects	The prevailing landscape character contains mainly natural elements. Human intervention is portrayed by coniferous plantations on the ridges in the background and semi-improved pasture land in the foreground along the shores of Oweninny River. The introduction of wind turbines will introduce a new energy harvesting character with large vertical elements into this view. These structures will considerably intensify the man influenced landscape character and partially change the landscape character. The landscape effects will therefore be Medium.

Photomontage 8B: View east/southeast from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	Primary Principal Visual Zone
Description of view	This photomontage represents a view east/southeast from the same location as Photomontage 8A. The wind farm will be visible but partially screened by intervening topography. The proposed 110kV transmission line structures and a proposed visitor centre in the middle distance (as shown in the wireframe image) will be fully screened by intervening topography. The foreground comprises the Oweninny River, semi-improved pasture and bog grassland extending into the distance and a small scale overhead transmission line. The middle ground comprises a bridge, an isolated house and farm buildings and clusters of trees. The silhouette of Nephin and the adjoining ridges of the Nephin Beg Range are visible in the background and are partially screened by intervening vegetation.
Visual Effects	No elements of the proposed Oweninny Wind Farm are visible within this view and therefore no visual effects are predicted.
Landscape Effects	The proposed development will not result in landscape effects at this location.

Photomontage 9A: View southwest from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint near the centre of the wind farm site is located between the eastern and western section approximately 1km further north than the viewpoint for Photomontages 7 & 8. Photomontages 9A & 9B show a panoramic view to the southwest, west and northwest. However, the observer would not be able to see the entire development in one view without turning the head. The overall view has therefore been divided into two panoramic photomontages. This view is directed to the southwest. The wind farm as well as sections of the proposed 110kV transmission line structures will be visible in the middle distance. The proposed substation and the majority of the proposed 110kV transmission line (as shown in the wireframe image) will be screened by intervening topography. The foreground and middle ground is covered with bog grassland and clumps of scrub. Slieve Carr and adjacent mountains define the background.
Visual Effects	The panoramic view is wide open across a slightly undulating, smooth, open landscape lacking in any significant vertical features. The mountains in the background apply scale and anchor the view. The overall vista portrays a remote and large landscape setting. The introduction of wind turbines will introduce immediately apparent elements which will, due to their scale and number, alter the overall character of the view. The turbines will be openly visible with the bottom or lower part of turbine towers partially covered by intervening topography. The turbines are laid out harmoniously. Visual confusion due to overlapping turbines is minimal from this viewpoint location. The majority of the turbines will be partially seen against the sky and the mountains in the background. Considerable sections of the mountains will be seen through the turbines, which will interfere with the ridgelines and reduce the scale of their presence. The turbines will form a sustained feature in this view but will not obliterate the view. The openness of the view will remain and existing landscape elements will not become subordinate. The visual effects are considered Substantial. There will be no cumulative effects with adjacent proposed or permitted wind farm development.
Landscape Effects	The introduction of wind turbines will re-establish the use of this landscape as harvesting area for energy production. The vertical, built nature of the proposed wind farm will alter the existing character of the landscape but the new elements will not be totally uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium.

Photomontage 9B: View northwest from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	Primary Principal Visual Zone
Description of view	This photomontage represents a view northwest from the same location as Photomontage 9A. The wind farm as well as the upper sections of the proposed substation and transmission line structures will be visible in the middle distance. The landform is gently undulating and rising to the north in this vista. The foreground is covered with bog grassland. A house with adjacent pasture land, a group of small trees and a small scale transmission line shape the middle ground in front of a coniferous plantation. Low mountain ridges covered with extensive coniferous plantations define the background.
Visual Effects	The lower parts of the wind farm will be partially screened by intervening topography and vegetation. The turbines are laid out harmoniously. Visual confusion due to overlapping turbines is minimal from this viewpoint location. Despite the existing built structures, the vista portrays a remote landscape setting. The majority of the turbine structures will be seen against the sky. Lower parts of the turbine tower and the upper section of the proposed substation building will be seen against the land in the background. The low mountain ridges in the background will be seen through the turbines. The turbines will form a sustained feature in this view but will not obliterate the view. The openness of the view will remain although the views to the mountains are altered. The visual effects are considered Substantial. There will be no cumulative effects with adjacent proposed or permitted wind farm development.
Landscape Effects	The overall landscape character is of a remote but inhabited landscape. The introduction of wind turbines will introduce a new energy harvesting character with prominent vertical and uncharacteristic elements into this landscape due to their scale. These structures will considerably intensify the man influenced landscape character and partially change the landscape character. The landscape effects will therefore be Medium.

Photomontage 10A: View east/northeast from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

Visual Zone	**Primary Principal Visual Zone**
Description of view	This view portrays a view east/northeast form the same viewpoint location as for Photomontages 9A & 9B. Photomontages 10A & 10B have been taken at the same viewpoint location but facing to the northeast, east and southeast. The overall panoramic view has been divided into two photomontages, as the observer would not be able to see the entire development in one view without turning the head. The vista contains an open and remote landscape setting with improved pasture lands in the foreground and on either side of Oweninny River as well as a single small scale transmission line. Coniferous plantations are located in the middle distance. Bog grassland and regenerating bog grassland with dots of scrub can be seen in the middle distance until the horizon. Gentle ridges of low hills, which are mostly covered with extensive coniferous forestry, form the backdrop. There are no significant vertical features present in this view. The wind farm and section of the proposed substation and overhead transmission line will be visible in the middle distance and background.
Visual Effects	The wind farm will be openly visible with some of the bottom parts of the turbine towers screened by intervening topography. The turbines are laid out harmoniously. There will be some visual confusion due to overlapping turbines towards the background. The majority of the turbine structures will be seen against the sky. Lower parts of the turbine tower and the upper section of the proposed substation building will be seen against the land in the background. The low hills in the background will be seen through the turbines. The turbines will form sustained vertical features altering the character of this view but they will not obliterate the view. The open and remote character of the view will remain and existing landscape elements will not become subordinate. The visual effects are considered Substantial. Cumulative effects in combination will be experienced together with Corvoderry Wind Farm located in the background to the right of the view. Turbines of the Oweninny Wind Farm towards the background of the view and the proposed Corvoderry wind farm turbines will be seen at a similar scale and distance from the viewpoint such that they would generally be perceived as one development.
Landscape Effects	The landscape character is influenced by human interaction. The landscape in the middle distance stretching to the horizon is mainly the result of intense peat harvesting activities in the past. The overall perception is of a remote but inhabited landscape. The wind turbines will introduce a prominent energy harvesting character into this landscape. The artificial nature of the proposed wind farm will considerably intensify the man-made character and partially alter the existing landscape character. However, the new elements will not be totally uncharacteristic as the existing Bellacorick Wind Farm has already introduced wind energy structures into this landscape. While on a far greater scale, Oweninny Wind Farm will not be totally uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium.

Photomontage 10B: View southeast from a local road (L52925) located between the western and eastern section of the proposed wind farm site west of Oweninny River

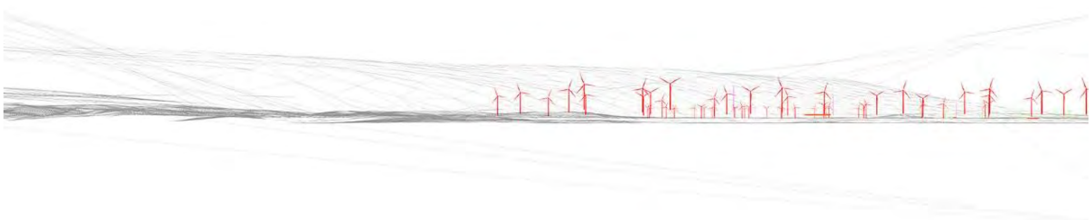
Visual Zone	**Primary Principal Visual Zone**
Description of view	This photomontage represents a view southeast from the same location as Photomontage 10A. The land cover is defined by bog grassland, regenerating bog grassland and pasture in the vicinity of Oweninny River, which is screened in this view by low vegetation. Apart from two groups of trees in the distance there are no natural vertical features in this landscape. A small scale transmission line runs across along the road. Nephin and the adjacent Nephin Beg Range define the background. Four turbines (T56, T67, T68 and T69) of the proposed Oweninny Wind Farm will be visible in close proximity to the viewpoint. The upper parts of the proposed substation and 110kV overhead transmission line structures (as shown in the wireframe image) will also be visible in the middle distance with the remainder screened by intervening topography.
Visual Effects	The panoramic view is wide open across a slightly undulating, smooth, open landscape lacking in any significant vertical features. The mountains in the background apply scale and anchor the view. The overall vista portrays a remote and large landscape setting. The introduction of wind turbines will introduce immediately apparent elements which will, due to their scale and proximity to the viewpoint will create a new focus within the view. The turbines will be openly visible with the bottom or lower part of turbine towers partially covered by intervening topography. The turbines are laid out harmoniously. The turbines will be seen against the sky. The Oweninny Wind Farm turbines are located to the left of the image and as a result the open character of the view will remain for the majority of the horizontal field of view. Furthermore, none of the proposed turbines will appear in front of the distant mountains or ridgelines and consequently will not immediately diminish their scale or presence. The turbines will form a sustained feature in this view but will not obliterate the fundamental visual character of the view. The visual effects are considered Moderate to Substantial. Cumulative effects in combination will be experienced together with the proposed Corvoderry Wind Farm and the permitted single turbine at Dooleeg, which are located in the background of the view. As a result of the separating distance between Oweninny Wind Farm and cumulative schemes there is a readily perceptible scale difference between turbines. The permitted Dooleeg wind turbine would appear as outlying from the proposed Corvoderry scheme, although perceived at a similar scale and in a similar context. The Oweninny Wind Farm would bring the influence of wind energy development closer to the viewpoint. The Oweninny Wind Farm turbines would increase the scale of wind turbines within the view, but would not extend their horizontal extent across the vista.

Landscape Effects	The existing landscape character has been altered by human activity. The middle ground is mainly the result of intense peat harvesting activities in the past and currently rehabilitating. The introduction of the proposed Oweninny Wind Farm will continue the use of this landscape as harvesting area for energy production. However, the vertical scale, and additional built form of the proposed wind farm in terms of ancillary structures will modify the existing character of the landscape, but these new elements will not be totally uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium.

Photomontage 11: View east from a local road T-Junction (part of Western Way walking route), in the townland of Tawnaghmore across the proposed Oweninny Wind farm

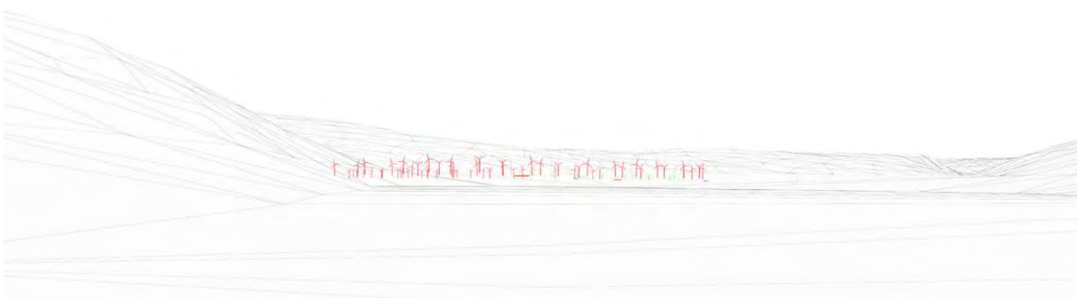
Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint is representative of a stretch of open views of the wind farm and ancillary structures for approximately 2.5km when driving or walking along the western boundary of the proposed wind farm. This view will be experienced when driving east from a cluster of residential properties reaching a T-Junction intersecting with the Western Way. This existing panoramic view is wide open across a flat, open landscape dominated by regenerating bog grassland. The viewed area was formerly used by industrial peat harvesting to fuel the now removed Bellacorick Power Station nearby. Low mountain ridges on the horizon are the only points of reference and orientation.
Visual Effects	The existing view lacks any vertical features and implies a sense of vastness. The low mountain ridges along the horizon frame the view and underline the large scale of the landscape. The introduction of wind turbines will introduce immediately apparent elements which will due to their scale and number alter the overall character of the view. The turbines will be openly visible with the bottom of turbine towers partially covered by intervening topography. The turbines located in the foreground and middle distance are harmoniously laid out. The effect of stacking is minimal from this viewpoint location and only increases towards the background where turbines appear to become more intense in terms of density. The majority of the turbines will be seen against the sky. While the turbines will be dominant features in this view, the sense of vastness and openness will remain due to the distance between each turbine. The mountain range in the background will be seen exclusively through turbines. The visual effects are considered Substantial. Cumulative effects in combination will be experienced as the proposed wind farm will be seen in conjunction with the more distant Corvoderry Wind Farm in the background. To the casual observer, all turbines will be perceived as belonging to one development.
Landscape Effects	The introduction of wind turbines will re-establish the use of this landscape as harvesting area for energy production. The sense of vastness to the landscape remains. The sustained presence and vertical nature of the proposed wind farm will alter the existing empty character of the landscape but the new elements will not be uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Low to Medium.

Photomontage 12: View east from a lay-by at the N59, north of the Owenmore River



Visual Zone	Mountain Range Zone
Description of view	This viewpoint is located at a lay-by along the N59 within the Owenmore River valley looking east towards the proposed Oweninny Wind Farm. This lay-by along the N59 provides parking facilities with an area information board. The ZTV (Tip height) mapping indicates that this location lies at the border of potential visibility. However, the wireframe model confirms that the proposed turbines will be located below the ridge line of the hills in the middle distance.
Visual Effects	The proposed development will not result in visual effects at this location.
Landscape Effects	The proposed development will not result in landscape effects at this location.

Photomontage 13: View east from car park (Trailhead of Bangor Trail) at the eastern edge of Bangor, beside the N59 and near a quarry entrance



Visual Zone	Mountain Range Zone
Description of view	This viewpoint is located at a car park, off the N59, at the back of a housing estate. The car park is also a Trailhead for the Bangor Trail. Similar to Photomontage 12, the ZTV (Tip height) mapping indicates that this location lies at the border of potentially visibility. However, the wireframe model confirms that the proposed turbines will be located below the ridge line of the hills in the background.
Visual Effects	The proposed development will not result in visual effects at this location.
Landscape Effects	The proposed development will not result in landscape effects at this location.

Photomontage 14: View north/northwest from a local road in front of a church and graveyard in the townland of Keenagh Beg

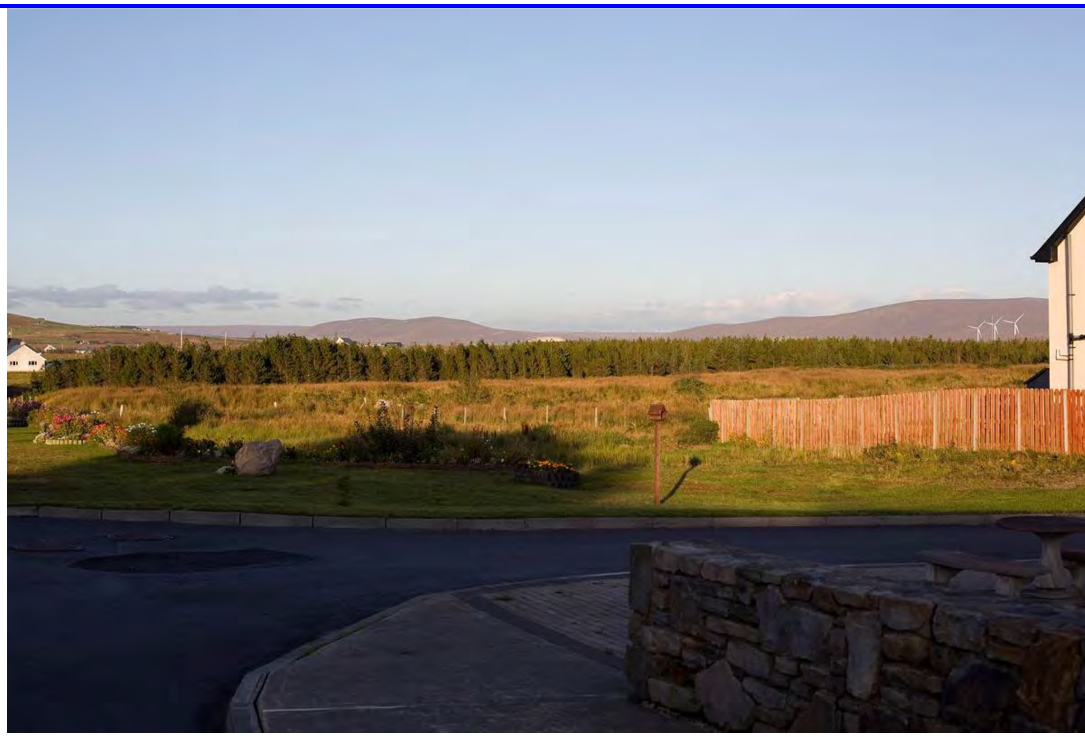
Visual Zone	Primary Principal Visual Zone
Description of view	This panoramic viewpoint is located along a local road and in front of a church yard. It represents a type of view which can be experienced when travelling along lower parts of this road. The foreground and middle distance are defined by gently undulating bog grassland, clusters of shrubs, woodland and patches of coniferous plantations. Isolated residential properties surrounded by improved pasture lands are scattered across the middle distance and background. Existing overhead transmission lines cross the vista. The background is structured by the ridgelines of low mountains, namely Slieve Fyagh and Maumakeogh. The proposed wind farm is visible towards the background.
Visual Effects	The wind farm will be openly visible and have a sustained presence in this vista, some lower turbine sections will be screened by intervening topography and vegetation. The central and eastern portions of the Oweninny Wind Farm are harmoniously laid out; turbines within the western portion of the wind farm will appear in a more irregular layout with some overlapping towards the background. Across the extent of the wind farm the turbines partially break the skyline. . The majority of the mountain range in the background, which is one of the principal features in the existing view, will be seen through the turbines due to the tall, slim nature of the structures, their density and relatively even spaced distribution. The proposed development will form a recognisable new element in the overall scene changing its overall character as the turbines will interfere with the ridgelines on the horizon. Visual effects are therefore considered Moderate to Substantial, however at a distance of 11.4km to the nearest proposed turbine visual effects would be dependent on weather. The permitted Dooleeg wind turbine and the proposed Corvoderry Wind Farm will be perceived as one overall development with resulting cumulative effects in combination.
Landscape Effects	The existing landscape character contains man-made structures set within a large natural landscape but does not contain any significant vertical elements. The transmission line in the foreground and middle distance as well as the existing Bellacorick Wind Farm indicates energy related activities. The introduction of the proposed wind farm would therefore not be totally uncharacteristic when set within the attributes of the receiving landscape. However, the perception of the full scale and extent of the proposed development from this sensitive location would stand in contrast to existing features of existing landscape character. The landscape effects are considered Medium to High.

Photomontage 15: View north from Nephin Beg approximately 250m northeast of the summit (representing the most open view from this mountain)

Visual Zone	**Mountain Range Zone**
Description of view	This panoramic viewpoint is located at a north-eastern vantage point (619m AOD) below the summit of Nephin Beg (627m AoD) within the Ballycroy National Park. This viewpoint offers better open views when compared to the summit of Nephin Beg, which is located at the south-western end of a long gently rising plateau. The viewpoint is only accessible by hiking across unmarked terrain. The proposed wind farm will be seen within a large landscape basin in conjunction with large areas of coniferous plantations, bog grassland, rehabilitating bog, a number of small lakes, clusters of residential settlements, low mountain ranges and the Atlantic Ocean with silhouettes of mountains located in County Donegal on the horizon.
Visual Effects	Oweninny Wind Farm will be fully visible and laid out in the middle distance across a wide open landscape basin. All adjacent proposed and permitted wind farm development will also be fully visible resulting in cumulative effects in combination. The western section of Oweninny Wind Farm will appear clearly separated from the eastern section. The development will be seen against the land, overlapping of turbines can be recognised but will not result in significant visual confusion due to the effects of distance (c.11.0km) and the elevation of the viewpoint. The scale of the existing landscape can visually accommodate the proposed development. However, as a result of the number and scale of the proposed wind turbines the Oweninny Wind Farm will result in the introduction of immediately apparent and extensive vertical punctuations in this sweeping landscape. It will become the main focus point in this view. However, the wide landscape panorama will not be dwarfed or obliterated by the wind farm. The visual effects are therefore considered Moderate to Substantial. There will be cumulative effects in combination with adjacent permitted and proposed wind energy schemes. The structures of the Corvoderry Wind Farm as well as the Dooleeg wind turbine will form more or less one unit together, albeit with the latter slightly outlying. Both of these schemes will be perceived as separate to the Oweninny Wind Farm as a result of the separating distances involved and readily perceptible difference in scale between turbine types. Cumulative effects in succession will be possible from parts of the summit of Nephin Beg, with the proposed (refused) Tawnanasool Wind Farm seen to the north-west and Oweninny Wind Farm, proposed Corvoderry Wind Farm and the Dooleeg turbine seen to the north. However, the separating distances involved would result in a lower level of cumulative effect than for schemes seen in combination.

Landscape Effects	While the vastness of the landscape is the key landscape characteristic in this location, human activity is recognisable across wide areas in this vista and it is an intrinsic part of the overall landscape character. The existing Bellacorick wind farm has already introduced wind energy harvesting elements to this landscape, although in a small scale. Considering the history of the proposed wind farm site as a former large scale peat harvesting area to fuel the now removed Bellacorick power station, items which were also clearly visible from this viewpoint, the proposed development would re-introduce a large scale harvesting' character in the landscape. The proposed Oweninny Wind Farm will be a large new feature in the landscape, changing its character but it will not be substantially uncharacteristic when set within the attributes of the receiving landscape. The landscape effects are therefore considered Medium to High.

Photomontage 16: View east from local road (Scenic Route SR 12) at the entrance of Gweesalia village



Visual Zone	Secondary Principal Visual Zone
Description of view	This viewpoint is located at the eastern entrance to the village of Gweesalia approximately 18.69km west of the nearest turbine, at the beginning of circular Scenic Route SR12. The view in the foreground contains an entrance to an adjacent housing estate and includes other residential properties, a coniferous plantation and small scale overhead transmission lines in the middle distance. The upper section of a quarry face located east of Bangor appears above the tree tops in the centre of this image. The quarry is located on the slopes of the northern end of the Nephin Beg Range, which defines the background. The wind farm will be recognisable by 2 blades and 4 blade tips appearing above the mountain ridges on the horizon.

Visual Effects	This or similar open and intermittent views can be experienced when driving from Gweesalia towards Bangor. The visibility of the wind farm from this viewpoint is due to the height of the turbines. The blades will appear in an irregular layout, with some blades overlapping. All structures will be viewed against the sky. The blades will be recognisable, although small in scale. The proposal introduces moving features along smooth gently undulating mountain ridges but it does not change the overall quality of the scene. Due to the long distance from the wind farm, visibility will be dependent on clear weather conditions. The visual effects are considered Slight to Moderate. There will be cumulative effects in combination with the proposed (refused) Tawnanasool Wind Farm which will be seen in conjunction with distant elements of the Oweninny Wind Farm. Taking into account the long distance to the Oweninny scheme, and separating distances between both cumulative schemes, they would appear as separate developments in the view; an effect emphasised by the intervening mountain range which visually and physically separates the cumulative schemes. The Tawnanasool structures will appear larger and more prominent in views, while the Oweninny Wind Farm would have a weak presence in the landscape.
Landscape Effects	The landscape character is defined by human activity. The open quarry face near Bangor indicates an industrial mining character. The introduction of wind turbines would add another layer of human influence to the overall scene but it would not been seen as substantially uncharacteristic when set within the attributes of the receiving environment. The landscape effects are considered Low.

Photomontage 17: View east/northeast from local road (Scenic Route SR 12) 5km west of Gweesalia village

Visual Zone	Secondary Principal Visual Zone
Description of view	This viewpoint is located approximately 23.8m west, southwest of the closest wind turbine, at the north-western corner of a peninsula extending into Blacksod Bay. The view in the foreground and middle distance is structured by a smooth pasture landscape with clusters of residential properties along the local road and a number of overhead transmission lines. Residential development in the outskirts of Bangor and a quarry east of Bangor will be visible along the western slopes of the Nephin Beg Range and Slieve Fyagh in the background. The wind farm will be recognisable by several blades and upper parts of turbine towers appearing above the mountain ridges on the horizon.

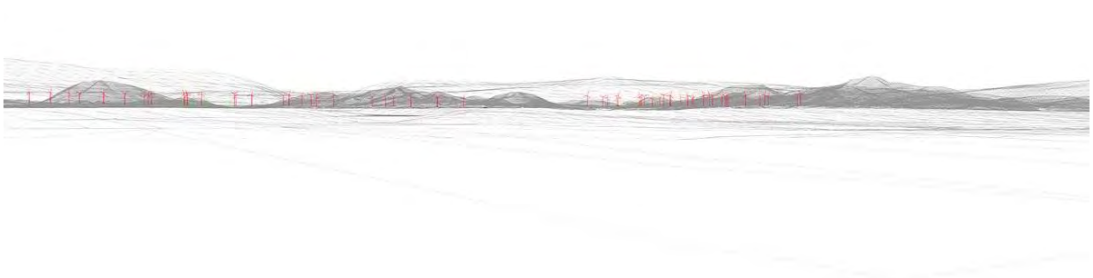
Visual Effects	This or similar open and intermittent views can be experienced for approximately 5km when driving along the circular scenic route in the west and north of the peninsula. The visibility of the wind farm from this remote coastal viewpoint is due to the height of the turbines. The blades/turbines will appear in an irregular layout, with some blades overlapping. All structures will be viewed against the sky. The visible section of the turbines will be recognisable in clear visibility, although small in scale. The proposal introduces vertical, moving features along the skyline of the smooth gently undulating mountain ridges but it does not change the overall quality of the scene. Due to the long distance from the wind farm, visibility will be highly dependent on clear weather conditions. The visual effects are considered Slight to Moderate. There will be cumulative effects in combination with the proposed (refused) Tawnanasool Wind Farm which will be seen in conjunction with elements of the Oweninny Wind Farm seen in the far distance. Taking into account the long distance to the Oweninny scheme, and separating distances between both cumulative schemes, they would appear as separate developments in the view. The Tawnanasool structures will appear larger and more prominent in the middle to background of the view, while the Oweninny Wind Farm would have a weak presence in the landscape.
Landscape Effects	The landscape character shows evidence of human activity. The open quarry face near Bangor indicates an industrial mining character. The introduction of wind turbines would add another layer of human influence to the overall scene but it would not been seen as substantially uncharacteristic when set within the attributes of the receiving environment. The landscape effects are considered Low.

Photomontage 18: View southeast across Carrowmore Lake from the R314 (Scenic Route SR 5 and part of the Pullathomas and North Mayo Linear Cycling Route)

Visual Zone	Secondary Principal Visual Zone
Description of view	This or similar panoramic views can be experienced when driving or cycling along a section of approximately 2km along the R314. The vista contains pasture and residential developments in the foreground as well as small scale overhead transmission lines. Carrowmore Lake is located in the middle distance, Slieve Fyagh to the left and mountains of the Nephin Beg Range to the right and on the horizon. Parts of the proposed wind farm will be visible by their upper turbine parts and turbine blades. The tip of one wind monitoring mast will be seen just above the ridgeline of the mountain range. However, the majority of the development will be screened by intervening topography and coniferous vegetation along the ridgelines.
Visual Effects	The visible sections of the wind farm will constitute a small component in the overall panoramic view, which comprises a collection of highly scenic landscape features. While there is evidence of human interaction in the landscape, the wind farm will form recognisable new elements in the background. The turbine layout is irregular. Visual confusion may occur due to effects of overlapping turbines. All visible turbines will be seen against the sky. From this specific location the smooth, uninterrupted skyline is punctuated by foreground elements within the same portion of

	the view as the Oweninny Wind Farm. The proposals would slightly extend this effect, however only across a small proportion of the overall horizontal field of view. The visual effects are considered Moderate. There will be no cumulative effects with any proposed or permitted wind farm development. Not shown within the field of view is the proposed (refused) Tawnanasool Wind Farm, located due south of the viewpoint. It is likely that users of this route would experience views in succession of the distant Oweninny Wind Farm and Tawnanasool scheme, albeit the latter at right angles to the direction of travel.
Landscape Effects	The current landscape character comprises elements of human activity in the foreground, around Carrowmore Lake and in form of large coniferous forestry across the mountain slopes and ridges in the distance. However, the introduction of vertical, rotating elements in this vista will add a new layer of human activity to this scene, which is not characteristic when set within the attributes of the receiving landscape. Due to the small scale of visibility, the turbines will not totally alter the existing landscape character, resulting in Medium landscape effects.

Photomontage 19: View south from the R314 at a lay-by with local area information boards



Visual Zone	Mountain Range Zone
Description of view	This viewpoint is located at a lay-by, which provides an area information board, along the R314 in the townland of Gortleatilla. This section of the R314 is part of the North Mayo Linear Cycling Route between Belmullet and Ballycastle. The ZTV (Tip height) mapping indicates that this location lies at the border of potential visibility. However, the wireframe model confirms that all but the blade tips of a small number of the proposed turbines will be located below the ridge line topography of the mountains in the middle distance. However, in reality, as shown on the existing view, the intervening rising topography from the fore to mid ground will completely screen views towards Oweninny Wind Farm and other wind energy schemes from this location.
Visual Effects	The proposed development will not result in visual effects at this location.
Landscape Effects	The proposed development will not result in landscape effects at this location.

Photomontage 20: View south from summit of Maumakeogh

Visual Zone	Mountain Range Zone
Description of view	This panoramic viewpoint is located on the summit of Maumakeogh (379m AoD). The smooth and gently rounded mountain top can be reached when hiking south from the Céide Fields Visitor Centre. The way to the summit is unmarked. The proposed wind farm will be seen in the middle distance in a wide landscape basin, and will be seen against the Nephin Beg Range in the background. The summit and slopes of Maumakeogh are covered with bog grassland; large coniferous plantations are visible in the middle distance.
Visual Effects	All of the proposed Oweninny Wind Farm turbines , ancillary structures including substations, wind monitoring masts and proposed visitor centre will be visible. However, lower parts of some turbines are screened by intervening topography, depending on the location of the observer in the vicinity of the summit. From this location the proposed wind farm can be visually distinguished as separate eastern and western sections. Turbines are spaced irregularly; overlapping of turbines can be recognised but it will not result in visual confusion due to the effects of distance and the elevation of the viewpoint. The large scale and open panorama into the basin and surrounding mountain ranges, when reaching the summit of Maumakeogh, creates a sense of remoteness and isolation. Oweninny Wind Farm will fill a large section of this basin with artificial vertical elements, standing in contrast to the existing landscape components in this view. Together with the permitted Dooleeg wind turbine, and proposed Corvoderry Wind Farm), the development will form numerous vertical punctuations in the landscape altering the overall character of the view. The turbines will be seen against the lower part of the mountain backdrop and will therefore not obliterate the view of the mountains and their ridges. The visual effects are therefore Substantial. All adjacent proposed and permitted wind farm development in this view will result in cumulative effects in combination.
Landscape Effects	The current landscape character will be altered by the introduction of Oweninny Wind Farm as it will form an extensive feature in a large scale, sweeping landscape. While coniferous plantations and the existing Bellacorick wind farm are also indicators of human activity, they were able to be absorbed into the existing landscape due to their scale. The scale and extent of the proposed development will become a central element to interpretation of this scene. Human structures will become an intrinsic part of the landscape character. Considering the history of the wind farm site as a former large scale peat harvesting area to fuel the now removed Bellacorick power station, the proposed development would re-establish a large scale energy harvesting character in the landscape. The wind farm would therefore not be substantially uncharacteristic when set within the attributes of the receiving environment. The landscape effects are therefore considered Medium to High.

Photomontage 21: View south/southwest from a local road north of the proposed wind farm site within the townland of Cluddaun

Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint is located along a remote local road northeast of the proposed wind farm near one of very few houses in this region of the study area. The view across bog grassland and a large coniferous plantation in the foreground and middle distance is framed by the Nephin Beg Range in the background. The wind farm will be visible in the middle distance beyond the forestry in front of the mountain range.
Visual Effects	The introduction of vertical elements in this open and flowing landscape panorama will change the overall character of the scene. The proposed visitor centre and substations associated with the Oweninny Wind farm will be screened by intervening topography and vegetation. There will be visibility towards approximately half of the proposed Oweninny Wind Farm to the right (west) of the image where whole turbine structures are visible; to the left (east) of the view turbine structures begin to be screened to increasing effect by the intervening coniferous woodland. The majority of turbine structures will be seen partially against the mountain backdrop and the sky, depending on weather conditions. Sections of the mountain range in the background will be exclusively seen through and between the wind farm structures, which will dwarf the perceived height of the mountain range in the background. Due to the large scale of the existing visual landscape components, the proposed structures will not dominate the overall view. The visual effects are therefore considered Substantial. There will be no cumulative effects in combination with either the permitted Dooleeg wind turbine or proposed Corvoderry Wind Farm which are screened from this view by intervening coniferous plantation woodland in the middle ground. The proposed Tawnanasool Wind Farm is screened by topography in the far distance.
Landscape Effects	Similar to Photomontage 20, the current landscape character will be altered by the introduction of Oweninny Wind Farm as it will set extensive man-made features in a large scale, sweeping landscape. While coniferous plantations are also indicators of human harvesting activity, they appear more natural and integrated in the existing landscape. The introduction of the large scale built structures will result therefore in Medium to High landscape effects.

Photomontage 22: View west from a local road near residential houses in the townland of Doobehy (viewpoint is located near the end of the local road)

Visual Zone	Primary Principal Visual Zone
Description of view	The proposed wind farm will be visible across approximately half of the horizontal field of view of a landscape which contains some pasture land in the foreground and transforms into open bog grassland in the middle distance and background, with a low hill as main focus point and further ridges of low hills along the horizon. The viewpoint is located near the end of a cul de sac beyond a small number of houses.
Visual Effects	Oweninny Wind Farm will be openly visible across approximately half of the horizontal field of view to the right of the image. Turbines are spaced irregularly; some overlapping of turbines can be recognised. Lower tower sections of the closest turbines are principally screened by gently undulating intervening topography; this effect is emphasised as the wind farm recedes into the distance. The majority of turbines will be seen against the sky. The overall wide panoramic view will be partially filled with tall artificial features which cannot easily be visually absorbed or related to any other feature in the existing view. Weather conditions are ephemeral in nature, and at the same location in clearer conditions the distant Nephin Beg Range would act to anchor the scene and assist in relating the scale of the proposed wind turbines to the wider landscape context. The proposal will become a new focal point of the scene. When visible, the Nephin Beg Range comprises a key topographic feature of the view that would add vertical mass to the scene, which the proposed wind turbines would not diminish or obscure. In this scenario, the scale of the Oweninny Wind Farm and existing topography would be balanced and accommodate the scale of development proposed. Visual effects are therefore considered Moderate to Substantial. Cumulative effects in combination in relation to the proposed Corvoderry Wind Farm will extend the influence of wind energy development across the majority of the horizontal field of view. However, at this distance the schemes will appear at a similar scale and they cannot visually be separated from each other.
Landscape Effects	The landscape character will be modified following the introduction of the scheme due to the current absence of significant built structures. While there are indicators of human influence, namely agriculture and regenerating bog grassland (related to former industrial harvesting), the introduction of the large scale artificial structures are not characteristic when set within the receiving environment. The turbine array would sit within a simple and large-scale landform and reflect the scale of the area. It would stand separate to the Nephin Beg Range which has a simple form and vertical mass. The lack of scale references within the view reduces the perception of vertical scale within the

	scene. The landscape effects are therefore considered Medium-High.

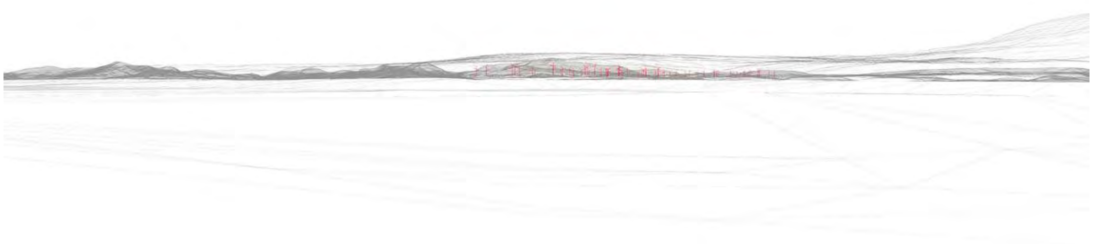
Photomontage 23: View west from a local road T-Junction in the townland of Doobehy

Visual Zone	**Primary Principal Visual Zone**
Description of view	The wind farm will be visible beyond a cluster of trees and shrubs relating to residences in the area. Pasture land is adjacent to the local road providing access to houses and farmsteads. Grassed bog areas can be seen in the middle distance and as well as the contours of low mountain ridges on the horizon.
Visual Effects	Oweninny Wind Farm will be almost entirely screened by intervening vegetation and topography, although during winter months there may be slightly greater visual exposure and views to turbines. Of the turbines visible, most will be seen against the sky. As demonstrated by the wireline image, turbines in the background of the view (obscured by vegetation) will be seen partially against the low mountain ridges in the background, which is subject to prevailing weather conditions. The turbine layout is irregular but this would not be very apparent from this location, where only a small number of individual turbines are visible. The structures will form new features across a small proportion of the overall view, altering the existing view by introducing new structuring elements into a currently more or less open background due to their height and density. The visual effects are therefore considered Slight to Moderate. Cumulative effects in combination in relation to the proposed Corvoderry Wind Farm and permitted Dooleeg wind turbine would extend the influence of wind energy across the view. People at this location would more readily perceive the Corvoderry and Dooleeg schemes to the left of the image as they do not benefit from the screening effect of foreground vegetation.
Landscape Effects	The existing landscape character is shaped by small scale agricultural and residential human activity in the foreground and middle distance. The proposed wind farm will introduce and new type of human activity and vertical element which would not be characteristic to the prevailing landscape character due to its height and extent. Notwithstanding this, from this location even modest amounts of foreground vegetation would serve to filter views of the majority of the Oweninny Wind Farm turbines such that the proposal will have a modest presence in the landscape. . The scale of the turbines as perceived from this location would be at equilibrium with, or subservient to other landscape elements in the view. Overall, the landscape effects are considered Low to Medium.

Photomontage 24: View southwest from the R315 in the townland of Garranard

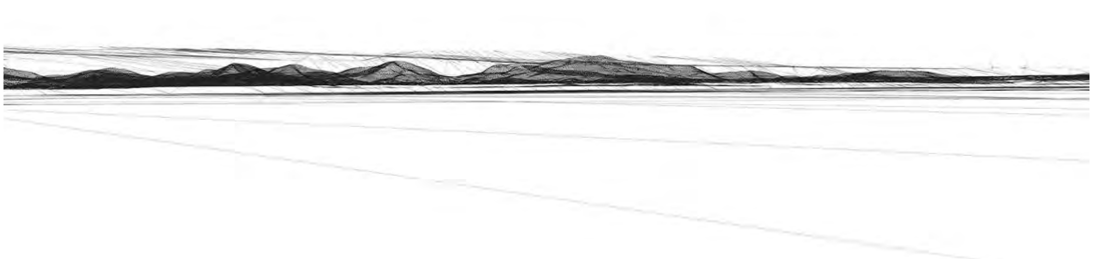
Visual Zone	Northern Mayo Drumlin Zone
Description of view	This view is representative of a series of intermittent views when driving along the R315 east and northeast of the proposed wind farm at a distance between of approximately 12-14km from the centre of the proposed wind farm. The view sweeps across a moderately undulating agricultural landscape with fields framed by overgrown hedgerows, clusters and bands of shrubs and trees and scattered residential developments. The mountain silhouettes of the northern end of the Nephin Beg Range define sections of the horizon. The wind farm will be visible along sections of the horizon in front of the mountainous backdrop.
Visual Effects	The proposed wind farm will be visible along less than one-third of the overall view, and will be largely screened by intervening clusters of trees and topography. The majority of visible turbines will be seen by their blades, there will be three turbines which will be seen by their nacelles and upper tower sections. The turbines are irregularly but generally harmoniously distributed along the horizon. Where turbine blades are overlapping this can result in some visual confusion. The wind farm structures constitute recognisable, but not dominant new components in the wider view. The wind farm will be visible against the sky; views to the mountain backdrop will be unaffected. The turbines will form a visible and recognisable new element in the overall scene but do not change the overall character of the scene. The visual effects are considered Slight to Moderate. Corvoderry Wind Farm will be perceived as being located within Oweninny Wind Farm without being recognised as a separate development. The wind turbine at Dooleeg will be screened by intervening vegetation in this view. Cumulative effects in combination will be experienced for visible proposed and permitted developments.
Landscape Effects	The proposal would introduce new vertical elements along the horizon in the background of an established man-altered rural landscape character. Existing built vertical elements comprise scattered houses and low voltage overhead transmission lines. The proposed development may be prominent due to its extent, but the wind farm can be partially absorbed by existing landscape elements and is not substantially uncharacteristic when set within the attributes of the receiving landscape. The landscape effects are therefore considered to be Low to Medium.

Photomontage 25: View southwest from the R315 approximately 3km south of Ballycastle



Visual Zone	Mountain Range Zone
Description of view	This viewpoint is located along the R315 south of Ballycastle. The ZTV (Tip height) mapping indicates that this location lies within the zone of potential visibility. However, the photomontage image and wireframe model confirms that the proposed Oweninny turbines will be located below the ridge line of the hills in the middle distance.
Visual Effects	The proposed Oweninny Wind Farm development will not result in visual or cumulative effects at this location. No other wind farm development is visible from this location.
Landscape Effects	The proposed Oweninny Wind Farm development will not result in landscape effects at this location.

Photomontage 26: View southwest from a local road (Scenic Route SR 14 and part of Western Way walking route) southeast of Killala



Visual Zone	Northern Mayo Drumlin Zone
Description of view	This viewpoint on the edge of Killala Bay represents stretches of short open views along a local road, which is part of Scenic Road SR 18 and the Western Way walking route. The view is across undulating established agricultural landscape with a number of residential properties in the foreground and middle distance. The background is mainly defined by slopes with deciduous woodland and medium sized industrial development with silos and other vertical building structures. Several blade tips of the proposed wind farm will be visible in the right hand side of this image.
Visual Effects	The majority of the proposed wind farm will be entirely screened by intervening topography and vegetation. However, some blade tips will be seen against the sky in the background. It should be noted that due to a distance of approximately 19.3km to the nearest turbine, actual visibility will be highly dependent on seasonal aspects and clear weather conditions. The visibility of blade tips will form a small part of the overall vista and be difficult to perceive within the view. Awareness of the proposal would not have a marked effect on the overall quality of the scene. The visual effects are therefore considered Slight.

	There will be no cumulative effects with either proposed or permitted wind farm developments.
Landscape Effects	The existing landscape character is shaped by human activity comprising, agricultural, industrial and residential elements. The introduction of the proposed development would intensify slightly the man-made character of the environment but would not be uncharacteristic when set within the attributes of the receiving landscape. The landscape effects are therefore considered Low.

Photomontage 27: View northwest from the R310 (Scenic Road SR 8) across Lough Conn

Visual Zone	**Northern Mayo Drumlin Zone**
Description of view	This viewpoint is located along the R310, which is part of Scenic Road SR 8, and represents a short stretch of open and intermittent views for approximately 400m across Lough Conn from the side if the road. The wind farm will be visible in the background with the silhouettes of low mountains, belonging to the Slieve Fyagh and Maumakeogh range, on the horizon. The foreground is dominated by Lough Conn and its shorelines. The foothills of Nephin enter the scene from the left side of this image.

Visual Effects	The wind farm will be visible as a dense band of small vertical structures in the background of the scene across just over one-third of the field of view. The wind farm will be partially seen against the sky and the land. The mountain range on the horizon, if visible, will be seen through the wind turbines, which will interfere with the ridge lines due to their height as well as with long distance views to the horizon. However, the visibility of the wind farm and the mountains on the horizon will be highly dependent on clear weather conditions. While a small component in the wider view, the wind farm will be located at a sensitive point where the sky meets the water of an interior landscape and will therefore be readily noticed as a new element within the overall scene. The visual effects are therefore considered Moderate. This type of view is only possible from small amount of locations along the eastern side of Lough Conn as indicated on Figure 11.4, 11.5 and 11.7. Parts of the open waters of Lough Conn would experience visibility of the proposal in good weather conditions. Visibility would be most likely from the central area of the lake as screening would be provided by intervening vegetation and topography closer to the shoreline. Where open views towards the site are possible, the upper section or blade tips of the proposed wind farm would be visible. Intervening vegetation and intervening topography will otherwise screen parts or all sections of the wind farm. Visual effects are considered Slight to Moderate. Both the proposed Corvoderry and permitted Dooleeg wind farm development will result in cumulative visual effects in combination. Dooleeg wind turbine and Corvoderry Wind Farm will be perceived as part of Oweninny Wind Farm in this view since they cannot be separated visually from each other.
Landscape Effects	The landscape character is dominated by the water of Lough Conn and its wooded and complex shoreline. Residential developments, agricultural pattern and the blade tips of the existing Bellacorick wind farm in the distance suggest human interaction but are overall not prominent features of the landscape. The introduction of the Oweninny wind turbines will intensify the human impact due to their number and scale, and present a new layer of human influence, which will result in a partial loss of the overall character in this view resulting in Medium landscape effects.

The following two viewpoint locations have been included to supplement submissions made by local residents of the Shanvolahan area. Photomontages illustrating the impact of the proposed development have been presented at the Oral Hearing in April 2014.

Photomontage A: View northwest from local road in the townland of Shanvolahan

Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint is located on a minor road to the south-east of local residential properties in the townland of Shanvolahan. The view looks north-west towards the near horizon formed by rising topography. An individual house with adjacent pasture land, a group of small trees, coniferous woodland plantation and a small scale transmission line define the fore-to-middle ground.
Visual Effects	The proposed development will not result in visual effects at this location.
Landscape Effects	The proposed development will not result in landscape effects at this location.

Photomontage B: View northwest from a private access road in the townland of Shanvolahan

Visual Zone	Primary Principal Visual Zone
Description of view	This viewpoint is located on a private access road to the south-east of local residential properties in the townland of Shanvolahan The foreground to middle ground of the view is defined by amenity grassland and established pastoral grazing land, hedgerows punctuated by occasional hedgerow trees and coniferous woodland planting. Built elements are visible in the form of an individual residential dwelling, small scale transmission line which spans the view and medium scale agricultural buildings in the background.
Visual Effects	The towers and rotors of some turbines will be visible; however, for the majority of the Oweninny Wind Farm, the turbines will be screened by intervening localised topography and vegetation. From this location the visible turbines are spaced irregularly across the horizon. The Oweninny turbines will be visible against the sky, and as such will have no defining background which the turbines can be measured against. Minimal visual confusion will arise as a result of overlapping turbines. The turbines will form apparent features in the background of the scene. However, the proposed Oweninny Wind Farm turbines will be subordinate to other elements within the view in terms of their scale. The visual effects will be Slight. The proposed Corvoderry Wind Farm will result in cumulative effects in combination. The proposed Oweninny Wind Farm turbines will be perceived as part of the Corvoderry scheme (seen closer to this viewpoint) in the view since the schemes cannot be separated visually from each other.
Landscape Effects	The landscape character is influenced by human interaction. The view is defined by managed, pastoral agricultural land use. Coniferous woodland plantation is further evidence of the managed nature of the landscape. Built form is conspicuous in terms of residential dwelling and associated infrastructure including small scale transmission lines and medium scale agricultural out buildings. While the nature of the proposed wind farm will intensify this man-made character, it is not at variance to it. The proposed Oweninny Wind Farm will become a new feature of a landscape already influenced by human interaction, but will have a relatively weak presence as a result of its limited scale and visible extents, The landscape effects are considered to be Low to Medium.

11.5.5 Cumulative effects

The cumulative assessment includes any nearby permitted and proposed wind farms, meteorological masts, substation and transmission line developments in the visual analysis in order to assess potential cumulative visual effects. Cumulative effects for representative viewpoints have been assessed and described in Section 11.5.4 above.

***Table 11.9*: Definitions[136] to determine cumulative effects on landscape and visual effects**

Definition of types of cumulative effects
In combination Where two or more features are seen together at the same time from the same place, in the same (arc of) view where their visual effects are combined.
In Succession Where two or more features are present in views from the same place (viewpoint) but cannot be seen at the same time, together because they are not in the same arc view – the observer has to turn to see new sectors of view whereupon the other features unfold in succession.
In sequence Where two or more features are not present in views from the same place (viewpoint) and cannot, therefore, ever be seen at the same time, even if the observer moved round the arc of view, the observer has to move to another viewpoint to see the second or more of them, so they will then appear in sequence. The frequency of occurrence in the sequence may be highly variable, ranging from **frequently sequential** when the features keep appearing regularly and with short time lapses between (clearly speed of travel influences this as well as distance between the viewpoints) down to **occasionally sequential** where there may be long time lapses between appearances, because the observer is moving very slowly and / or there are large distances between the viewpoints (even if not between the features).

11.5.5.1 Wind Farms

The following wind farms are located within the study area and have been included in a cumulative effects assessment as detailed below:

- Dooleeg Wind Farm (1 permitted turbine), adjacent to south-western site boundary, separated by N59;
- Corvoderry Wind Farm (10 turbines), located within land surrounded by the eastern section of the proposed Oweninny Wind Farm site; and

[136] Based on criteria set out on Page 9 & 10, in the "*Guidance - Cumulative Effect of Windfarms*" Version 2, revised on 13.04.05, Scottish Natural Heritage

- Tawnanasool Wind Farm (8 Turbines), located to the west of the Nephin Beg Range of mountains, approximately 3km south-west of Bangor.
- Potential future development of Oweninny Phase 3

An application was received by Mayo County Council on 22nd July 2015 for the temporary (3 years) installation of a meteorological mast comprising a 100m high steel lattice supported by cable stays at Sheskin, east of Slieve Fyagh. This development has also been considered as part of the assessment of potential cumulative effects.

The ZTV maps indicate where visibility of Oweninny Wind Farm will occur alone.

The extent of visibility is shown in Figure 11.6 - Visual Impact and in Figure 11.7 - Nature of Visibility. Generally, the majority of cumulative effects will be experienced within the Primary Principal Visual Zone for prolonged stretches along public roads, scenic roads and walking routes as well as from higher ground such as hill or mountain summits located to the south, west and north of the wind farm. This is due to the close proximity of the proposed and permitted developments to each other and their location within or on the slopes of a large flat or gently undulating landscape basin lacking often in significant vertical vegetation.

Cumulative effects will become increasingly intermittent further east from vantage points located within the Northern Mayo Drumlin Zone, outside of the Primary Principal Visual Zone.

Views from within the Secondary Principal Visual Zone as indicated in Figure 11.6 will result in limited cumulative effects with the proposed (refused) Tawnanasool Wind Farm. Such cumulative effects will be largely contained within the SPVZ due to intervening topography of the northern extents of the Nephin Beg Range and separating distances between schemes.

Cumulative Effects in Combination

The majority of cumulative effects will be in combination. The potential observer will be able to see two or more features together at the same time from the same place and in the same (arc of) view, where their visual effects are combined. For the majority of available views, one or all proposed or permitted wind farm development will be seen as belonging to one large wind farm unit when seen together with Oweninny Wind Farm (refer to Photosheets 1, 2, 3, 4B, 6, 8A, 8B, 10A, 10B, 11, 14, 15, 20 - 24 & 27 and supplementary photomontage A and B).

Cumulative Effects in Succession

Cumulative effects in succession will be possible but can only be experienced from a limited number of locations when the observer is located between two neighbouring developments, or where the separating distance between schemes is sufficient to require the viewer to turn to see the separate wind farm developments.

In relation to the permitted Dooleeg wind turbine, when located at the N59 (such as in the vicinity of Photomontage location 4A/B) with the Dooleeg scheme located south of the observer the separate developments would be visible from the same place, the observer would need to turn to see the other features as it would not be possible to view all schemes at the same time.

These effects will not be experienced in relation to Corvoderry Wind Farm as it is located in close proximity to the proposed turbines within the Oweninny Wind Farm application boundary. The distribution and distance of surrounding receptors is such that there are very limited opportunities from the surrounding landscape where it would be possible to see the cumulative schemes in isolation (refer to Photomontages 4A/B, 5 and 8B) Therefore the cumulative interaction between these schemes even in close proximity is always likely to be in combination, as demonstrated by Photomontages 3, 4B, 6, 8A/B, 10 A/B, 22 and 23)..

In relation to the proposed (refused and appealed) Tawnanasool wind farm, taking into account the separating distances involved between cumulative schemes, and the intervening Nephin Beg Range, there are very few locations where cumulative effects would be experienced. Within the study area views in succession would only be possible from distant elevated locations along the Nephin Beg Range, for example at Photomontage 15, or at distant locations from both schemes within the SPVZ as at Photomontage 18.

Cumulative Effects in Sequence

It will be possible to view the proposed Oweninny Wind Farm and other proposed and permitted wind farms in sequence along some roads within the Primary and Secondary Principal Visual Zones across the study area.

In relation to the PPVZ, when travelling east from Bangor on the N59, initially Oweninny Wind Farm will become visible frequently across long durations of the route. The proposed Corvoderry Wind Farm as well as the permitted wind turbine at Dooleeg will become visible as one proceeds further east towards Bellacorick and Crossmolina. Views from the R312 heading north towards Bellacorick would have infrequent sequential views of Oweninny Wind Farm, proposed Corvoderry Wind Farm and the permitted Dooleeg turbine (perceived as one development) which would become more frequent along approximately one-third of this route when in close proximity to the wind energy schemes. The R315 passes to the east of the PPVZ. Between Creevagh More and Crossmolina users of this route would experience oblique, infrequent sequential views of the Oweninny Wind Farm, proposed Corvoderry Wind Farm and permitted Dooleeg wind turbine

Elsewhere within the PPVZ there are several minor routes that would experience intermittent and / or open views of the Oweninny Wind Farm. The locations of these routes and theoretical visibility are shown on Figure 11.6. In terms of sequential cumulative effects, the Oweninny Wind Farm encircles the proposed Corvoderry Wind Farm, and is sited in close proximity to the permitted Dooleeg wind turbine, which would result in the schemes being perceived as one development from most locations. For the majority of minor routes within the PPVZ, even in close proximity, there would be infrequent sequential views of the Oweninny Wind Farm seen in conjunction with the adjacent proposed and permitted wind energy schemes. More frequent sequential visibility is possible from elevated locations to the south of the Northern Mayo Drumlin Zone and north of the Mountain Range Zone.

In relation to routes within the SPVZ, when travelling east from Dooyork to Bangor, initially Tawnanasool Wind Farm will be visible. Oweninny Wind Farm will be occasionally visible sequentially to Gweesalia, and then more frequently sequentially visible as the route continues to Bangor (refer to Figure 11.6 and photomontages 17 and 16). This would also be the case for short sections of roads to the east and south-east of Barnatra and along approximately one-fifth of the R313 when travelling east from Belmullet to Bangor. Tawnanasool Wind Farm would be visible (albeit generally oblique to the road and direction of travel) and Oweninny Wind Farm would be seen infrequently across a short stretch of the route travelling eastwards.

In general, intervening topography and vegetation will prevent or allow for intermittent views of the proposed wind farm development from most routes within the Primary and Secondary Principal Visual Zones. Outside of the PPVZ and SPVZ views would be increasingly intermittent as a result of intervening topography and vegetation and, with increasing distance, dependent highly on weather conditions.

Potential future development of Oweninny Phase 3

A detailed landscape appraisal with respect to all three phases of Oweninny formed the basis for the landscape impact assessment of the original wind farm application made to An Bord Pleanála in 2013. This included photomontages from 37 viewpoints showing the visual impact of all three phases of the development.

The conclusion to the assessment of the original development of all three phases was that Oweninny Wind Farm will alter the landscape and visual character within the landscape basin in the centre of the study area due to its extent and height. However, considering the large scale of the surrounding generally homogeneous landscape, the introduction of the wind farm will not be perceived as being out of context with the overall underlying landscape character. Large areas within the basin have been transformed by industrial peat harvesting activities in the past to fuel the now removed Bellacorick Power Station. The majority of the former peat harvesting areas are now in the process of natural rehabilitation. Considering the existing Bellacorick wind farm, operating for more than two decades, and a planning permission to erect 180 wind turbines on the proposed site, wind energy harvesting has already been introduced to the site location. The introduction of large scale wind turbines will therefore not be uncharacteristic when set within the attributes of the receiving landscape. It will intensify and re-establish an industrial sized energy harvesting activity. In contrast to the large scale horizontal extraction method of the past and the current small scale wind harvesting, the proposed development will result in a sustained presence of vertical man-made elements, which will form a new landmark over time.

11.5.5.2 Meteorological Mast

In addition, an application was received by Mayo County Council on 22nd July 2015 for the temporary (3 years) installation of a meteorological mast comprising a 100m high steel lattice supported by cable stays at Sheskin, east of Slieve Fyagh. This proposed development is located within an existing coniferous plantation and has also been considered as part of the assessment of potential cumulative effects.

It is likely that the proposed meteorological mast will be visible in combination and / or succession with the proposed Oweninny Wind farm and cumulative assessment schemes from a number of viewpoints within the Primary Principal Visual Zone (PPVZ); specifically those facing Slieve Fyagh. The proposed meteorological mast would add a single vertical element to a landscape containing numerous larger vertical structures as part of the proposed Oweninny Wind Farm, Corvoderry Wind Farm and Dooleeg wind turbine. Taking into account the temporary nature of the planning application, the corollary is that any combined cumulative effects seen in combination or in succession would, at most, be Slight to Negligible.

11.5.5.3 Substation development

A planning application has also recently been made for a minor modification of the existing Bellacorick 110kV Substation. The works are all within the existing substation and comprise a small extension to the control room and installation of a new 100kV cable bay. These alterations are relatively minor and would have little influence on the impression of the substation and as such has not been considered further in the assessment of potential cumulative landscape and visual effects.

11.5.5.4 Transmission line developments

The following existing overhead transmission lines have been granted planning permission for an uprate:

Bellacorick to Castlebar 110kV and Bellacorick to Moy 110kV lines

Both transmission lines are located in the Bellacorick area. The permitted uprate includes alterations to the existing structures (wooden poles and steel angle masts), some of which will be replaced with new similar structures. The appearance of the uprated lines will generally be similar to that of the existing lines, and therefore there will be little apparent change. For this reason these two projects have not been considered further in the assessment of potential cumulative landscape and visual effects.

Bellacorick to Bangor Erris 38 kV line

The permitted uprate will consist of replacing the majority of the existing wood pole structures and fittings with similar structures including additional pole sets where spans are too long. A new wooden pole-set will also replace the only steel mast along this line. The majority of the line route will remain unchanged except at two locations where the line deviates slightly from its current route. These locations are situated within an area extending approximately 3.5km east of Bangor Erris and will be out of sight of the proposed Oweninny Wind Farm development. A new conductor will be strung along the entire line. The appearance of the uprated line, where visible in conjunction with the proposed Oweninny Wind Farm development, will generally be similar to that of the existing line resulting in little apparent change. This project has therefore not been considered further in the assessment of potential cumulative landscape and visual effects.

11.5.5.5 Grid West

Grid West is part of the strategy for the development of Ireland's Electricity Grid for a Sustainable and Competitive future which is set out in EirGrid's Grid 25 Programme. County Mayo forms part of the North West Region in Grid 25.

As part of the route selection programme, EirGrid published details of underground and overhead options for the Grid West project in July 2015 (http://www.eirgridprojects.com/projects/gridwest/iep/). This report, which was prepared by the Government-appointed Independent Expert Panel (IEP), sets out, in detail, the technical, environmental and cost aspects of three technology options:

- a fully underground direct current cable;
- a 400kV overhead line; and
- a 220kV overhead line with partial use of underground cable.

The project will include a substation/converter station in north Mayo and a substation/converter station near Flagford, Co. Roscommon. Converter stations, to convert the direct current to alternating current would be required if a direct current underground cable is provided.

While a preferred route has not yet been selected by EirGrid for Grid West, the specific corridors for the underground cable and the overhead line options are identified in the report prepared for the Independent Expert Panel. A preliminary assessment can therefore be made of possible landscape and visual cumulative effects between the proposed Oweninny Wind Farm and the Grid West Project.

It is noted that the location for the new 110 kV GIS substation in the Moygownagh area (i.e. western limit of Grid West project) is approximately 6-7 km straight-line distance (depending on which location is selected) from the northeast boundary of the Oweninny wind farm property.

Underground Cable Option (UGC)

The Underground Cable Option runs from north Mayo to Flagmount over a distance of approximately 113 km.

The route commences at a location from a potential Converter Station to the northwest of Moygownagh. It runs in a southeast direction east of Crossmolina and east of Foxford (and the Lough Conn system). It then turns in an easterly direction running to the north of Swinford and Charlestown. The route again turns to a southeast direction keeping just north of Ballaghaderreen. The final stretch is eastwards towards the Flagford substation, passing north of Frenchpark and south of Boyle.

The nature of the UGC option results in the majority of the development being underground and, therefore, not visible. Potential landscape and visual effects would be largely limited to the construction phase and would be temporary in duration. There would be no significant residual cumulative effects.

400kV Overhead Line Option (OHL)

The OHL option runs from north Mayo to Flagmount over a distance of approximately 103 km.

The route commences at a location for a Converter Station to the northwest of Moygownagh. It runs in a south-southeast direction east of Crossmolina and east of Foxford (and the Lough Conn system). It then turns in a south-easterly direction running to the north of Swinford and to the south of Charlestown and then Ballaghaderreen. The final stretch is eastwards towards the Flagford substation, passing just south of Frenchpark.

Cumulative Effects In Combination

Combined cumulative effects 'in combination' would likely be possible from viewpoints 15 (Nephin Beg) and 20 (Maumakeogh). There may be localised cumulative effects in combination from isolated, elevated locations within the north-eastern area of the PPVZ in proximity to the proposed 400kV OHL. In respect of Viewpoint 15, when looking north-east in clear weather conditions there is the potential for distant views towards the 400kV OHL, seen beyond the proposed Oweninny Wind Farm. However, the cumulative visibility will not result in significant effects due to the intervening distance involved, nature of the OHL lattice structures and their visibility against land within the undulating North Mayo Drumlin Zone (refer to Figure 11.2), which will help to absorb these structures into the overall landscape at this distance.

In respect of Viewpoint 20, when looking south-east from this location in clear weather conditions there is the potential for views towards 400kV OHL, seen to the left of the proposed Oweninny Wind Farm and to the left outside of the current photomontage image. However, the cumulative visibility will not result in significant effects due to the intervening distance involved, and nature of the OHL lattice structures and their visibility against / within the undulating North Mayo Drumlin Zone (refer to Figure 11.2), which will help to absorb these structures into the overall landscape at this distance.

Cumulative Effects In Succession

There are very limited locations within the study area with the potential for combined cumulative effects 'in succession', when the observer is located between the proposed Oweninny Wind Farm and 400kV OHL option, or where the separating distance between schemes is sufficient to require the viewer to turn to see the separate developments.

There may be localised cumulative effects in succession from isolated, elevated locations within the north-eastern area of the PPVZ in proximity to the proposed 400kV OHL, for example at Viewpoint 24.

In respect of Viewpoint 24 (R315, Garranard), with reference to Figure 11.2 and 11.6, this viewpoint is located within the North Mayo Drumlin Zone and on the periphery of the PPVZ where intermittent views of the proposed Oweninny Wind Farm are afforded as a result of intervening topography. From this location the 400kV OHL would potentially be visible at right angles to views of Oweninny Wind Farm, or at angles greater than 180º (i.e. in the opposite direction), Taking into account the intervening distance involved, separation between the developments, and intermittent pattern of visibility from this area, such cumulative effects would not be significant.

Cumulative Effects in Sequence

With reference to Figure 11.6 and Viewpoint 24, there is the potential for cumulative effects in sequence from the R315, and potentially the local road network, in the vicinity of the proposed transmission line and within the north-eastern area of the PPVZ. Cumulative effects would not be significant for the reasons given above.

There would be no views of the proposed 400kV OHL option from within the SPVZ and, therefore, no cumulative effects within this area.

No other viewpoint locations are predicted to experience combined cumulative effects in combination or succession.

220KV Overhead Line and Partial Underground Cable Option (OHL & PUG)

EirGrid considered a 220kV OHL option and a 220kV PUG option that uses the maximum amount of UGC possible. The indicative 220kV OHL follows the same routing principles as the 400kV OHL option. The 220kV PUG option incorporates an additional 2km section of UGC at north Mayo and up to an additional 20km UGC mid-section.

The nature of the Partial Underground Cable option (PUG) results in some of the development route being underground and, therefore, not visible. For underground sections of the route potential landscape and visual effects would be largely limited to the construction phase, and would be temporary in duration. There would be no significant residual cumulative effects in relation to these sections of the route.

In respect of the 220kV OHL, for these sections of the route the effects would be broadly similar to those assessed for the 400kV OHL; while the 220kV towers appear overall more slender, their height is often similar to that of 400kV towers resulting in similar effects.

There would be no views of the proposed 220kV OHL option from within the SPVZ and, therefore, no cumulative effects within this area.

11.5.6 Cumulative effects – Conclusion

In conclusion, the main cumulative effects arising from Oweninny Wind Farm will occur from the public road network within the Primary Principal Visual Zone (refer to Figure 11.6) and from elevated areas within the Mountain Range Zone to the south, west and east within the study area. The majority will be cumulative effects in combination resulting in an increase in density of vertical elements in the landscape and the strengthening of a sustained presence of wind farm development within available views, in which it is mainly not possible to clearly distinguish one development from another. In terms of combined cumulative effects 'in combination' or 'in succession' experienced together with the development at Dooleeg and Corvoderry, landscape effects are considered Negligible to Low and visual effects are considered Slight.

More distant views from the Northern Mayo Drumlin Zone will also experience cumulative effects in combination but these become generally restricted by intervening topography and vegetation further to the east. Where combined cumulative effects 'in combination' or 'in succession' are experienced together with the development at Dooleeg and Corvoderry, landscape effects are considered Negligible to Low and visual effects are considered Negligible to Slight.

Areas located west of the Nephin Beg Range within the Secondary Principal Visual Zone, will experience cumulative effects in combination with the proposed (refused) Tawnanasool Wind Farm. Taking into account the long distances to the Oweninny Wind Farm from within the SPVZ, separating distance between schemes, and screening effect of the intervening Nephin Beg Range, the Oweninny Wind Farm would have a weak presence in views from within this visual zone.

The proposed temporary meteorological mast at Sheskin is likely to be visible in combination and / or succession with the proposed Oweninny Wind farm and cumulative assessment schemes from a number of viewpoints within the PPVZ; specifically those facing Slieve Fyagh. The mast would add a single vertical element to a landscape containing various larger vertical structures as part of the proposed Oweninny Wind Farm, Corvoderry Wind Farm and Dooleeg wind turbine. Taking into account the temporary nature of the planning application, the corollary is that any combined cumulative effects seen in combination or in succession would, at most, be Slight to Negligible.

In respect of the three Grid West technology options (described above): the UGC option, and sections of the PUG, result in the development being underground and, therefore, not visible. Potential landscape and visual effects would be largely limited to the construction phase and would be temporary in duration. There would be no significant residual combined cumulative effects for either of these options.

With regard to the 400kV and 220kV OHL options, there would be localised combined cumulative effects in combination and succession from elevated locations within the vicinity of the proposed OHL transmission line within the north-eastern area of the PPVZ, for example at Viewpoint 24. Taking into account the intervening distances involved, separation between the developments, and intermittent pattern of intervisibility within this area, such cumulative effects would not be significant.

Within the wider landscape there are very limited locations where cumulative effects in combination would be experienced; viewpoint 15 and 20 are representative of where these cumulative effects are likely to occur. However, the cumulative visibility will not result in significant effects due to the intervening distances involved, the nature of the OHL lattice structures and their visibility against land within the undulating North Mayo Drumlin Zone (refer to Figure 11.2), which would help to absorb these structures into the overall landscape at this distance.

With reference to Figure 11.6 and Viewpoint 24, there is the potential for cumulative effects in sequence from the R315, and potentially the local road network, in the vicinity of the proposed transmission line and within the north-eastern area of the PPVZ. Cumulative effects in sequence would not be significant for the reasons given above.

Overall, residual combined cumulative effects between the proposed Oweninny Wind Farm and Grid West would not be significant as a result of the different nature of the two development types, intervening distances from viewpoint locations, orientation, and separating distance between the two developments.

11.5.7 Effects of warning lights

No aviation warning lights are required for the proposed Oweninny Wind Farm.

11.5.8 Summary of Landscape and Visual Effects

Detailed site surveys have been carried out to assess the potential landscape and visual effects of the proposed development on the study area. These impacts have been described in terms of landscape effects, visual effects and cumulative effects. The findings of the landscape and visual impact assessment are to be read in conjunction with Figures 11.1 – 11.7 and Photomontages 1 - 27.

11.5.9 Summary of effects on viewpoints

A summary of landscape, visual and cumulative effects as described for each photomontage in Section 11.5.4 is listed below:

Table 11.10 – Summary of landscape, visual and cumulative effects as illustrated in Photomontages 1 – 27

Photomontage no.	Visual Effects	Landscape effects	Cumulative effects
	Primary Principal Visual Zone		
A	None	None	None
B	Slight	Low to Medium	Combination
2	Substantial	Medium	Combination
3	Moderate to Substantial	Medium	Combination
4A	Moderate to Substantial	Medium	None in this view
4B	Substantial	Medium	Combination
5	Substantial	Medium	None in this view
6	Moderate to Substantial	Medium	Combination/Succession
7A	Substantial	Medium	None in this view
7B	Substantial	Medium	None in this view
8A	Substantial	Medium	Combination
8B	None	None	None in this view
9A	Substantial	Medium	None in this view
9B	Substantial	Medium	None in this view
10A	Substantial	Medium	Combination
10B	Moderate to Substantial	Medium	Combination
11	Substantial	Low to Medium	Combination
14	Moderate to Substantial	Medium to High	Combination
21	Substantial	Medium to High	None in this view
22	Moderate to Substantial	Medium to High	Combination

Photomontage no.	Visual Effects	Landscape effects	Cumulative effects
23	Slight to Moderate	Low to Medium	Combination
	Secondary Principal Visual Zone		
16	Slight to Moderate	Low	Combination
17	Slight to Moderate	Low	Combination
18	Moderate	Medium	None
	Mountain Range Zone		
12	None	None	None
13	None	None	None
15	Moderate to Substantial	Medium to High	Combination / Succession
19	None	None	None
20	Substantial	Medium to High	Combination
25	None	None	None
	Northern Mayo Drumlin Zone		
1	Slight	Low	Combination
24	Slight to Moderate	Low to Medium	Combination
26	Slight	Low	None
27	Slight to Moderate	Medium	Combination

11.5.10 Visual Effects

The majority of open and intermittent views of the wind farm within the study area occur within the Primary Principal Visual Zone, which comprises the wind farm site itself and the following surrounding areas within a distance of the centre of the wind farm site of approximately:

- up to 9km to the west;
- up to 14km to the south and southeast;
- up to 12km to the east; and
- up to 8km to the north and northeast.

The visual effects resulting from the introduction of the wind turbines are illustrated in Photomontages A, B, 2, 3, 4A - 10B, 11, 21, 22 & 23 and range between Slight to Moderate within the outer areas and increase to Substantial when close or within to the proposed development. The wind farm would be visible from most locations along public roads within this zone due to its scale and the absence of screening features such as significant vertical vegetation or intervening topography.

Proposed ancillary development such as meteorological masts, substations and 110kV overhead transmission lines as well as a proposed Operations and Maintenance facility and visitor centre will be located within the wind farm site. From most locations, the structures will always be seen in conjunction with the wind turbines and will therefore not result in significant visual effects due to their proposed location, colour and material.

Views from within the Secondary Principal Visual Zone comprise views from locations west of the proposed Oweninny Wind Farm and the Nephin Beg Range between approximately 11 – 29km from the centre of the wind farm site. The visual effects are illustrated in Photomontages 16 - 18 and range from Slight to Moderate and Moderate. Views will comprise sections of the upper parts, mainly blades or blade tips of the wind farm, which will appear above the intervening mountain ridges. Views will be open and panoramic but become increasingly dependent on clear weather conditions with distance.

Views from within the Northern Mayo Drumlin Zone located between approximately 12 – 30km northeast, east and southeast of the wind farm will experience views of various sections of the proposal but become increasingly intermittent due to the screening effects of the undulating landform, intervening vegetation and the increasing dependence on clear weather conditions with distance to the wind farm. Visual effects are illustrated in Photomontages 1, 24, 26 & 27 and range between Slight to Slight to Moderate.

Visual effects from the Mountain Range Zone located to the north, west and south of the wind farm have been illustrated in Photomontages 15 & 20 and range between Moderate to Substantial. The wind farm will be openly visible from mountain summits and slopes facing the wind farm. However, a large number of slopes facing the wind farm have been covered with commercial coniferous forestry. There would be no available views from within easily accessible paths within these areas.

Open views from elevated areas east of Carrowteige, northwest of the study area between approximately 24 -27km from the wind farm centre will experience Slight to Moderate visual effects. Considering the long distance from the wind farm site, visibility is dependent on clear weather conditions.

11.5.11 Landscape Effects

Effects on landscape character are closely related to the nature and extent of visibility as described above. The landscape effects of the proposed wind farm within the Primary Principal Visual Zone and from within the Mountain Range Zone (8-20km) will range between Low to Medium and High. The current landscape character will be altered by the introduction of Oweninny Wind Farm as it will form an extensive new feature in a large scale, open landscape. While coniferous plantations and the existing Bellacorick wind farm are also indicators of human activity, and cover large areas, they are smaller in vertical scale than the proposal. The scale and extent of the proposed development will become a central element to interpretation of the landscape. Human structures will become an intrinsic part of the landscape character and dominate when viewed from a close distance. The open and large scale characteristics of the landscape would remain, but the “empty” characteristic would change. Considering the history of the wind farm site as a former large scale peat harvesting area to fuel the now removed Bellacorick power station, the proposed development would re-establish a large scale energy harvesting character to the landscape. The simple form and colour of the wind turbines in combination with a contour-conscious layout will result in a clear and cohesive image.

The majority of Landscape Effects from within the Secondary Principal Visual Zone, the Northern Mayo Drumlin Zone and sections of the Mountain Range Zone (20-30km) from the centre of the wind farm site, will range between Low and Medium. The landscape character in these areas is often altered by human activity and comprises pasture, agriculture, settlements and coniferous plantations across a number of mountain slopes as well as open bog grassland. The introduction of vertical, rotating elements in the vista will add a new layer of human activity to this scene, which is not characteristic when set within the attributes of the receiving landscape. Due to the distance and often panoramic scale of the vista, the turbines will not form prominent structures and therefore not substantially alter the existing landscape character.

The proposed Oweninny Wind Farm is located within the Landscape Character Unit F – North Inland Bog Basin / Policy Area 3. The County Mayo Landscape Appraisal applies an overall landscape sensitivity rating of 'High' within this area.

11.5.12 Effects on Natural Heritage Areas and Natura 2000 sites

The proposed Oweninny Wind Farm is located largely outside all relevant designated Natural Heritage Areas and Natura 2000 sites in its vicinity. There will be therefore no effects arising on the existing landscape character of these sites. A number of designated sites, (Bellacorick Iron flush and Lough Dahybaun SAC areas refer to Figure 11.2 – Natural Heritage Areas and Natura 2000 sites, for their location) located within the study area will experience visual effects, particularly from within the Primary Principal Visual Zone and Secondary Principal Visual Zone as indicated in Figure 11.6 – Visual Impact. Sites located outside of the principal zones, within the Northern Mayo Drumlin Zone and on elevated slopes and summits of the mountain ranges to the south, west and east will also experience visual effects. Large sections of Natural Heritage Areas and Natura 2000 sites are not publicly accessible. However, in areas where public roads traverse or border along designated sites, visual effects will arise to different extents. The majority of visual effects will be experienced from designated sites between 1 and 10km radius from the wind farm site boundary. Visual effects will range between Moderate to Substantial and have been illustrated in the following Photomontages which are either located within or in close proximity to designated sites:

- Natural Heritage Areas (NHA)

  Photomontages 15 & 12
- Proposed Natural Heritage Areas (pNHA)

  Photomontages 2, 3, 4A, 4B, 5, 11, 12, 14, 19, 20, 22
- Special Areas of Conservation (SAC)

  Photomontages 2, 3, 4A, 4B, 5, 11, 12, 14, 19, 20, 22
- Special Protection Areas (SPA)

  Photomontages 15 & 12

Views from areas between 10 - 25km of the wind farm site will become increasingly intermittent or some areas will experience no views. Visual effects will range between Slight to Moderate and have been illustrated in the Photomontages 26 & 27.

It should be noted that Natural Heritage Areas and Natura 2000 sites, as stated in Section 11.3.9, are primarily concerned with ecological issues. The above stated effects will have no impact on the designated sites themselves or their conservation objectives but on potential observers located within these sites.

11.5.13 Effects on Scenic Routes and Protected Views

The effects on scenic routes and highly scenic routes are shown in Table 11.11 and

Table *11.12*.

Table 11.11: List of Scenic Routes within the study area

No.	Scenic Route Description	Visual Effects arising from the development
County Mayo		
SR 1	N59 from Bangor to east of Rosturk	There will be no visual effects arising due to intervening topography.
SR 2	R297 from Castleconor (border to County Sligo) to Crockets Town (Ballina)	The ZTV indicates potential visibility in this area. Potential views from elevated areas would result in Slight visual effects due to intervening topography and vegetation and the effects of distance. However, visibility is unlikely due to intervening vegetation.
SR 3	R312 from Derreen to Beltra Lough	There will be no visual effects arising due to intervening vegetation and topography.
SR 4	R313 Barnatra to Blacksod Point	Orientation of designated views is pointing north/northwest and away from the proposed wind farm. Potential visibility may arise when looking southeast, close to Barnatra resulting in slight to moderate visual effects.
SR 5	R314 from Belderg to Bunatrahir Bay and from Glenamoy to Barnatra	Open and intermittent visibility will arise for approximately 4km along this route. Visual effects are considered Moderate and are illustrated in Photomontage 18.
SR 6	R315 from Lahardaun to Pontoon (west of Lough Conn)	There will be no visual effects arising due to intervening vegetation and topography.
SR 7	R319 from Mulranny to south of Bunacurry (northern part of Achill Island)	There will be no visual effects arising due to intervening topography.
SR 8	R310 and L134 from Knockmore to north of Ross West (between Lough Conn and Lough Cullin)	The majority of this scenic route will not experience views of the proposed wind farm due to intervening topography and vegetation. However, short open and intermittent views will be experienced from Pontoon Bridge and from an elevated short stretch of approximately 400m along the R310. Visual effects are considered Moderate and are illustrated in Photomontage 27.
SR 9	Local road from Rathlackan west to Gortmore, south of Downpatrick Head	There will be no visual effects arising due to intervening topography.

No.	Scenic Route Description	Visual Effects arising from the development
SR 10	Local road from south of Pollatomish to Barnatra	There will be no visual effects arising due to intervening topography.
SR 11	Local road along the west shores of Carrowmore Lake, from Barnatra to the R313 junction	There will be open views of blades or blade tips possible when driving along the western shore of Carrowmore Lake. The visual effects are considered Moderate.
SR 12	Local road from Gweesalia and around the peninsula	The majority of this scenic route will not experience view of sections of the proposed wind farm. However, short stretches of elevated areas along the western section and prolonged sections along the northern side of this scenic route will experience visibility. The visual effects are considered Slight to Moderate and are illustrated in Photomontages 16 and 17.
SR 13	Local road from Beltra to the R315 junction at Lough Conn	There will be no visual effects arising due to intervening topography and vegetation.
SR 14	Local road from Killala to Moyne Abbey	Orientation of designated views is pointing northwest to Killala Bay and away from the proposed wind farm. There will be open views of blades or blade tips possible when driving along this scenic route. The visual effects are considered Slight due to intervening topography, vegetation and the effects of distance. Visual effects are illustrated in Photomontage 26.
SR 15	Local road east of Lough Conn, from Garrycloonagh to Brackwanshagh	The majority of this scenic road will not experience views of the proposed wind farm due to intervening vegetation and topography. However, intermittent views will be possible at some locations where intervening vegetation and buildings structures open up. Visual effects are considered Slight to Moderate.
SR 16	Local road west of Lough Conn, from the R312 junction north of Keenagh to Newport	Mostly open views can be experienced when travelling along this road after passing the ridgeline northeast of Sharer opening up views to the north. Visual effects are considered Moderate to Substantial and are illustrated in Photomontage 14. Intervening topography and vegetation will obstruct views along this road occasionally. After passing ridgelines located northeast of Srahmore, all sections south to Newport will not experience visual effects due to intervening topography.

No.	Scenic Route Description	Visual Effects arising from the development
SR 17	Local road from Srahmore, running east of Furnace Lough, to Newport	There will be no visual effects arising due to intervening topography.
SR 18	Local road from Srahmore, running north joining the R312 to Bellacorick	The majority of this road is part of the Western Way, located within coniferous forestry and not suitable for use by ordinary vehicles until reaching the townland of Derry Lower and the R312. Open views of the proposed wind farm will be possible for the majority of these sections. Visual effects are considered Significant and are illustrated in Photomontage 5.
County Sligo		
SR 19	R297 from Enniscrone running southwest and diverting to a local road continuing south along the east side of River Moy towards Ballina	The ZTV indicates potential visibility in this area. Potential views from elevated areas would result in Slight visual effects due to intervening topography and vegetation and the effects of distance.

Table 11.12: List of Highly Scenic Views within the study area

Highly Scenic Vistas Description	Visual Effects arising from the development
R310 south of Lough Conn and north of Lough Cullin (looking to both lakes)	Intermittent views will be experienced looking northwest from Pontoon Bridge. Visual effects are considered Slight to Moderate.
R314 at Céide Fields (looking towards the Atlantic Ocean)	There will be no visual effects arising due to intervening topography.
R315 from Cuilkillew to Pontoon (looking towards Lough Conn)	There will be no visual effects arising due to intervening topography and vegetation.
Local road north of Pollatomish (looking towards Broad Haven)	There will be no visual effects arising due to intervening topography and the orientation of highly scenic views is pointing north, northwest and west to Broad Haven and away from the wind farm development.
Local road west of Carrowmore Lake, from Barnatra to the R313 junction (looking towards Carrowmore Lake)	There will be open views of blades or blade tips possible when driving along the western shore of Carrowmore Lake. The visual effects are considered Moderate.
Local road at Dooyork (looking towards Blacksod Bay)	While view of section of the proposed wind farm will be available from sections of this road designated highly scenic vistas will be facing away from the wind farm development resulting in no visual effects.
Local road from the R312 junction north of Keenagh running to the west of Furnace Lough to Newport (looking towards the Beg Range, Lough Feeagh and Furnace Lough)	As described for Scenic Road 16: Mostly open views can be experienced when travelling along this road after passing the ridgeline northeast of Sharer opening up views to the north. Visual effects are considered Moderate to Substantial and are illustrated in Photomontage 14. Intervening topography and vegetation will obstruct views along this road occasionally. After passing ridgelines located northeast of Srahmore, all sections south to Newport will not experience visual effects due to intervening topography.

11.5.14 Effects on Walking Routes

Western Way

The ZTV indicates visibility of the wind farm for prolonged stretches within the study area. Actual visibility will be significantly obstructed by intervening often coniferous vegetation (refer to Figure 1), particularly sections located within the proposed Nephin Wild Project and northwest and north of the proposed wind farm. The majority of open views will be experienced within approximately 5 - 7.5km from the centre of the wind farm and areas in the immediate vicinity of the wind farm site boundary to the south and west. The nature of landscape and visual effects has been illustrated and described in Photomontages 5, 6 & 11. Landscape effects will range between Low – Medium while the majority of visual effects will be significant in open views.

The ZTV also indicates long distance visibility from sections located approximately 20 – 30km northeast and east of the proposed wind farm site. The majority of potential views from these areas will be obstructed by intervening vegetation. Photomontage 26 illustrates and describes landscape and visual effects from a vantage point in this part of the study area. The landscape impact in available views is considered Low. Visual effects are considered Slight.

Bangor Trail

There will be no landscape and visual effects arising from the proposed wind farm for the majority of the walking trail. There will be potential views of the wind farm along a short stretch located in Ballycroy National Park, on the eastern slopes below mountain summits west of Maumakelly and south of Knocklettercuss resulting in Moderate visual effects. Intervening topography will partially screen the full extent of the Oweninny Wind Farm.

Burrishoole Loops

- Newport (comprising 4 looped walks)
- Derradda (comprising 3 looped walks)
- Tiernaur (comprising 3 looped walks)
- Mulranny (comprising 2 looped walks outside if the study area)

There will be no landscape and visual effects due to intervening topography.

Crossmolina Loop Walks

- White Walk (Gortnoor Abbey), 4km
- Blue Walk (Grange), 6km
- Red Walk (Deel Castle), 11km

The ZTV indicates potential visibility from these walking routes. Intervening vegetation will often screen fully or partially the wind farm development. Potential visibility of wind farm elements would result in Low landscape effects and Slight to Moderate visual effects.

Achill Spur

There will be no landscape and visual effects due to intervening topography.

Enniscoe House Loop

There will be no landscape and visual effects due to intervening vegetation.

Keenagh Loop

The ZTV indicates potential visibility from elevated areas of this walking route. Actual visibility of wind farm elements would result in Low landscape effects and Slight to

Moderate visual effects, due to the distance from the proposed development and intervening vegetation.

Letterkeen, Bothy, Lough Aroher Loops

There will be no landscape and visual effects due to intervening topography and vegetation.

Ceathrú Thaidhg Loop Walks

The ZTV indicates potential visibility from elevated areas of this walking route. Actual visibility of wind farm elements would result in Low landscape effects and Slight to Moderate visual effects, due to the long distance from the proposed development.

Belleek Nature Trail

There will be no landscape and visual effects due to intervening topography.

Sralagagh Loop Walk

There will be no landscape and visual effects due to intervening topography.

Inishbiggle Loop Walks

There will be no landscape and visual effects due to intervening topography.

The Great Western Greenway

There will be no landscape and visual effects due to intervening topography.

Carrowteige, Ceathrú Thaidhg 'Slí na Sláinte' walking route

The ZTV indicates potential visibility from elevated areas of this walking route. Actual visibility of wind farm elements would result in Low landscape effects and Slight to Moderate visual effects, due to the long distance from the proposed development.

Belmullet, Broadhaven 'Slí na Sláinte' walking route

There will be no landscape and visual effects due to intervening topography and vegetation.

Ballina 'Slí na Sláinte' walking route

There will be no landscape and visual effects due to intervening topography and vegetation.

11.5.15 Effects on Cycling Routes

Belmullet Cycle Hub

Carrowmore Loop

The majority of views will be experienced from sections along the R313 and along Carrowmore Lake. The landscape effects are considered Low to Medium. Visual effects are considered Slight to Moderate.

Pullathomas Loop

The majority of views will be experienced from elevated areas along the R314 north of Carrowmore Lake as illustrated and described in Photomontage 18. The landscape effects are considered Medium and the visual effects are considered Moderate.

North Mayo Linear Route – Belmullet – Ballycastle

This route shares sections with the Pullathomas Loop and landscape and visual effects will the same as described above. However, the majority of the linear cycling route will not experience visibility of the proposed development as shown in Photomontage 19, which has been taken in an area of potential visibility indicated by ZTV mapping.

Glinsk & Rossport Linear Route, Coastal Route between Belmullet and Ballycastle

This route diverts from the North Mayo Linear Route and begins at Glenamoy and loops around to coastal areas and finishes at Belderg where it joins the North Mayo Linear Route. The ZTV indicates potential visibility from elevated areas along the coastline. Potential views of the wind farm would be similar in nature as shown in Photomontage 18. Landscape effects are considered Low to Medium and visual effects are considered Slight to Moderate.

Great Western Greenway

There will be no landscape and visual effects due to intervening topography.

11.5.16 Effects on Céide Fields

There will be no landscape and visual effects arising in excavated and publicly accessible areas. Landscape and Visual effects arising from the summit of Maumakeogh have been described in Photomontage 20.

11.5.17 Effects on Ballycroy National Park

The theoretical visibility from Ballycroy National Park is indicated in Figure 7 – Nature of Visibility. The majority of the National Park will not experience visibility of the proposed wind farm development apart from the most north, north-eastern summits and slopes. Photomontage 15 taken from a location close to the summit of Nephin Beg illustrates the potential landscape and visual effects from elevated areas. The landscape effects are considered Medium and the visual effects Moderate to Substantial. It should be noted that the majority of areas experiencing visual impact are not way marked or accessible by public roads.

11.5.18 Effects on the proposed Nephin Wild Project

The area proposed for the Nephin Wild Project is currently almost entirely covered with forest plantation (mainly coniferous). Views of the wind farm from accessible paths, within this area, such as the Western Way walking route, will not be possible. Potential visual effects will arise from areas close to the northern boundary of the proposed Nephin Wild Project site, where views will open up north, northeast when walking along the Western Way. Landscape effects will range between Low – Medium while visual effects will range between moderate and substantial, depending on the extent of visible wind farm sections and the height and density of intervening coniferous vegetation.

11.5.19 Summary of Effects on Designated Areas

Oweninny Wind Farm will be openly visible mainly from landscape designated areas, views and routes located within 1 to 10km radius from the wind farm site boundary, due to the flat or very gently undulating nature of the terrain surrounding the wind farm site and the lack of significant vertical features, as well as from elevated slopes and mountain summits located to the north, west and south. Visual effects will generally range from Moderate to Substantial, with the highest effects on locations close to the boundary of the wind farm site. Large designated areas are not accessible by public roads and can be reached by foot only.

Visual effects between 10-25km radius from the wind farm site boundary will be become increasingly intermittent and many areas will experience no views due to intervening topography and vegetation. Visual effects will generally range between Slight to Moderate.

There are a considerable number of walking, cycling and scenic driving routes within the study area. However, the majority are located between 15-30km from the centre of wind farm site. The visual effects in available views will range from slight to moderate depending on the distance of the observer from the proposed wind farm site.

The Western Way and Scenic Routes 18 & 16 are located within the Primary Principal Visual Zone and will experience substantial visual effects in areas where open views are possible and are not fully or partially obstructed by intervening often coniferous commercial vegetation.

11.5.20 Effects on Built-Up Areas

Settlement is generally sparse within the Primary Principal Visual Zone, but individual houses located in the landscape will experience views of the proposal. Settlement is more sparse and dispersed within the mountain ranges to the north, west and south (refer to Photomontages 15 & 20). The majority of available views of the proposed wind farm from within this area will result often in Substantial visual effects due to open views of the proposal and the absence of significant vertical screening by natural or built features. The visual effects within the vicinity of residential properties are illustrated in Photomontages 2, 3, 7-11 & 21-23.

There are no known views from the towns and villages of Pontoon, Beltra, Newport, Rosturk, Mulranny, Ballycroy, centre of Bangor (refer to Photomontage 13), Belmullet, Killala, Ballycastle, Belderg, Glenamoy and Ross Port due to intervening topography and vegetation.

Visual effects on available views beyond 14km and up to 30km from the centre of the wind farm site will range from slight to moderate depending on the distance from the wind farm and extent of turbines visible. The visual effects within the vicinity of residential properties are shown in Photomontages 1, 16, 17, 18, 24, 26 & 27.

11.5.21 Effects on Roads within the study area

Visibility from roads in the study area is indicated on Figure 11.6 – Visual Impact.

National Roads

N26

There will be no visual effects for the majority of this road within the study area due to topography and intervening vegetation.

N59

Figure 11.4 – ZTV Hub Height and Figure 11.5 – ZTV Blade Tip Height, indicate potential visibility from the majority of the road within 10km of the centre of the wind farm site to the west and until the study area boundary 30km to the east with exception of sections located within Ballina. ZTV mapping does not take account of the screening effects of vegetation and intervening built structures. Actual visibility, mapped during a public road survey, has been indicated in Figure 11.6 – Visual Impact.

The actual visibility can be separated into two zones. The first is located within the Primary Principal Visual Zone and within a flat or gently undulating landscape basin in which the wind farm itself is located. Sections of the N59 run along the southern boundary of the wind farm site. The lack of significant vertical vegetation and the close proximity to the proposal will allow for prolonged open views of the wind farm. Visual effects are illustrated in Photomontages 2, 3, 4A, 4B & 6 and range from Moderate to Substantial.

The second zone of visibility is located within the Northern Mayo Drumlins. The nature of the landscape becomes undulating and diverse. Topography and intervening vegetation allow for mainly glimpsed views of the proposed wind farm. These views for a short distance become more and more intermittent along eastern sections of the N59 within the study area. Visual effects will range between slight to moderate in these areas and depend on clear weather conditions.

Topography will fully screen views of the proposed development in views from sections located to the west, outside a 10km radius of the wind farm as illustrated in Photomontages 12 & 13.

Regional Roads

R297

Long distance open and intermittent views of the wind farm will be possible from elevated sections of the road where there is no roadside vegetation and from within the centre of Enniscrone. Visual effects are considered slight to moderate and will highly depend on clear weather conditions due to the long distance.

R310

Views of the proposed wind farm will not be possible for the majority of this road. However, short open and intermittent views for approximately 400m will be experienced from an elevated section without roadside vegetation above the shores of Lough Conn and from Pontoon Bridge. Visual effects are considered moderate and are illustrated in Photomontage 27.

R312

Open and intermittent views will be possible from this road from locations located within15km of the centre of the wind farm site. Prolonged open views will be experienced in sections within 6km to the south of the wind farm site. Visual effects will range between Moderate and Substantial and are illustrated in Photomontage 5.

R313

Open views will be experienced within the Secondary Principal Visual Zone as indicated in Figure 11.6 – Visual Impact. Similar to effects shown in Photomontage 18, visual effects will be Moderate.

R314

Open and intermittent views will be experienced within the Secondary Principal Visual Zone as indicated in Figure 11.6 – Visual Impact. Visual effects are considered Moderate and are shown in Photomontage 18.

R315

A series of mainly intermittent view of parts of the wind farm will be experienced along this road between Lahardaun in the south and the townland of Creevagh in the north. Visual effects are considered Slight to Moderate and are shown in Photomontages 1 & 24.

R316

The majority of this road will not experience visual effects. However, short stretches of open and intermittent views of the proposed development will be experienced along sections located northwest of Nephin. Visual effects are considered Slight to Moderate.

R317

There will be no visual effects arising from the proposed wind farm from sections located within the study area due to intervening topography.

R319

There will be no visual effects arising from the proposed wind farm from sections located within the study area due to intervening topography.

Local Roads

The majority of open and intermittent views from local roads occur from within the Primary Principal Visual Zone (refer to Figure 11.6). Photomontages 7A-10B, 11, 14 & 21 – 23 illustrate views from a distance of approximately up to 15km from the centre of the wind farm site. Visual effects will range between Slight to Moderate to Substantial depending of the distance from the wind farm.

Views from beyond 15km radius become increasingly intermittent to the east and southeast due to localised undulating topography and vegetation. Open long distance views can be experienced from areas to the west as illustrated in Photomontages 16 & 17 and east as shown in Photomontage 26 as well as north, northeast along the local road network between Carrowteige and Belderg. Visual effects are considered Slight to Moderate.

11.5.22 Connection to the National Grid

The wind turbines will be connected to four proposed 110kV substations via underground cables. Two proposed 110kV overhead transmission lines located within the wind farm site will connect to the National Grid. Proposed overhead transmission lines are recognisable in Photomontages 4A, 4B, 5, 6, 7A, 7B, 8A & 9A – 11. They are potentially visible, but not easily perceptible, from more distant viewpoints 14, 15, 20 and 21. The extent of their visibility is described in Section 11.5.4 – Landscape and Visual Effects.

11.6 MITIGATION

Wind turbines are by their nature highly visible elements and cannot be easily screened. Their function dictates that they are located on exposed sites. However, in some cases, the topography of the site can be used in order to screen the development from sensitive viewpoints.

The following mitigation measures were taken into account at the initial stage in the layout and design of the turbines, substation and transmission line structures:

11.6.1 Sitting, Design and Layout

As described in Sections 11.2.2 and 11.2.3, the proposed layout was based on the following:

- To meet the planning constraints in relation to preservation of visual amenities; and
- To improve the nature of visibility.

The principal objectives considered in the layout were:

Wind Farm:

- To produce a clear and simple layout that was visually unified and relates to the surrounding landform;
- To minimise visual confusion;
- To provide visual balance and harmony. Harmony and balance create clarity;
- To provide visual unity; and
- Minimise adverse cumulative effects with proposed surrounding wind farms.

Ancillary structures (substations and transmission lines):

- Restricting the siting of structures close to a public road
- Transmission line structures were set well back from the edges of public roads
- Avoidance of running the transmission line close to or parallel to a road;
- Avoidance of placing transmission line and substation structures on axial views, or where there was a change in direction of a road;
- Alignment of the proposed access road to substation locations as level as possible with the existing ground, where possible.

11.6.2 Comparison of alternative turbine heights

Chapter 4 – Alternatives, describes the design and layout development process and contains an assessment of alternatives. Different turbine heights have also been assessed as part of the landscape and visual impact assessment. Zone of Theoretical Visibility (ZTV) maps were produced and used as a tool to compare the visual effects of two different turbine height options within the study area. The following turbine dimensions have been compared:

- 120m hub height
- 176m blade tip height

and

- 100 hub height
- 150 blade tip height

There is very little difference between these two options in terms of the extent of visibility. The extent of visibility of the lower tip height wind farm is slightly less within the Secondary Principal Visual Zone and in areas within a similar distance of the wind farm site to the northwest, north, northeast and east. The majority of visual effects within the Primary Principal Visual Zone will remain similar when compared to the taller wind farm option due to the nature of the topography and the absence of intervening screening vegetation.

In conclusion, the larger turbines will appear slightly taller than the smaller turbines in short to middle distance views within a radius of up to 15km from the wind farm site. The taller turbine option will result in slightly more areas experiencing visibility of the wind farm in middle and long distance views to the east, north and west of the wind farm site.

Therefore in conclusion, the taller turbine option results in slightly more areas experiencing visibility of the wind farm. However, where views are available, there would be no significant difference in the visual effects of the two options that were assessed. Similarly, there is no significant difference in the landscape effects of the two assessed turbine height options.

11.6.3 Design of Site Access Roads

The overall length of roads required accessing the turbines during construction and maintenance has been minimised.

11.6.4 Colour

Wind Farm:

A number of colour options have been considered to reduce the visual impact of the proposed turbines. The turbines, in the majority of views, would be seen against the sky. It is proposed to paint them Goosewing Grey or matt white. These colours are neutral and the appearance of these colours means that whatever the weather conditions or nature of the surrounding landscape characteristics, the turbines would never aesthetically clash in colour. Taking into consideration the prevailing weather conditions within the centre of the study area, a darker colour other than Goosewing Grey or matt white would make the turbines appear dirty and industrial in character. They would also be more visible against the clear sky.

Substations:

Appliance of a dark ochre colour matching the surrounding bog grassland for all substation building structures to help the integration of the buildings into the surrounding landscape in close and distant views;

- Appliance of dark grey paint on line/cable interface masts and angle masts in order to minimise their visual effects resulting from light reflections and to improve their integration into the surrounding landscape; and
- Use of material for building facades/cladding, fencing and gates which is local or appropriate to the area in scale, colour and design, e.g. sandstone cladding.

11.6.5 Planting

Considering the nature of the wind farm development, screen planting within or in close proximity of the site would not provide significant levels of screening. The wind farm site consists mainly of rehabilitating bog-grassland and few clusters of coniferous plantations. The introduction of significant vertical screen planting is not considered appropriate as it would stand in contrast with the surrounding rehabilitating landscape. Screening should be carried out by taking advantage of existing topography, appropriate ground modelling and natural re-vegetation. Proposed planting in the vicinity of proposed ancillary buildings such as substations and the visitor centre should be limited to native species found in the vicinity only.

11.6.6 Decommissioning

The general lifetime of wind turbines is considered to be twenty-five years or more. An environmental and landscape appraisal would be carried out prior the removal of the wind farm, together with an economic analysis. If further turbines were to be erected, they would be the subject to a new Planning Application. The outcome of the landscape / environmental appraisal would be discussed with Mayo County Council and a decision made as to whether or not the site roads and control buildings are to be removed.

11.7 CONCLUSIONS

The development will form two main sections to the east and west separated by the Oweninny River. The centre of the study area is characterised by open and unimpeded panoramic views across a smooth and uniform landscape which lacks significant vertical landmarks and results in a sense of openness, emptiness, remoteness and isolation. Mountain ranges enclosing the basin to three sides provide a backdrop on the horizon anchoring the scenery when looking north, west and south.

The proposed development will be often seen as one unit with a balanced composition of turbines. It will form a prominent new feature and result in generally medium landscape effects and moderate to substantial visual effects. The majority of available open views will be experienced from within the proposed wind farm site, within approximately 8km of its boundary and from mountain summits and slopes located to the north, west and south facing the proposed development.

The development will have an impact on the overall landscape and visual character of the centre of the study area, which cannot be reduced due to number and scale of the proposed wind turbines. However, the openness of short and long distance views will remain due to the spacing of the turbines in relation to each other and due to the large scale and uniformity of the landscape. Turbines can appear higher than the mountain backdrop in some views to the west and south. Sections of mountains will then be seen through the turbines, interfering with their ridgelines and dwarfing the scale of their presence. These effects are localised and limited to locations within the wind farm site or in close proximity to the development. The punctuation of verticality will structure the landscape, removing the currently “empty” characteristic but retaining its openness and underlying basin character.

The proposed Oweninny Wind Farm will be located within a large landscape basin. Long distance views, beyond 15km of the centre of the wind farm site will experience generally slight to moderate visual effects and low landscape effects. The development will be partially screened by intervening topography and vegetation helping to integrate the turbines as one element of many in the wider view. Long distance views may lose the sense of remoteness as a new man-made feature in an often already man altered landscape will be added. Sections of the wind farm would form small moving features within a wide panorama. Visibility of the wind farm, and particularly, visibility from viewpoints beyond a 15km radius from centre of the site will increasingly depend on clear weather conditions.

Cumulative effects will be experienced when Oweninny Wind Farm is seen together with proposed Corvoderry and Tawnanasool wind farms and permitted Dooleeg wind turbine developments. The majority will be cumulative effects in combination’ resulting in an increase in density of vertical elements in the landscape and the strengthening of a sustained presence of wind farm development within available views. In the majority of available views, the cumulative wind farm schemes will not be distinguishable from one another and will be seen as one development due to their close proximity to each other. There will be limited combined cumulative effects ‘in combination’ with the proposed (refused) Tawnanasool Wind Farm as a result of the long distances to the Oweninny Wind Farm from / to the SPVZ, separating distance between schemes, and screening effect of the intervening Nephin Beg Range. There are very limited opportunities for combined cumulative effects ‘in succession’ other than in very close proximity to schemes adjacent to the site, or from distant elevated locations where extensive (often 360˚) views are possible. Sequential cumulative effects will be experienced where the proposed Oweninny Wind Farm and other proposed and permitted wind farms are visible in sequence along some roads within the Primary and Secondary Principal Visual Zones across the study area. In relation to the PPVZ, sequential cumulative effects will be visible frequently from routes within c.10km of the centre of the proposed wind farm. Elsewhere within the PPVZ there are several minor routes that would experience intermittent and / or open views of the Oweninny Wind Farm. More frequent sequential visibility is possible from elevated locations to the south of the Northern Mayo Drumlin

Zone and north of the Mountain Range Zone. In relation to routes within the SPVZ, Oweninny Wind Farm would generally be infrequently visible, although with some long duration visibility within sections of routes within the SPVZ. In general, intervening topography and vegetation will prevent or allow for intermittent views of the proposed wind farm development from most routes within the Primary and Secondary Principal Visual Zones. Outside of the PPVZ and SPVZ views would be increasingly intermittent as a result of intervening topography and vegetation and, with increasing distance, dependent highly on weather conditions.

There are a number of walking and cycling routes, scenic viewpoints and scenic routes within the study area. The majority of these recreation and tourism routes are located outside of the Primary Principal Visual Zone and will experience therefore slight to moderate visual effects or no visual effects due to intervening topography and vegetation. Substantial visual effects will occur when in close proximity to the wind farm site.

Oweninny Wind Farm will alter the landscape and visual character within the landscape basin in the centre of the study area due to its extent and height. However, considering the large scale of the surrounding generally homogeneous landscape, the introduction of the wind farm will not be perceived as being out of context with the overall underlying landscape character. Large areas within the basin have been transformed by industrial peat harvesting activities in the past to fuel the now removed Bellacorick Power Station. The majority of the former peat harvesting areas is now in the process of natural rehabilitation. Considering the existing Bellacorick wind farm, operating for more than two decades, and a planning permission to erect 180 wind turbines on the proposed site, wind energy harvesting has already been introduced to the site location. The introduction of large scale wind turbines will therefore not be uncharacteristic when set within the attributes of the receiving landscape. It will intensify and re-establish an industrial sized energy harvesting activity. In contrast to the large scale horizontal extraction method of the past and the current small scale wind harvesting, the proposed development will result in a sustained presence of vertical man-made elements, which will form a new landmark over time.

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KEY

- Proposed Oweninny Wind Farm
- Proposed Tawnanasool Wind Farm
- Proposed Corvoderry Wind Farm
- Permitted Dooleeg Wind Turbine
- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- Significant vegetation
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Scenic Routes
- Highly Scenic Views/Viewpoints
- Scenic Views/Viewpoints
- Ballycroy National Park
- 'Wild Nephin' Area (Coillte)
- Walking Routes
- Cycling Routes
- Vulnerable Features (Ridges/ Skylines) according to County Mayo Landscape Appraisal 2014-2020
- Céide Fields System *according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report*

AECOM

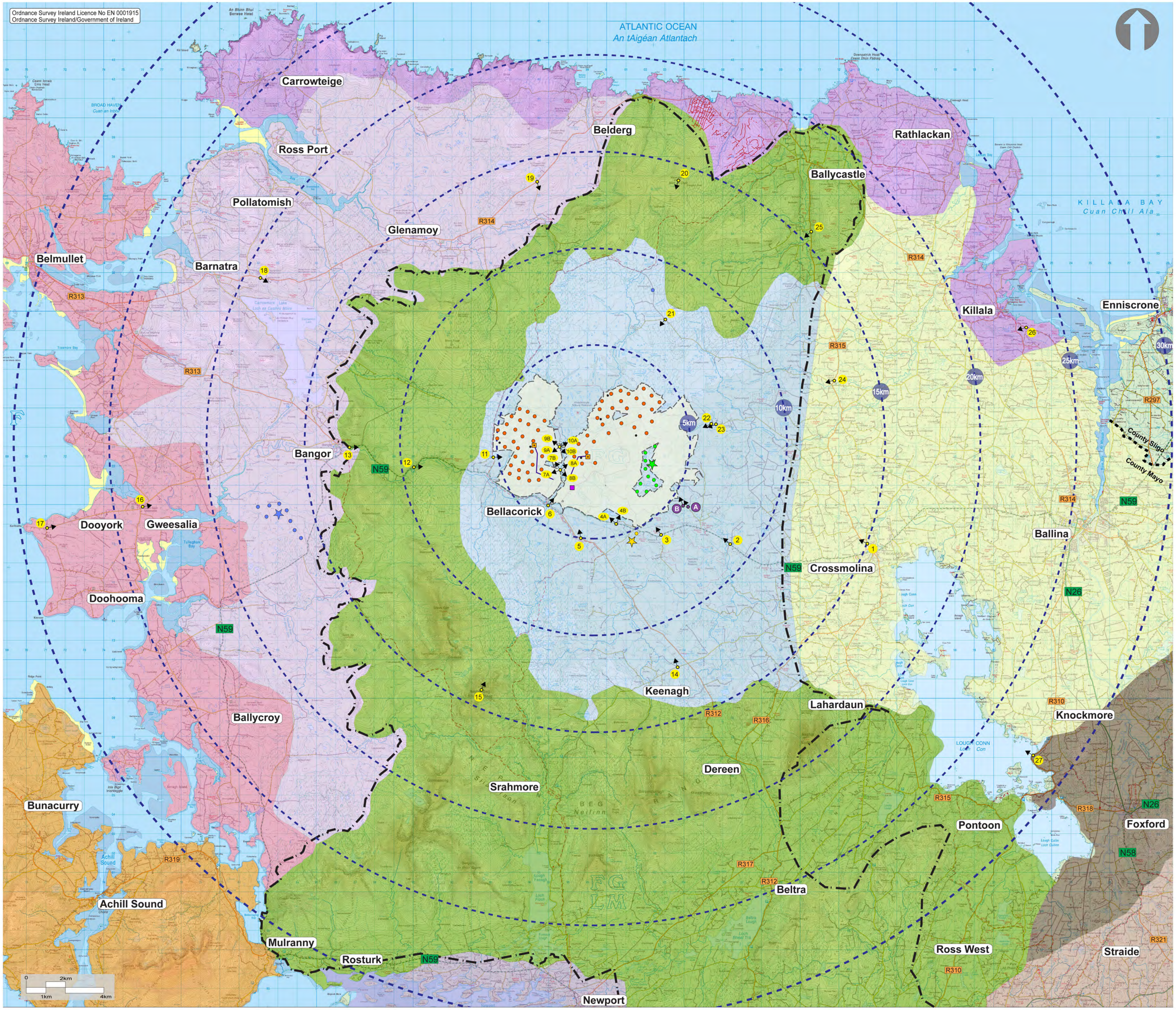
OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

LANDSCAPE DESIGNATIONS AND PHOTOMONTAGE LOCATIONS

FIGURE 11.1 September 2015

Drawn: MH Checked: JS Approved: EF



KEY

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- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Céide Fields System *according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report*

Landscape Character Areas
according to the Landscape Appraisal contained in Mayo County Development Plan 2014-2020

- A - Achill, Clare and Island Complex
- B - North West Coastal Moorland
- C - North West Coastal Bog
- D - North Coastal Plateaux
- E - North Mayo Mountain Moorland
- F - North Mayo Inland Bog Basin
- G - North Mayo Drumlins
- H - East Mayo Uplands
- J - Clew Bay Glacial Drumlins

Landscape Protection Policy Areas
according to the Landscape Appraisal contained in Mayo County Development Plan 2014-2020

- Boundary of Policy Area 3 - Uplands, moors, heath or bogs *(Note that Policy Area 3 is not congruent with Landscape Character Areas)*

AECOM

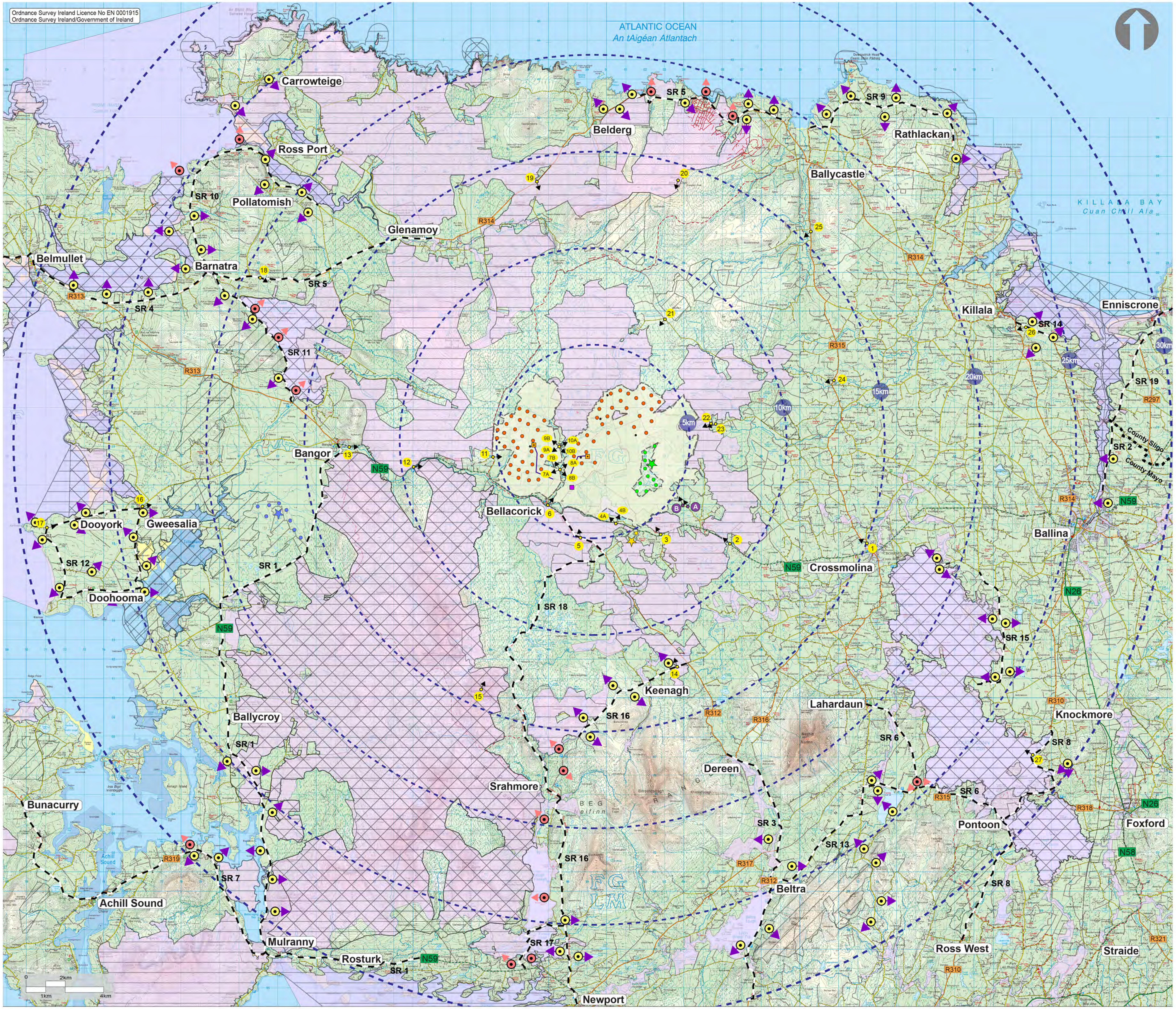
OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

LANDSCAPE CHARACTER

FIGURE 11.2 September 2015

Drawn: MH Checked: JS Approved: EF



KEY

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- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Scenic Routes
- Highly Scenic Views/Viewpoints
- Scenic Views/Viewpoints
- Céide Fields System *according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report*

Natural Heritage Areas according to National Parks and Wildlife Service

- Natural Heritage Area (NHA)
- Proposed Natural Heritage Area (pNHA)

Natura 2000 sites according to National Parks and Wildlife Service

- Special Area of Conservation (SAC)
- Special Protection Area (SPA)

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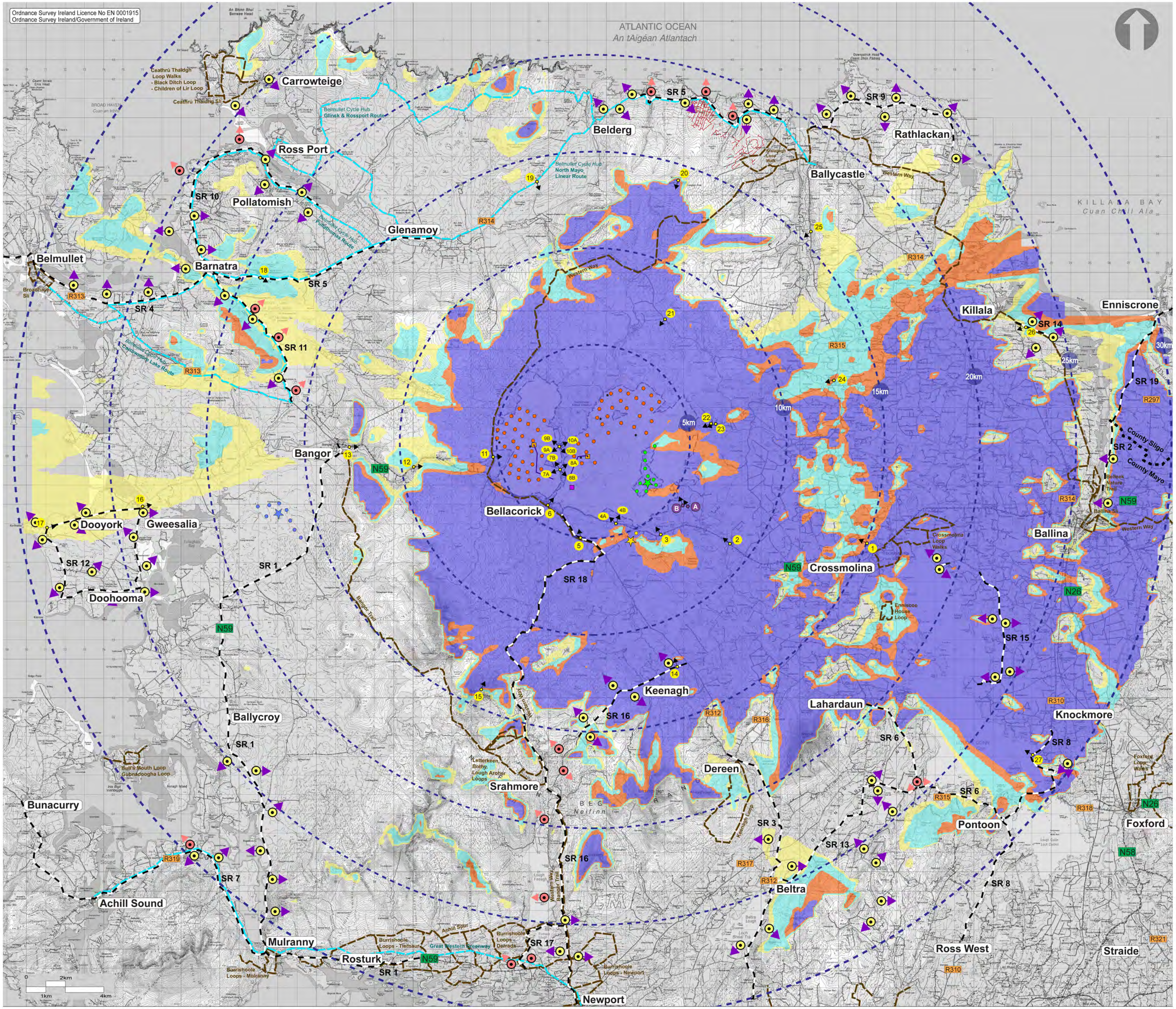
OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

NATURAL HERITAGE AREAS AND NATURA 2000 SITES

FIGURE 11.3 September 2015

Drawn: MH Checked: JS Approved: EF



KEY

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- Proposed Corvoderry Wind Farm
- Permitted Dooleeg Wind Turbine
- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Highly Scenic Views/Viewpoints
- Scenic Views/Viewpoints
- Scenic Routes
- Walking Routes
- Cycling Routes
- Céide Fields System *according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report*

Zone of theoretical visibility

Number of visible turbines

- 1 to 10 visible
- 11 to 30 visible
- 31 to 50 visible
- 51 to 61 visible

The zone of theoretical visibility has been mapped for an approximately 30km radius and at contour intervals of 10m. This map indicates areas where turbines are visible, where they are not visible, and numbers of turbines visible.

However in areas where turbines are visible the precise amount of visibility is not illustrated e.g. areas from which only part of one turbine is visible appear in the same colour code as areas from which all of one turbine is visible.

This mapping does not take account of vegetative screening and hence reflects a bare earth landscape, which for the visual impact assessment process represents the "worst case scenario".

AECOM

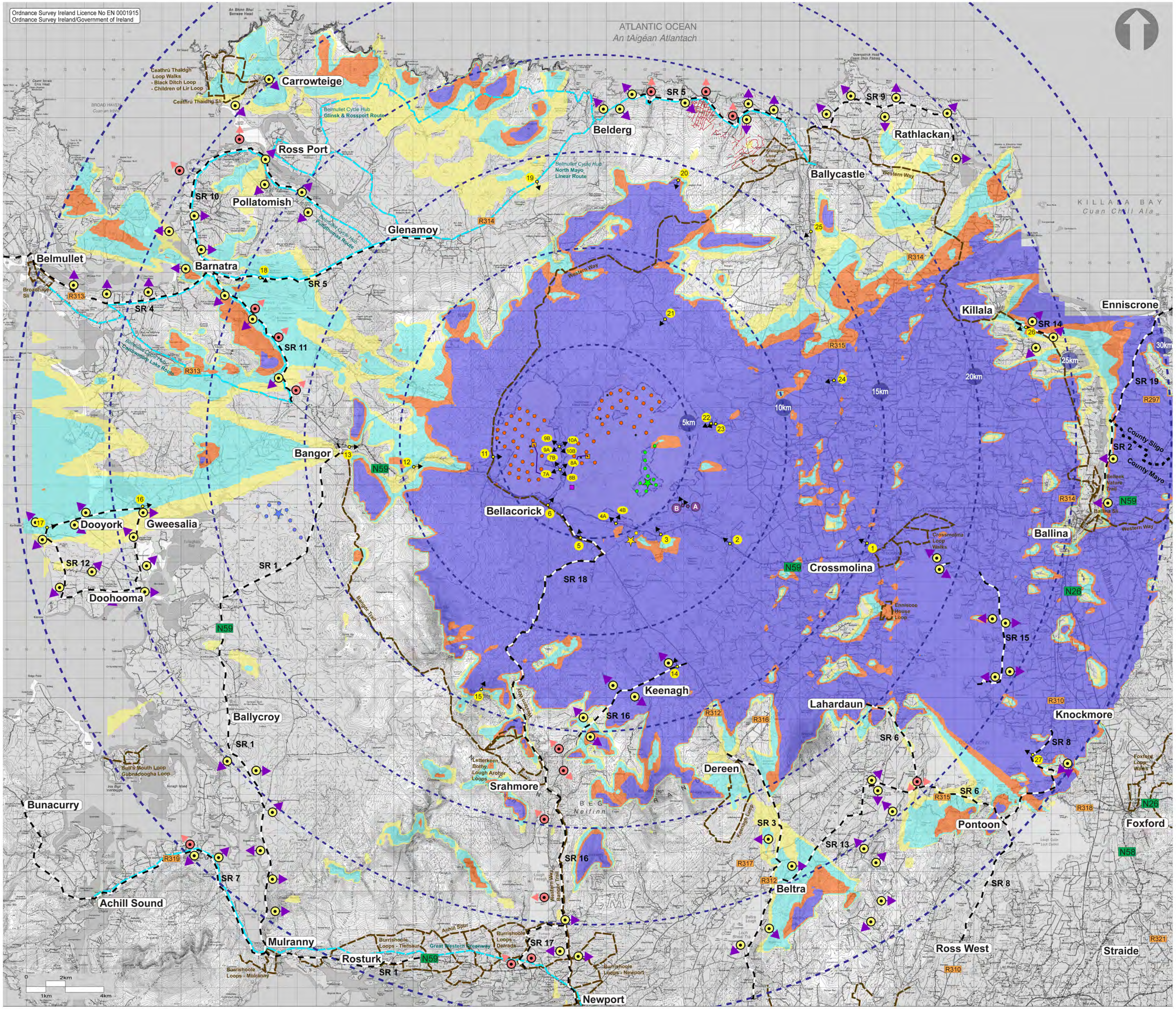
OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

ZONE OF THEORETICAL VISIBILITY 120m HUB HEIGHT

FIGURE 11.4 September 2015

Drawn: MH Checked: JS Approved: EF



KEY

- Proposed Oweninny Wind Farm
- Proposed Tawnanasool Wind Farm
- Proposed Corvoderry Wind Farm
- Permitted Dooleeg Wind Turbine
- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Highly Scenic Views/Viewpoints
- Scenic Views/Viewpoints
- Scenic Routes
- Walking Routes
- Cycling Routes
- Céide Fields System
  according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report

Zone of theoretical visibility

Number of visible turbines

- 1 to 10 visible
- 11 to 30 visible
- 31 to 50 visible
- 51 to 61 visible

The zone of theoretical visibility has been mapped for an approximately 30km radius and at contour intervals of 10m. This map indicates areas where turbines are visible, where they are not visible, and numbers of turbines visible.

However in areas where turbines are visible the precise amount of visibility is not illustrated e.g. areas from which only part of one turbine is visible appear in the same colour code as areas from which all of one turbine is visible.

This mapping does not take account of vegetative screening and hence reflects a bare earth landscape, which for the visual impact assessment process represents the "worst case scenario".

AECOM

OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

ZONE OF THEORETICAL VISIBILITY
176m BLADE TIP HEIGHT

FIGURE 11.5 September 2015

Drawn: MH Checked: JS Approved: EF

KEY

- Proposed Oweninny Wind Farm
- Proposed Tawnanasool Wind Farm
- Proposed Corvoderry Wind Farm
- Permitted Dooleeg Wind Turbine
- Proposed visitor centre location
- Proposed substation locations
- Proposed met mast locations
- Proposed 110kV overhead transmission lines
- Photomontage locations
- Photomontage locations included at Oral Hearing Stage
- County boundaries
- Kilometres distance from the centre of the wind farm site
- Potential intermittent views of the proposed wind farm from public roads
- Potential open views of the proposed wind farm from public roads
- Ballycroy National Park
- 'Wild Nephin' Area (Coillte)
- Relevant High Points over 200m
- Primary Principal Visual Zone (P-PVZ)
- Secondary Principal Visual Zone (S-PVZ)
- Vulnerable Features (Ridges/Skylines) according to County Mayo Landscape Appraisal 2014-2020
- Céide Fields System *according to Figure 2: The Céide Field System, prepared by Seamus Caulfield, published within the Neolithic and Bronze Age Landscapes of North Mayo 2009: Excavations at the Céide Fields Visitor Centre: Stratigraphic Report*

AECOM

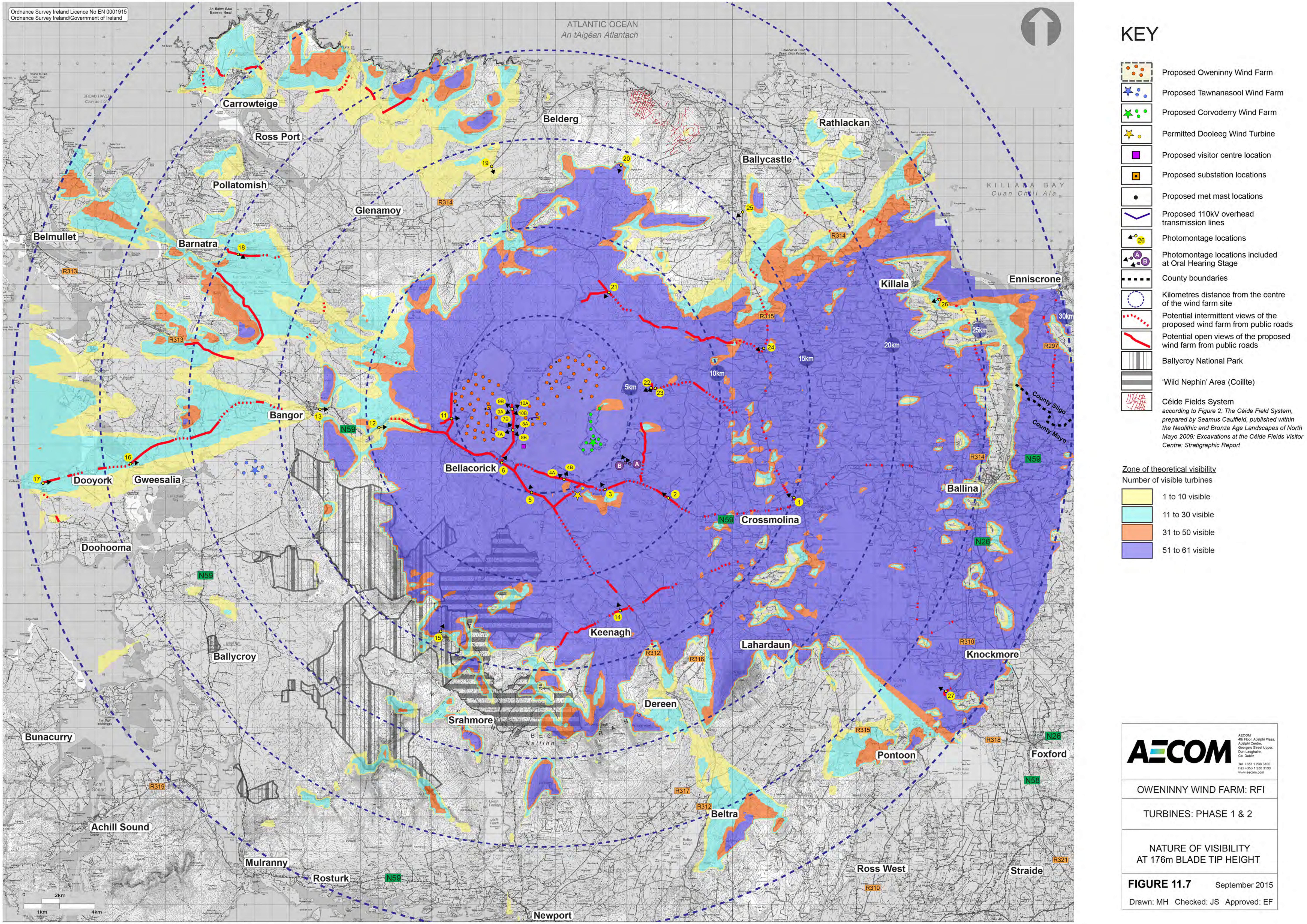
OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

VISUAL IMPACT

FIGURE 11.6 September 2015

Drawn: MH Checked: JS Approved: EF



OWENINNY WIND FARM: RFI

TURBINES: PHASE 1 & 2

NATURE OF VISIBILITY AT 176m BLADE TIP HEIGHT

FIGURE 11.7 September 2015

Drawn: MH Checked: JS Approved: EF

12 AIR QUALITY & CLIMATE

12.1 RECEIVING ENVIRONMENT

This chapter presents an assessment of impacts on air quality and climate arising from the proposed development of Phases 1 and Phase 2 only. The assessment predicts the potential impacts on the surrounding environment arising from the construction and operation of the proposed development and specifies mitigation measures to reduce potential impacts where appropriate. It also provides an assessment of the operational benefit of the wind farm in terms of CO_2 avoided and the overall benefit to the Irish economy in terms of displaced fuel import savings.

12.1.1 Air Quality

12.1.1.1 Legislative Context

In order to protect human health, vegetation and ecosystems, EU Directives have been adopted which set down air quality standards for a wide variety of pollutants. The current standards are contained in the Clean Air for Europe (CAFE) Directive (EP & CEU, 2008) and the 4th Daughter Directive (EP & CEU, 2004). These Directives also include rules on how Member States should monitor, assess and manage ambient air quality.

EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe was adopted in 2008. This Directive (known as the CAFÉ Directive) merges earlier Directives on limit values for a range of air quality parameters and one Council Decision into a single Directive on air quality.

The CAFÉ Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and S.I. No. 33 of 1999. The 4th Daughter Directive was transposed by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. no. 58 of 2009).

Air quality standards are constantly reviewed by the European Commission and in particular alignment of the standards for Polycyclic Aromatic Hydrocarbons (PAH), particulate matter up to 10 microns in size (PM_{10}) and particulate matter up to 2.5 microns in size ($PM_{2.5}$) with World Health Organisation (WHO) may mean stricter limits in the future. Since 2012 the European Commission (EC) has been carrying out a review on air quality policy and legislation. This review is ongoing. The 7th Environmental Action Plan of the EC has outlined the pressing need for the update of the air quality Directives, setting out clear goals for the EU by 2020. However, until such time as any new limits are introduced by the EU then air quality assessment is made against the current standards.

EU legislation on air quality requires that member states divide their territory into zones for the assessment and management of air quality. Ireland is divided into four such zones [See Figure 12-1]. Zone A is the Dublin conurbation, Zone B is the Cork conurbation, Zone C comprises large towns in Ireland with a population >15,000 and Zone D, principally rural, is the remaining area of Ireland. The proposed development site is located within Zone D.

In conjunction with individual local authorities, the EPA undertakes ambient air quality monitoring at specific locations throughout the country in the urban and rural environment (see Figure 12-2). It prepares an air quality report[137] based on data from 29 monitoring stations and a number of mobile air quality monitoring units. The EPA as the National Reference Laboratory for Air coordinate and manage the monitoring network. Monitoring stations are located across the country, with new stations added in 2013 at Davitt Road, Dublin, St. Anne's Park in Dublin and Finglas in Dublin. The EPA have also published air quality summary bulletins for PM10[138], Ozone[139] and Nitrogen Dioxide[140] in 2012, provide year to date monthly bulletins and also provide real time air quality data on their website.

12.1.1.2 Baseline Air Quality

Air quality in Zone D areas is generally very good with low concentrations of pollutants such as Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2) Particulate Matter 10 microns in size (PM_{10}), and Carbon Monoxide (CO). This is due mainly to the prevailing clean westerly air-flow from the Atlantic and the relative absence of large cities and heavy industry. Concentrations of ozone are higher in rural areas than is urban areas due to the absence of the nitrogen oxide in rural areas as an ozone scavenger. Ozone is also a transboundary pollutant, with locations on the west coast having the highest concentrations in Ireland.

The most recent EPA report published in 2014 indicates that overall, air quality in Ireland continues to be of good quality and remains the best in Europe. Measured values in Zone D for NO_2, SO_2, CO, Ozone, PM_{10}, $PM_{2.5}$. A summary of air quality parameters and air quality assessment for Zone D taken from the EPA Annual Report 2013 is provided in Table 12.1.

Table 12.1: Summary of air quality assessment in Zone D

Parameter	Lower Assessment	Limit Value	Number of national Monitoring	Number of Zone D Monitoring	Zone D result

[137] Air Quality in Ireland (2013) – Key Indicators of Ambient Air Quality; Environmental protection Agency. http://www.epa.ie/pubs/reports/air/quality/Air_quality%20Report%202013.pdf
[138] http://www.epa.ie/whatwedo/monitoring/air/reports/pm2011/
[139] http://www.epa.ie/whatwedo/monitoring/air/reports/ozone2011/
[140] http://www.epa.ie/whatwedo/monitoring/air/reports/no22011/

	Threshold		Locations	Locations	
NO_2 and NOx	26ug/m^3	200ug/m^3 one hour -, Calendar year 40ug/m^3	15	3	Below the annual limit value and the lower assessment threshold
SO_2	50 ug/m^3	125 ug/m^3/d one day human beings/ / 20ug/m^3 calendar year vegetation	10	3	Below the daily limit value for human beings and vegetation and the lower assessment threshold
CO	5 mg/m^3	8 hour - 10 mg/m^3 (human beings	5	1	Below the annual limit value and the lower assessment threshold
Ozone	Daily maximum 8 hour mean - 120 ug/m^3 over 25 days per year/Long term objective 120 ug/m^3	Daily maximum 8 hour mean - 120 ug/m^3 human beings/18,000 ug/m^3/h for vegetation. Information to be supplied at 180 ug/m^3	12	5	Below both the annual limit value and the lower assessment threshold.
Particulate Matter (PM_{10}, and Black Smoke)	25 ug/m^3 (one day)/20 ug/m^3 (calendar year)	One day 50 ug/m^3, Calendar year 40ug/m^3	20	3	Below both the annual limit value and the lower assessment threshold.
Particulate Matter $PM_{2.5}$ ug/m^3	12 ug/m^3 averaged over a calendar year	25ug/m^3 average over a calendar year	7	2	Below both the annual limit value and the lower assessment threshold.

Heavy metals, benzene and polycyclic aromatic hydrocarbons (PAH) were all below the annual limit values in Zone D also. The report noted however, that domestic fuel burning emissions in rural areas was the main source of particulate matter and poly-aromatic hydrocarbons (PAH). Levels of particulate matter in some smaller towns for example are similar or higher than those in cities, where bituminous coal is banned.

More recent air quality data for air monitoring stations at Castlebar and Claremorris in county Mayo based on the EPA's published bulletins. The daily limit for PM_{10} is 50 ug/m3. The limit is deemed breached if more than 35 exceedances occur during the year. The health information threshold for ozone is 180 ug/m^3. Table 12.2 shows the number of exceedances at stations in Castlebar and Claremorris based on 2014 report.

Table 12.2: EPA 2014 Air Quality Bulletin for monitoring stations in County Mayo

Parameter	Station	Assessment	Number of times limit exceeded
NO_2	Castlebar	Number of values greater than 200 ug/m^3	0
Ozone	Castlebar	Number of values greater than 180 ug/m^3	0
PM_{10}	Castlebar	Number of values greater than 50 ug/m^3	2
PM_{10}	Claremorris	Number of values greater than 50 ug/m^3	0

In general air quality is good with two exceedances recorded for PM_{10} in Castlebar reflecting the impact of the likely use of bituminous coal in this location.

Overall air quality in Zone D where the site is located is generally good and it would be expected to be high at the Oweninny site itself due to the rural nature of the area with low density of rural housing.

12.1.2 Atmospheric Emissions

12.1.2.1 Legislative Context

Increased atmospheric levels of greenhouse gases enhance the natural greenhouse effect and are widely recognised as the leading cause of climate change. The most important long-lived greenhouse gases are Carbon Dioxide (CO_2), Nitrous Oxide (N_2O), and Methane (CH_4). CO_2 arises from a range of sources including the combustion of fossil fuels. According to the EPA[141], agriculture remains the single largest contributor to overall greenhouse gas emissions in Ireland, at 32.3%% of the total, followed by Energy (power generation and oil refining) at 19.6% and Transport at 19.1%. The remainder is made up by Industry and Commercial at 15.4%, the Residential sector at 11.1%, and Waste at 2.5% (see Figure 12-3).

Under the Kyoto agreement, Ireland committed to limiting the increase of greenhouse gases to 13% above its 1990 levels during the period 2008-2012 and a 20% reduction in emissions of 1990 levels by 2020. The baseline emissions total for Ireland was calculated as the sum of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions in 1990 and the contribution from fluorinated gases in 1995.

[141] Ireland's Provisional Greenhouse Gas Emissions in 2013, EPA Report (December 2014) http://www.epa.ie/pubs/reports/air/airemissions/GHGprov.pdf

Key objectives for reductions in greenhouse gases across the agriculture, energy, transport, industrial, forestry and built environment sectors, which will ensure that Ireland can meet its international commitments, are set out in the National Climate Change Strategy 2007 – 2012. This strategy includes the Government's target of achieving 40% of electricity consumption on a national basis from renewable energy sources by 2020, including a significant contribution from more wind energy. Achieving this target will potentially contribute significantly to limiting the increase of greenhouse gases in Ireland.

Under the EU National Emissions Ceiling Directive (2001/81/EC), Member States are required to limit their annual national emissions of SO_2, NO_x, VOC and NH_3 to amounts not greater than the emissions ceilings laid down in Annex 1 of the Directive, by the year 2010 at the latest.

12.1.2.2 Greenhouse Gas Emissions

Ireland is subject to several conventions and protocols that place limits on and force reductions in these emissions.

The baseline value in CO_2 equivalent was established based on 1990 levels at 55.3 Mt and results in total allowable emissions of approximately 314.2 Mt over the commitment period, which equates to an average of 62.8 Mt per annum. Compliance with the Kyoto Protocol limit is achieved by ensuring that Ireland's total emissions in the period 2008-2012, adjusted for any offsets from activities under Article 3.3 and the surrender of any purchased Kyoto Protocol credits, are below 314.2 Mt at the end of the five-year period.

Estimates of greenhouse gas emissions between the period 1990 to 2013 indicated a peak in 2001 (70,128 million tonnes carbon dioxide equivalent) when emissions reached a maximum following a period of unprecedented economic growth and began to reduce from 2008 on, see Figure 12-4. In 2013, total emissions of greenhouse gases in Ireland across the six key National Climate Change Strategy sectors (see Table 12.3) were estimated at 57.8 million tonnes carbon dioxide equivalent, which is approximately 4.5% higher than emissions in 1990. However, the total for 2013 is 18.2% lower than the peak level of 2001. This is 6.7% lower (4.12 Mt CO2eq) than emissions in 2010.

Table 12.3: Greenhouse Gas Emissions in Ireland (in Mt of $C0_2$ equivalent)

Year	Energy	Residential	Industry	Agriculture	Transport	Waste	Total
1990	11.4	7.5	9.6	20.5	5.1	1.3	55.3
2013	11.3	6.4	8.9	18.7	11.1	1.5	57.8

The EPA[142] indicated that CO_2 emissions from the energy (principally electricity) sector decreased by 11.1% in 2013 with a reduction in fossil fuel fired power generation and an increase in renewable energy generation.

Key emission reductions in 2013 occurred in Energy (Emission Trading Sector (ETS) 7.2%) and Industry and Commercial (0.7%) sectors. Increases occurred in the Residential sector (2.6%), Transport sector (2.1%), Waste sector (15.2%) and Agriculture Sector (2.6%).[142]

Lower emissions from the energy sector reflect an increase in the share of renewables in gross electricity consumption

Ireland's combined emissions in 2008, 2009, 2010 and 2011 were 1.77 million tonnes above its Kyoto limit when the EU Emissions Trading Scheme (ETS) and approved Forest Sinks are taken into account. Ireland is on track to meet its Kyoto commitment taking unused allowances from the ETS into account. However, the country still faces considerable challenges in meeting EU 2020 targets and developing a low-carbon emission pathway to 2050.

Commenting on the figures Dara Lynott, Deputy Director General, EPA said:

> *"Ireland's progress in meeting its commitments under the Kyoto Protocol is very welcome. However, we must not assume that recession induced reductions mean that environmental pressures are being managed in a sustainable way. Reducing our reliance on fossil fuels and moving Ireland to a resource efficient and sustainable society will require an integrated approach by policy makers and behavioural change by us all."*

The EPA is also designated under the National Climate Change Strategy to prepare annual national emission projections for greenhouse gases relating to key sectors of the national economy. In their latest projection report[143] the following was stated with respect to the energy sector:

> *"Energy sector emissions comprise emissions from power generation, oil refining, peat briquetting and fugitive emissions. Emissions from power generation accounted for 97% of energy sector emissions in 2010 and are responsible for a similar share of emissions over the projection period.*

[142] EPA, Irelands Provisional Greenhouse Gas Emissions in 2013, Key Highlights, December 2014
[143] EPA, Irelands Greenhouse Gas emissions Projection 2011 – 2020, April 2012.

> *Under the With Measures scenario, total energy sector emissions are projected to decrease by 8.7% over the period 2010 – 2020 to 12.2 Mtonnes of CO2eq. The decrease in emissions is caused by a displacement of gas by renewables which are projected to reach 27% penetration in 2020.*
>
> *Under the With Additional Measures scenario, total energy sector emissions are projected to decrease by 19.8% over the period 2010 – 2020 to 10.7 Mtonnes of CO2eq. In this scenario, it is assumed that renewable energy reaches 40% penetration by 2020 with the largest contribution coming from wind[144]. It is envisaged there will be an expansion of biomass electricity generation capacity to 270 MW through the implementation of co-firing biomass, the construction of two waste to energy units and the continued development of landfill gas electricity generation and biomass CHP. In addition the construction of at least 75 MW of wave energy is forecast.*

The "with measures scenario" incorporates the effects of policies and measures in place by 2010. The "with additional measures" is based on Sustainable Energy Authority of Ireland's National Energy Efficiency Action Plan[145] and National Renewable Energy Action Plan[146] and their implementation.

Achieving greenhouse gas reduction targets not only requires a reduction in emissions from the energy sector it also requires emissions from agriculture, transport, industry and commerce and the residential areas to achieve significant reductions. These pose significant challenges in their own right. Critically, if the renewable energy target of 40% and energy efficiency targets are not achieved then emissions are predicted to increase over the period 2013 – 2020.

Policy context for greenhouse gas emission reductions beyond 2020:

The proposed National Climate Action and Low Carbon Bill 2015 was published in January 2015. It provides for five yearly "Mitigation Plans" to transition Ireland to a low

[144] http://www.epa.ie/pubs/reports/air/airemissions/EPA%202015%20GHG%20Projections%20Publication%20Final.pdf

[145] Maximising Ireland's Energy Efficiency. The National Energy Efficiency Action Plan 2009-2020. Department of Communications, Energy and Natural Resources, 2009.

[146] National Renewable Energy Action Plan, Ireland. Submitted to the European Commission under Article 4 of Directive 2009/28/EC. Department of Communications, Energy and Natural Resources, 2010.

carbon economy in line with existing EU legislation and wider commitments made under the United Nations Framework Convention on Climate Change (UNFCCC)

The EU leaders have also agreed a European 2030 policy framework in October 2014 that will see a domestic greenhouse gas reduction of at least 40% compared to the 1990 level. To achieve this the energy sector (mainly electricity generation) will need to reduce emissions by 43% compared to 2005.

In the International sphere, UN negotiations to develop a new international climate change agreement that will cover all countries are underway. This is to be discussed and agreed at the Paris climate conference in December 2015 and subsequently implemented post 2020. At this conference all countries will propose their mission reduction targets.

The Environment Council approved the EU's intended nationally determined contribution as per the European 2030 policy framework.

The EPA greenhouse gas projections report noted that even if Ireland complies with its 2013-2020 obligations there will be new obligations (as yet undefined) for the years 2021- 2030. A starting point for post-2020 obligations in excess of the range of expected outcomes for 2020 (i.e. 9%-14% below 2005 levels) will inevitably lead to severe compliance challenges early in the following decade and beyond. In this context Ireland is not on track towards decarbonising the economy in the long term in line with the Climate Action and Low Carbon Development Bill 2015 and will face steep challenges post-2020 unless further polices and measures are put in place over and above those envisaged between now and 2020.

Benefit of the development

The development of renewable wind energy, such as that at Oweninny, will significantly reduce Ireland’s dependence on imported fossil fuels helping the country achieve its Kyoto and 2020 target in line with the National Renewable Energy Action Plan and reduce greenhouse gas emissions through displacement of fossil fuel energy generation.

12.1.2.3 Other Emissions

The pollutants sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC) and ammonia (NH_3) are responsible for long-range transboundary air pollution such as acidification, eutrophication and ground-level ozone pollution.

- SO_2 is the major precursor to acid deposition, which is associated with the acidification of soils and surface waters and the accelerated corrosion of buildings and monuments. Emissions of SO2 are derived from the sulphur in fossil fuels such as coal and oil used in combustion activities.
- NOx emissions contribute to acidification of soils and surface waters, tropospheric ozone formation and nitrogen saturation in terrestrial ecosystems. Power generation plants and motor vehicles are the principal sources of NOx emissions, through high-temperature combustion.
- VOCs are emitted as gases by a wide array of products including paints, paint strippers, glues, adhesives and cleaning agents. They also arise as a product

of incomplete combustion of fuels and as such are a component of car exhaust and evaporative emissions.

- NH3 emissions are associated with acid deposition and the formation of secondary particulate matter. The agriculture sector accounts for virtually all (over 98%) ammonia emissions in Ireland.

Under Article 4.1 of the National Emissions Ceiling Directive [2001/81/EC], Member States are required to limit their annual national emissions of SO_2, NO_x, VOC and NH_3 to amounts not greater than the emissions ceilings laid down in Annex 1 of the Directive, by the year 2010 at the latest.

Ireland's provisional position in 2013 in relation with respect to the limits to the above is set out in Table 12.4[147].

Table 12.4: Table 12.2: Annual Air Emissions

Pollutant	Sulphur Dioxide	Nitrogen Oxides	VOC	Ammonia
Limit	42 kt	65 kt	55 kt	116 kt
Emissions	25.4 kt	76.5 kt	90.0 kt	107.8 kt

SO_2 emissions are estimated to have decreased by 86% since 1990 with power generation plant responsible for about 34% of the remaining SO_2 emissions despite the fact that emissions in this sector have reduce by almost 92% in the same period.

NOx emissions in Ireland have decreased by 45% between 1990 and 2013 and have decreased by over 35.4 kt, or 32% since 2008. Nonetheless, limits were exceeded in 2011.

The transport sector is the principal source of NOx emissions, contributing approximately 53 per cent of the total in 2013. The industrial and power generation sectors are the other main source of NOx emissions, accounting for 16 and 11 per cent of emissions respectively with the remainder emanating from the residential/commercial and the agriculture sectors.

The agricultural sector accounts for virtually all ammonia emissions.

The main sources of VOC emissions in Ireland are from manure management in agriculture and solvent use accounting for 74 per cent of the annual total in 2013. The

[147] EPA, Ireland Transboundary Gas Emissions in 2013, April 2015, http://www.epa.ie/pubs/reports/air/airemissions/NECD%20Summary%20Report%202015.pdf

agriculture sector is now the principal source of VOC emissions, contributing approximately 47 per cent of the total in 2013. Domestic coal burning in the residential sector is another important but declining source as coal consumption decreases.

The development of Oweninny wind farm will increase the availability of renewable energy contributing to further reductions in SO_2 and NO_x emissions associated with displaced fossil fuelled power generation.

12.1.3 Local Emission Sources and Receptors

The site is situated in a remote rural landscape mainly on cutover and cutaway peat with areas of bog remnants, standing water and commercial forest plantation within its boundaries. Beyond the boundaries of the site, the land is predominantly blanket bog and commercial forest plantation. The closest population centres are the towns of Crossmolina to the east and Bangor Erris to the west. The main N59 passes to the south of the site and provides access to it. The local roads are of tertiary standard and facilitate the movement of the local landowners.

The closest receptors to the proposed wind farm development are the isolated houses dotted around the local road network. The main local emissions from these sources arise from the burning of fossil fuels for heating purposes and from vehicles using the N59 and the local road network. In general, air quality impacts on local receptors from these emission sources are considered negligible.

12.2 IMPACT OF THE DEVELOPMENT

12.2.1 Construction Phase impacts

12.2.1.1 Atmospheric Emissions

Electricity generation by wind turbines does not lead to environmental emissions.

A study[148] by the International Energy Agency (IEA) showed that renewable energy, and particularly wind energy, must dominate the electricity generation sector in a sustainable energy future. The IEA has clearly acknowledged that wind power is now a mainstream energy technology and that it must play a central role in combating climate change.

The IEA report acknowledges that wind power, along with energy efficiency and fuel-switching will play the major role in reducing emissions in the power sector in the next

[148] Energy Technology Perspectives 2008

10-20 years, the critical period during which global emissions must peak and then begin to decline if the worst effects of climate change are to be avoided.

Amongst the benefits of electricity generation from wind are considered to be its contribution to environmental sustainability and displacement of imported fossil fuels. It is estimated that Oweninny Wind Farm will generate between 497,218MWh and 557,486MWh (units) of electricity per annum (based on 172MW of Phase 1 and Phase 2 MW rating per annum and a 33 - 37% capacity factor).

Construction, maintenance and operation of the wind farm will result in some CO_2 emissions from transport and construction activities. These include emissions from steel and cement production and quarrying as well as from transport, erection, road building and maintenance. A Life Cycle analysis of Oweninny farm was calculated and provided as clarification at the oral hearing for the Oweninny wind farm. The calculation has been repeated allowing for a Phase 1 and Phase 2 development of 61 wind turbines operating at a 33% capacity factor. Accounting for the loss of CO_2 from manufacturing of turbines, transport, construction, loss from displaced peat material and loss of forest sequestration the wind farm would have a carbon footprint of 383,817 tonnes of CO_2

Over its 30-year operating life, the wind farm with a capacity factor of 33% would generate:

172 MW x 30 years x 365 days x 24 hours x 0.33 capacity = 14,916,5280 MWh.

Not all of the electricity generated by the wind farm will reach the target market. Collection, grid and transmission losses could account for up to 7% of the generated power. This would leave a total of 13,872,371 MWh delivered to the Irish grid.

The renewable electricity from Oweninny would displace electricity generated from non-renewable sources. This has an average carbon intensity of 0.489 tCO_2/MWh. Therefore, over the life of the wind farm, it would displace 6,908,441 tonnes CO_2.

In summary, the Oweninny wind farm built on a cutaway peatland area, with an operational life of 30 years:

- The carbon footprint is: 383,817 tonnes CO2
- The fossil carbon saved is: 6,908,441 tonnes CO2
- The carbon emitted is: 5.56% of the carbon saved
- The carbon payback period is: 1.67 years

Such emissions are of course also involved with constructing, maintaining and operating conventional electricity plants, where particularly procurement of the energy source needs to be taken into account.

The development of Oweninny Wind Farm will lead typically to an annual reduction in equivalent direct air emissions as shown in Table 12.5.

Thus, the wind farm development will have a significant positive impact on air quality and climate.

Table 12.5: Approximate Annual Equivalent Air Emissions

Carbon Dioxide (CO2)	Sulphur Dioxide (SO2)	Oxides of Nitrogen (NOx)
213,804 t	3,490 t	2015 t

The above uses the 2012 average carbon dioxide emission for the grid (average including all generating technologies such as coal, gas, oil, peat, combined heat and power (CHP), and wind). Sulphur dioxide and nitrous oxide estimates are based on displacement of energy derived from coal combustion.

Construction on peat lands has also been identified as potentially giving rise to CO_2 emissions. This arises as peat is comprised of dead plant material which in a natural bog land has failed to decompose completely. Hence peat acts as a carbon store. Wind farm construction such as excavations and drainage can cause peat to dry out over time releasing its stored carbon content. The carbon loss from peat on the site has been accounted for in the lifecycle analysis). It should be noted that the site has already been subject to significant drainage and peat harvesting and now comprises cutover and cutaway bog land with isolated areas of remnant intact peat. Although there will be some peat excavation required for access track and turbine foundation construction these bog remnants will not be impacted significantly by the wind farm development hence there will be no additional significant loss of CO_2 from construction arising from impact on them. Bord na Móna has also completed a bog rehabilitation programme on the site aimed at restoring water tables and providing the conditions for natural peat flora to develop. As the rehabilitation progresses the site will provide additional carbon fixing potential, as evidenced by the EPA's carbon restore programme on the site.

In Ireland, cement manufacture is the second largest industrial source of CO_2 and NO_X emissions, after the generation of electricity from fossil fuels. At Oweninny construction, there will be a small amount of emissions associated with the cement used in concrete production.

In addition to its position regarding CO_2, Ireland also has binding international commitments to meet targets for emissions of air pollutants and for local and regional air quality, including cuts in SO_2 and NOx. Meeting these will require significant reductions in emissions from electricity generation.

There are continuing strong pressures for further reductions in these air emissions. The development of renewable energy and, particularly wind energy with zero emissions, is seen as an essential element in achieving these reductions while allowing continuing economic expansion. Increased utilisation of renewable energy for electricity generation forms part of the national response strategy in relation to climate change and is a central feature in the strategy for greenhouse gas abatement.

12.2.1.2 Air Quality

There is some potential for local air quality to be impacted during the construction phase periods. Dust generated by construction activity can give rise to local nuisance. However, the impact of this will depend largely on climatic factors. For example the potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust also depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations.

The primary air quality issue related to construction is dust potentially arising from the following activities:

- Earth moving and excavation equipment including handling and storage of soils and subsoil material.
- Extraction from borrow pits for use on access track construction.
- Transport and unloading of crushed stone around the site during road construction.
- Vehicle movement over hard dry surfaces on the site, particularly freshly laid access tracks.
- Vehicle movement over surfaces off-site contaminated by muddy materials brought off the site.
- Operation of the batching plant

In general the main wind turbine, substations, O&M building, borrow pit and visitor centre construction sites are located more than one kilometre from occupied dwellings and the potential for dust impact will be insignificant.

Construction vehicles and machinery within the site and transport associated with delivery of materials will also give rise to exhaust emissions during the construction phase. The potential impact is not considered significant in the context of the extent of traffic movements arising and the extended period of construction.

12.2.1.3 Impact of Air emissions on Protected Areas

At the Oweninny Oral Hearing National Parks and Wild Life Service raised through submission the issue of potential impact of concrete dust on the Bellacorick Iron Flush cSAC from the operation of the proposed Batching Plant as follows:

“The batching plant lies directly south-west of the of the Bellacorick iron flush in line with prevailing winds. This plant in operation will be using 25 tons aggregate/cement combined to produce 50mJ of concrete per day. The potential risk of cement dust being wind borne and reaching the flush cannot be ignored. Cement can be considered lethal to any ecological site and the probability of some dust reaching the flush is deemed to be extremely serious. It is strongly recommended that the batching plant be placed somewhere else off the site entirely.”

Section 3.4.4 of the original EIS (Emissions and emission control) recognises the potential for impacts that can arise from the operation of a concrete batching plant. The main potential for emissions from the batching plant site will occur during the operational phase (of the batching plant) and will be very intermittent in nature. For example for turbine foundation pour the batching plant would produce concrete on 30 days, 31 days and 51 days during each of the indicative development phases.

The original EIS does acknowledge that with respect to dust emissions, these can arise from materials delivery and fugitive emissions from silos, conveyor belt system and batching plant operation.

The most effective means of reducing dust emissions at batching plants is to hard-surface roadways and any other areas where there is a regular movement of vehicles. The batching plant area itself within the site will consist of a concrete apron which will be cleaned on a regular basis to remove any spilled materials.

Suppression of dust emissions from unsealed yards and roadways, will be achieved by hard coring the stockpile areas and access tracks to these and regular light watering when required

Dust emissions due to vehicles will be minimised by provision of a hard surfaced access road within the batching plant site to the batching plant area.

The batching plant site will be operated in accordance with best practice with good maintenance practices, including regular sweeping to prevent dust build-up.

The batching plant will be operated to the highest standards and will include automatic control systems to ensure that no system failures would occur during cement loading from cement tankers to the cement silos.

Such control systems typically comprise interlocked systems linking pressure drop or particle emission from the bag filters or other containment areas to the control system that will instantaneously shut down the cement filling process in the event of a pressure drop or dust detection. These control systems typically respond in milliseconds. Hence if a rupture of the bag filter occurred the filling process would stop immediately and minimal release from the bag filter would occur.

An estimate of the impact of a cement dust release from the batching plant on the Bellacorick Iron Flush was provided at the oral hearing in the expert witness statement of Dr. Paddy Kavanagh ESBI. Farner[149] published a review of the effects of dust on vegetation. This included sensitive plant species including Sphagnum species (under less tolerant taxa of mosses, the species *Messia triquetra* and *Tomenthypnum nitens* are listed. The former is now assumed extinct at Bellacorick with the latter, being one of the current rare species). In the review paper, it is noted that the lowest rates of application of cement/lime dust deposition observed to cause an effect were 0.6 and 0.5 g /m2/day.

The estimated dust deposition on the iron flush arising from a one second release of cement dust from the proposed batching plant is 0.014g/m2 which is over 40 times lower than the value of 0.6 g/m2 as identified by Farner and which is the lowest rate of deposition which can cause impact on the sensitive plant species in the iron flush.

[149] Farner A. M.., , The Effects of Dust on Vegetation A Review, Environmental Pollution ,79 (1993) 63 – 75

The proposed cement batching plant is located a distance of 2.43 km from the Bellacorick Iron Flush. Filling of the cement silos from sealed cement transport vehicles is a strictly controlled operation incorporating interlocking control mechanisms to prevent cement dust release. Any drop in pressure associated with a loss of integrity of the dust control filter system will lead to an automatic shutdown in milliseconds preventing an escape of cement dust.

In the extremely rare event of an emission occurring from the batching plant the automatic system would shut down the transfer system in milliseconds.

This indicates that no significant impact on the vegetation of the iron flush will occur.

12.2.2 Operational phase impacts

12.2.2.1 General

In terms of climate change the wind farm will contribute significantly to achieving the Governments 2020 target for renewable energy producing an estimated 497,217 MWh of renewable electricity annually and displacing 213,804 tonnes of CO_2. This will significantly reduce Ireland's greenhouse gas emissions and contribute towards controlling global climate. It will also contribute significantly to reducing transboundary air pollution through displacement of SO_2 and NO_x emissions from fossil fuels.

There will be no impacts on local ambient air quality during operation of the wind farm. The wind farm will have no emissions to atmosphere and thus no adverse impact on general air quality.

It will have a beneficial effect in providing for energy without emissions of the primary recognised pollutants.

12.2.2.2 Loss of Forestry

Approximately 1.05 hectares of forest plantation will be clearfelled to facilitate the development of the windfarm. Assuming a conservative yield class of $16m^3$/ha/year for the forest plantation on site this equates to a loss of 3.64 t.C/ha/annum or 13.3 t CO_2/ha/annum. Over the 30 year wind farm lifespan this would amount to 419 tons of CO2 .

The extent of forestry loss will be inconsequential when compared to the equivalent environmental benefit in avoided annual air emissions that Oweninny Wind Farm will confer.

12.3 MITIGATION

The potential for dust during construction depends on a number of factors, most notably the prevalent weather conditions. While a need for significant active dust control during construction is not foreseen, good practice site management measures will be implemented as necessary and will include:

- Wheel wash facilities and use of mechanical road sweeper at the entrance from the public road.
- Dust suppression by water spray on access tracks.

- Use of appropriately covered trucks during delivery of materials to the site.
- Control of vehicle speeds within the site.
- Regular inspection of public roads outside the site for cleanliness and cleaning as necessary.
- Regular inspection and maintenance of the concrete batching plant equipment and dust control equipment.
- Use of recycled cement products where feasible, e.g. pulverised fly-ash (PFA) or blast furnace slag cement.

The dust minimisation measures will be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

12.4 Cumulative Impacts

12.4.1 Wind Farms

The proposed and permitted wind farm developments in the general region are as follows:

- Corvoderry Wind Farm Development comprising ten wind turbines with 100m overall height (Planning reference 11/838) and a rated output of 23MW.
- Planning permission 09/259 for a wind farm development at Dooleeg, Bellacorick (one 2MW wind turbine) granted on appeal to ABP (PL16.236402).
- Bellacorick Wind Farm - this 21 turbine wind farm has been operational since 1992 with an installed capacity of 6.45 MW. The final phase of the Oweninny Wind Farm project will be installed near where the existing turbines are located.
- Tawnanasool Wind Farm comprising 8 wind turbines

12.4.1.1 Cumulative Benefits to greenhouse gas reduction from Wind Farm Developments

Reductions in greenhouse gas and transboundary pollutants will occur through the displacement of energy derived from conventional fossil fuel combustion plant by renewable wind energy. The estimated displacement of CO2 from other windfarms which could operate in the immediate vicinity is as follows:

- Corvoderry wind farm at a rated output of 23MW, a capacity factor of 33% and a displacement factor of 0.46Kg per KWh would displace approximately 30,585 tonnes of C02 from fossil fuel energy production annually.
- Dooleeg wind turbine with a rated output of 2 MW a capacity factor of 33% and a displacement factor of 0.43Kg per KWh displace would displace approximately 2,660 tonnes of C02 from fossil fuel energy production annually.

- Tawnanasool wind farm at a rated output of 23MW a capacity factor of 33% and a displacement factor of 0.43Kg per KWh would displace approximately 21,276 tonnes of C02 from fossil fuel energy production annually.

However, as the existing Bellacorick wind farm, rated at 6.45MW will be decommissioned following Phase 1 and Phase 2. This would result in loss of the current CO_2 displacement from this wind farm, which is estimated at 8,643 tonnes per annum

Should all of the above windfarms operate simultaneously with the proposed Oweninny wind farm then a total displacement of 311,831 tonnes of CO_2 annually would occur from displacement of fossil fuel energy production.

Cumulatively, there would also be reductions in SO_2 emissions and NOx emissions from displaced fossil fuel energy arising from the combined operation of all the windfarms.

12.4.2 Cumulative impacts on air quality

There is potential for cumulative air quality impacts to arise from dust and equipment emissions arising from the construction activities associated with the developments. These are discussed below.

12.4.2.1 Wind farms

Corvoderry Wind Farm

Corvoderry wind farm is located within the Oweninny site and would comprise a development of 10 wind turbines, access tracks and hard stands and the construction activities could potentially give rise to localized dust from ground clearance, excavation, quarrying, stockpiling and fill placement. However, mitigation measures have been clearly set out in Section 8.4 of the Corvoderry the environmental impact statement which will ensure no significant impact will occur.

With the implementation of the mitigation measures set out in the Oweninny wind farm EIS and the Corvoderry EIS no significant cumulative impacts are predicted to occur with this wind farm.

Dooleeg, Bellacorick Wind Farm

This wind farm has permission to construct a single one 2 MW turbine at Dooleeg, Bellacorick. The level of construction, localised nature of any dust emissions and short duration together with good engineering practice during construction will ensure no significant cumulative impact with Oweninny wind farm development will occur.

Tawnanasool Wind Farm

The Tawnanasool proposed wind farm is located about 10km to the west southwest of the Oweninny site Although there is potential for dust and equipment emissions to occur during construction any impact of these would be very localised with dust settling out within 200- 300m of the construction location as stated in Chapter 11 of the Tawnanasool wind farm EIS. There will therefore be no potential for cumulative impact from dust.

Potential future development of Oweninny Phase 3

As described in Chapter 12, Air Quality & Climate, in the original EIS submitted as part of the planning application to An Bord Pleanála in 2013, a significant positive benefit of reducing greenhouse gas emissions with consequent positive impact on the climate change process would arise from the operation of all three phases of Oweninny. Although increased short term air quality impact could potentially arise during the construction of Phase 3, these were assessed as not been significant when mitigation measures are implemented. Overall the operation of all three phases of Oweninny would be very positive in terms of greenhouse gas reduction and meeting Ireland's commitments towards decarbonising our economy in line with National and EU policies.

12.4.2.2 Meteorological Mast

ABO Wind Ireland Limited have applied (22nd July 2015) for permission to install a temporary (3 yrs) meteorological mast at Sheskin Townland, Bellacorick, Co Mayo. The mast comprises a 100 m high steel lattice tower, supported by cable stays. The site for the proposed mast is within conifer forest plantation. The appropriate assessment screening document for the project identified that there would be no significant emissions to air from the project hence no significant cumulative air or climate impacts with Oweninny are foreseen.

12.4.2.3 Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410)

Planning permission has been granted to EirGrid for the project which will comprise upgrading activities of 100 structures over a distance of 19.5 km of power line. Most uprating work comprises replacing fittings and cross arms, some pole set replacement and six angle mast replacements. The dispersed nature of the construction activities will result in only very limited and localised air quality impacts from dust emissions associated with temporary access track construction and foundation replacement for the towers. This impact will be of very short duration and with the mitigation outlined in the planning and environmental considerations report accompanying the proposal will not result in any significant cumulative impact with the Oweninny wind farm development

12.4.2.4 Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45)

This EirGrid project was granted planning permission by Mayo County Council on 4th August 2015. Comprising the uprating of approximately 27 km of power line between Bellacorick and Gorteen construction activities and air emissions would be similar in nature to the uprating of the Bellacorick to Castlebar 110 kV OHL.

No significant cumulative impact is predicted to occur between the Oweninny project and the planning approved line uprates

12.4.2.5 Uprate of the Existing Bellacorick to Bangor Erris 38 kV Overhead Line (planning reference PL15/611)

A planning application has been submitted by ESB Networks for the project which will comprise upgrading activities over a distance of 12.3 km of power line. The proposed upgrading to the existing overhead transmission line will involve reinforcement of foundations of steel towers, changes to the conductors, replacement of intermediary/angle wooden pole sets and rerouting of existing line at two locations along with ancillary works.

The dispersed nature of the construction activities will result in only very limited and localised air quality impacts from dust emissions associated with temporary access track construction and foundation replacement for the towers. This impact will be of very short duration and with the mitigation outlined in the planning and environmental considerations report accompanying the proposal will not result in any significant cumulative impact with the Oweninny wind farm development

12.4.2.6 Substation Project

The works associated with the permission (Planning Reference 15/456) are all within the existing substation site at Bellacorick. The works are short term in nature with no significant impact on air quality and no significant cumulative impact will occur

12.4.2.7 Power Plants

Planning permission has been granted for the following power plants:

- 68 MW gas turbine peaking plant at Bellacorick – Bellacorick Power Plant (Planning reference 01/1250).
- Conventional 200 MW natural gas fired peaking plant along the Srahnakilla road (Planning permission 09/286 granted to Constant Energy on 16/11/2001). Site located between the eastern and western parts of the Oweninny site.

As the planning documentation for the above projects did not identify significant adverse impacts on air quality, it can be assumed that there would be no cumulative effects with the Oweninny development.

12.4.2.8 Grid 25/Grid West

The proposed EirGrid Grid West Project is located to the east of the Oweninny wind farms site. As stated in Section 5.6.8, Section 6.4.8 on Air Quality there are positive benefits that would result from the Grid West Project as it would facilitate the development of renewable power generation in north Mayo, by enabling the installation and integration of renewable energy sources. This facilitates a reduction in fossil fuel related energy generation having a net positive benefit of reducing carbon emissions. The proposed Grid West development will comprise a major improvement in electricity transmission system infrastructure.

With respect to potential negative cumulative impacts with the Oweninny project these could potentially occur from construction works associated with

- a fully underground direct current cable;
- a 400kV overhead line and;
- a 220kV overhead line with partial use of underground cable
- substation/converter station in north Mayo
- and a substation/converter station near Flagford, Co. Roscommon.

Potential impacts could occur from the dust emissions particularly the small diameter PM10 and PM2.5 which could impact sensitive receptors such as human beings and sensitive ecology. Construction vehicle emissions could also impact on air quality.

Air quality issues were assessed in Section 5.6.8 of the Independent Expert Panel Review Report published by EirGrid in July 2015. These concluded as follows:

In terms of the underground cable route option the report stated that

"Overall, the effect on local air quality as a result of the works along the cable route and at converter station sites will be negligible. It also has the potential to affect traffic flows due to construction, which, in turn, has the potential to increase pollutant concentration at sensitive receptors over a wider area than in the vicinity of the construction sites".

In terms of the 400kV OHL route options the IEEP report Section 6.4.8 states that

"Overall, the effect on local air quality and amenity of the construction works at the tower sites and substations will be negligible for the OHL option. Construction related traffic is also expected to be small in scale, less than 200 vehicles per day, at each site, and as such would not be capable of causing a significant adverse effect on local air quality at receptors located along site access roads".

in terms of the 220 kV OHL with partial undergrounding Section 7.5.1.7 of the IEP Report states that

"The effect on local air quality from the proposed works at the OHL tower sites, substations and sealing-end compounds will be negligible. Construction related traffic will be small and will not have significant adverse effects on local air quality at houses located along site access roads.

The effect on local air quality will be negligible for the UGC section(s). However, this section(s) has the potential to affect houses on the route and also affect traffic flow which, in turn, has the potential to increase pollutant concentration at the construction sites."

With the implementation of mitigation proposed for each option of the Grid West project relating to air quality no significant impacts have been identified and no significant negative Cumulative impact with Oweninny will occur.

12.5 CONCLUSION

The proposed development will result in significant positive contribution towards management of environmental emissions from electricity generation leading to a reduction in greenhouse gas emissions and transboundary pollutants with the consequential effect on climate

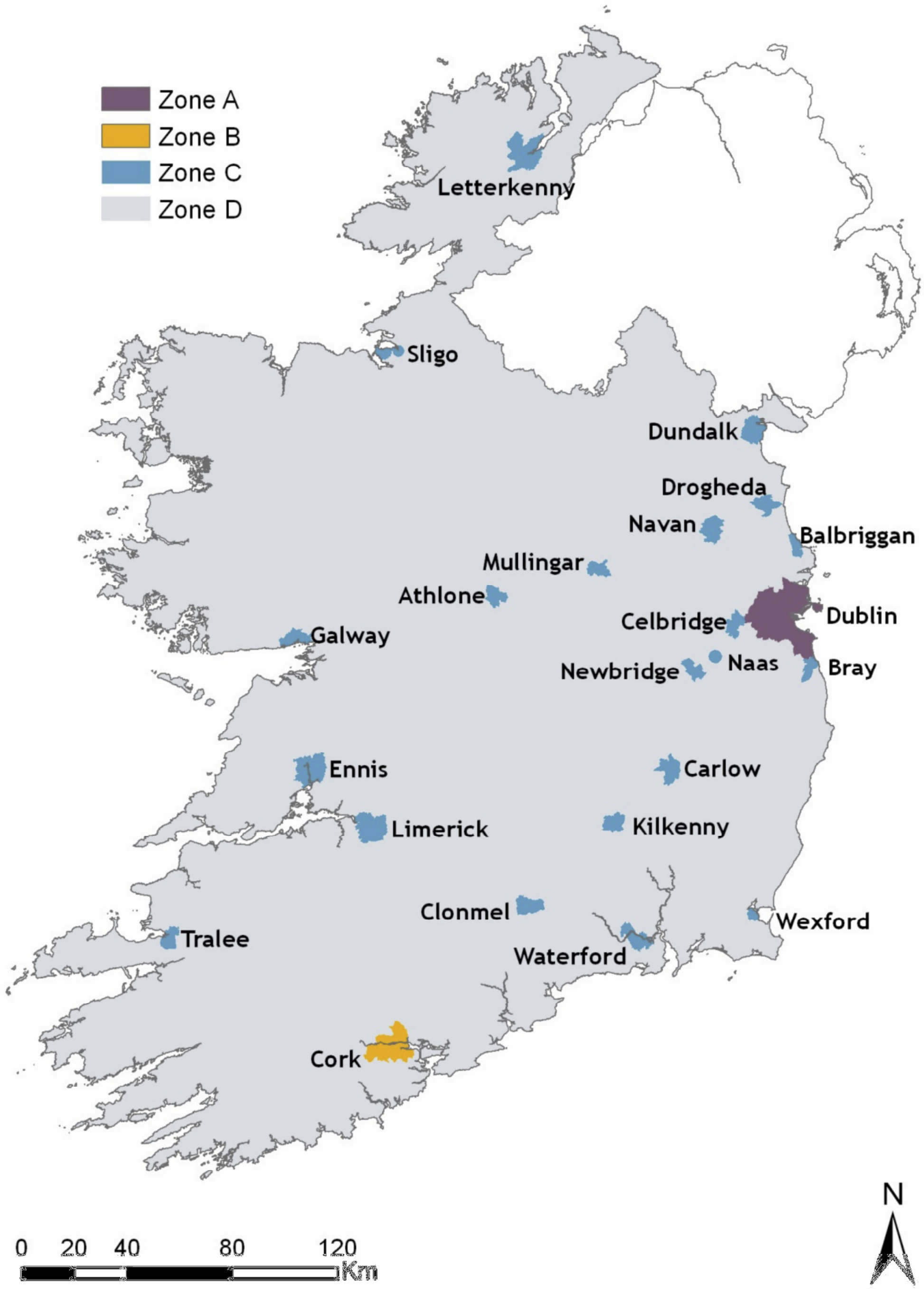


Figure 12-1: Air quality Zones

(Source: EPA Air Quality in Ireland 2013)

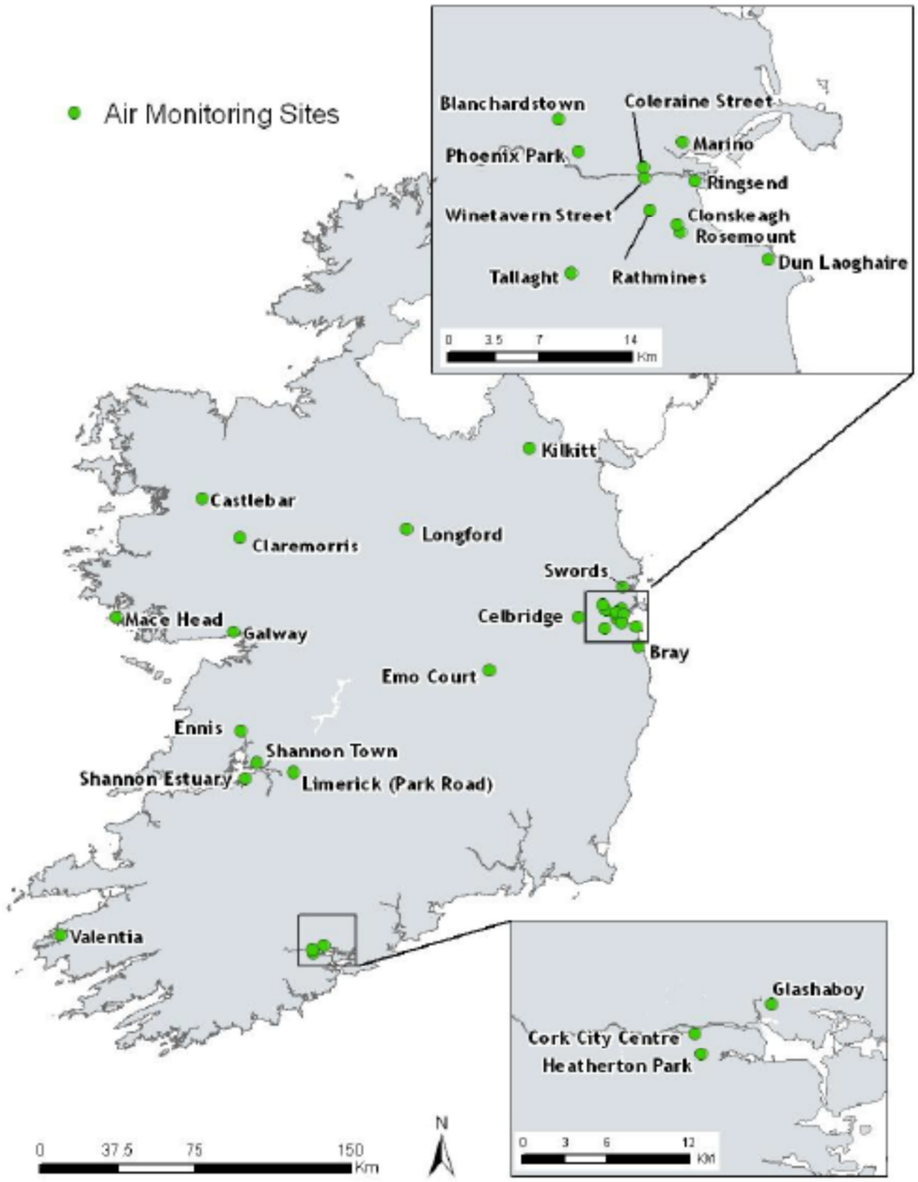


Figure 12-2: Air quality monitoring locations

(Source: EPA Air Quality in Ireland 2011)

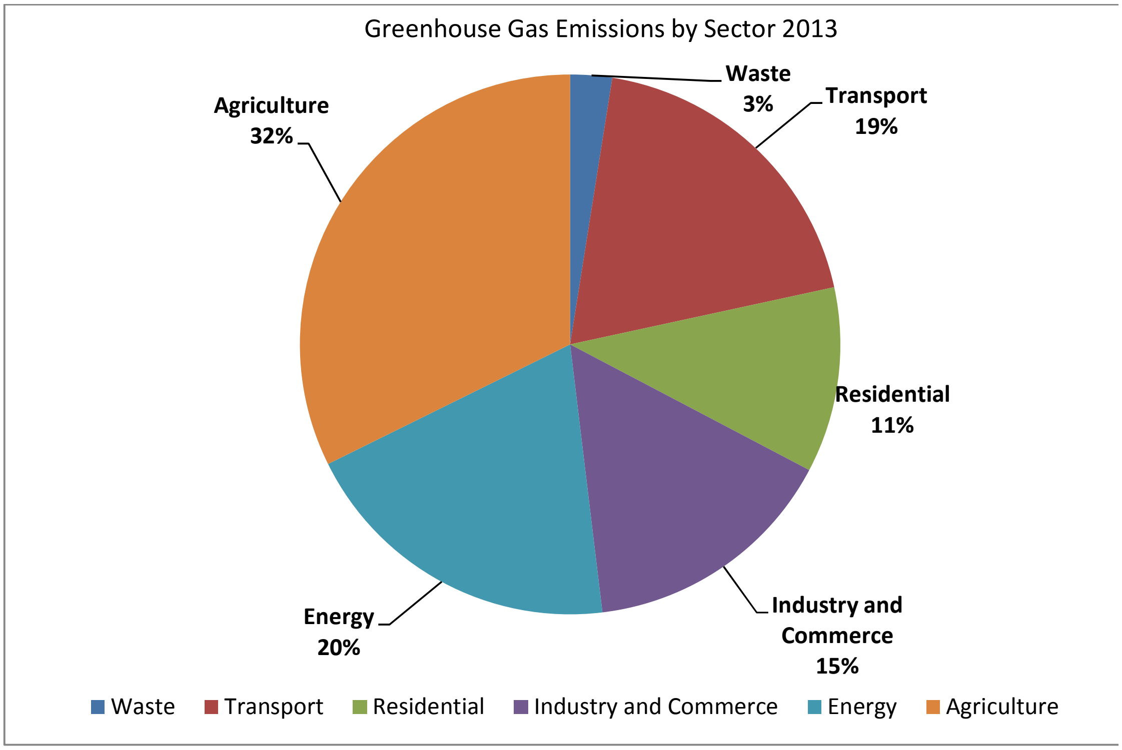


Figure 12-3: Greenhouse gas emissions in 2013 by Sector

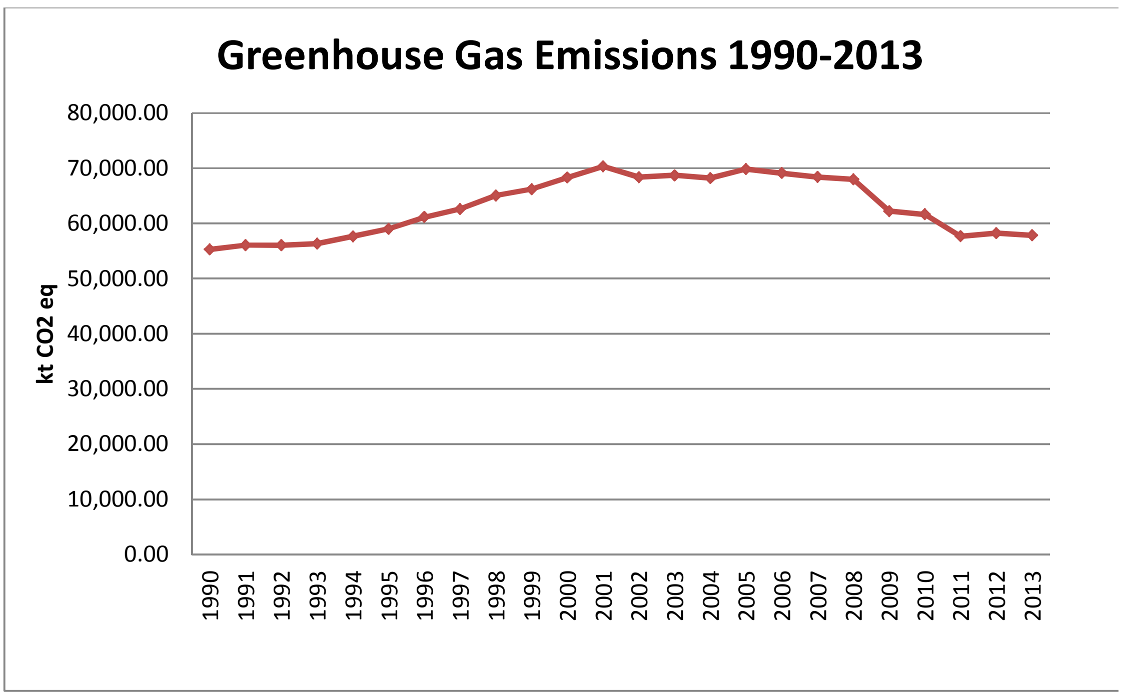


Figure 12-4: Greenhouse Gas Emissions in Ireland 1990 – 2013

(*EPA, IRELAND'S PROVISIONAL GREENHOUSE GAS EMISSIONS IN 2013*

13 SOILS & GEOLOGY

13.1 INTRODUCTION AND METHODOLOGY

The data used in compiling this soil and geology section of the Environmental Report for the Oweninny Wind Farm Project has primarily been completed using the data made available to the public by the Department of Communications, Energy and Natural Resources and the Geological Survey of Ireland (GSI), via http://www.gsi.ie/Mapping.htm.

This assessment was undertaken with reference to the Institute of Geologists of Ireland Guidelines – Geology in EIS (2002). None of the guideline's project types refer to the development of all the elements of this project, therefore some of the issues identified as potentially significant with regard to this assessment are based on those given for Industrial Installations for the Production of Electricity (Project Type 2). Linear Projects (Project Type 20) and Development Projects (Project Type 28) and includes assessment of:

- Nature of rock/soil
- Removal of rock/soil
- Impact on groundwater
- Impact on geological heritage
- Impact on natural resources e.g. resource sterilisation

This chapter was prepared by Richard German of ESB International.

13.2 RECEIVING ENVIRONMENT

13.2.1 Soils

The proposed project is generally underlain by blanket peat bog, this was worked in the past by Bord na Móna to provide fuel to the former ESB Bellacorick Power Station, and is considered to generally be cut away peat bog. In places across the site glacial till is recorded, as are glacial sand and gravel deposits, particularly in the south and east of the site. Alluvial deposits are shown to be present along the course of the Oweninny/Owenmore River.

It is anticipated that peat will be encountered at nearly all development locations. Peat is an organic soil derived by the accumulation of partially decomposed plant matter in favourable locations, following the end of the last ice age.

Glacial deposits are derived due to glacial activity during the last ice age, which ended approximately 10,000 years ago, and post-glacial conditions during and immediately following the end of the last glaciation. The glacial deposits are in places associated with topographical elevation, but in general terms represent the haphazard deposition of soils in glacial and post glacial environments.

It could be assumed that the peat bog is draped across the glacial soils, and it is possible that glacial deposits in the form of glacial till will be found underlying the peat across much of the site. Glacial till is recorded as being present in some areas where peat has been fully cut away. Glacial till is a catch all term for the poorly sorted soils deposited by some glacial processes, although is frequently encountered as boulder clay, i.e. poorly sorted gravel, cobbles and boulders in a clay matrix.

Glacial sand and gravel deposits tend to be found as discrete entities; their deposition having been in river channels or streams associated with glacial and post-glacial processes

The alluvial deposits along the principal river course would be expected to be granular material ranging from silt to gravel/cobble size particles. The river bed is generally gravelly/cobbly in nature and it is anticipated that the alluvium may be coarse close to the river channel becoming finer in nature into the flood plain.

Groundwater vulnerability mapping in this area indicates that soil is over 5 m in thickness across the site, apart from a small area adjacent to the Oweninny River in the south of the site and to the east of Lough Dahybaun where soil is indicated to be thinner in places. Historic investigation for the development of the former ESB Bellacorick Power Station showed glacial deposits in excess of 20m thickness. The GSI indicates two wells to the north of the former ESB Power Station site. These boreholes were drilled as monitoring wells under the supervision of Mr German in 1998, and indicate penetrated thickness of glacial deposits in excess of 5m.

The soils present across the proposed development are shown on Figure 13-1. Soil thickness associated with groundwater vulnerability is presented in Table 13.1 derived from the Geological Survey of Ireland Groundwater Protection Scheme guidance as groundwater vulnerability mapping, see Figure 13-2. Different soil types present may present different issues and benefits. Glacial till often provide good foundations, but their excavation and storage may generate run-off with elevated levels of mineral particulates. Sands and gravels may provide a variable founding material; these granular deposits may contain perched and elevated groundwater that may make excavation difficult. Peat may be problematic in terms of stability and where excavated material is stored and may also give rise to increased organic particulate loading of waters.

Table 13.1: Groundwater Vulnerability Classification

Vulnerability Rating	**Hydrogeological Conditions**				
	Subsoil Permeability and Thickness			Unsaturated Zone	Karst Features
	High Permeability	Moderate Permeability	Low Permeability		
	(sand gravel)	(sandy till)	(clayey till, clay, peat)	(sand and gravel aquifers only)	
Extreme	0 to 3 m	0 to 3 m	0 to 3 m	0 to 3 m	-

Vulnerability Rating	Hydrogeological Conditions				
High	>3 m	3 to 10 m	3 to 5 m	>3 m	N/A
Moderate	N/A	>10 m	5 to 10 m	N/A	N/A
Low	N/A	N/A	>10 m	N/A	N/A

The designated (pNHA/SAC) Bellacorick Bog Complex is present at or close to the site boundaries. The designated (pNHA/SAC) Bellacorick Iron Flush, a groundwater dependent terrestrial ecosystem, is fully enclosed by the site but is not part of the development. The Lough Dahybaun SAC is present towards the southeast corner of the site and the project boundary includes part of this SAC, although no development is proposed within or immediately adjacent to it, this water body is anticipated to be primarily controlled by surface water flows.

13.2.2 Bedrock

The site is underlain by the Downpatrick Formation. This Carboniferous age formation comprises a sequence of interbedded rocks of mudstone and siltstone, sandstone and siltstone, and bioclastic limestones with calcareous shales. The geological mapping of the area does not show any faults beneath the sites, but faults are present to the east and west and these faults typically have a northeast southwest orientation. Bedrock geology of the project and area is shown on Figure 13-3.

13.2.3 Groundwater

The majority of the site lies within the catchment of the Oweninny/Owenmore River. However, part of the northeast of the site lies within the catchment of the Owenmore/Cloonaghmore River and part of the southeast of the site lies within the catchment of the River Deel. The site does not exhibit strong topographical trends and might be considered to be generally flat lying with gentle falls to principal water course; occasional isolated hills exist within the site and represent discrete glacial/post glacial geomorphological features.

It is generally assumed that groundwater flow would mirror topography, and local flows are likely to be varied reflecting the local drainage patterns. Across the majority of the site it is assumed that the groundwater flow in the Oweninny/Owenmore catchment would be towards the south and west, reflecting the general flow direction of the Oweninny/Owenmore catchment. However, in the parts of the site within the Cloonaghmore and River Deel catchments the groundwater flows would be expected to be northeast and southeast respectively. The designated areas of the Bellacorick Iron Flush and Lough Dahybaun lie within the Oweninny/Owenmore catchment; the Bellacorick Bog Complex occurs across several catchments.

The soils of the proposed development are dominated by blanket peat, which with regard to groundwater has a higher porosity, but low permeability, so infiltrating water may be trapped in the soils matrix but unable to flow.

Glacial till, which may underlie the peat beneath part of the project is generally anticipated to be cohesive, as boulder clays, but due to its depositional environment and intrinsic variability in particle size, may have granular horizons. Generally, cohesive glacial tills may be considered impermeable, but the presence of granular horizons allows the development of perched water tables of limited extent. Granular horizons in glacial tills are unlikely to represent significant groundwater resources, but provide pathways for the movement of contaminants to surface waters or deeper bedrock groundwater bodies. GSI mapping does not indicate any sand or gravel aquifer in the general vicinity of the project.

Sand and gravel deposits are likely to contain groundwater due to their porous nature, but this will primarily be as isolated perched water tables within the deposits. More extensive sand and gravel deposits to those shown at the site can contain significant groundwater resources, such as those to the west of Crossmolina and east of the site.

The rocks beneath the proposed development include both incompetent and competent rocks. Incompetent (‘plastic’) rocks, such as siltstones, mudstones and shales, are unlikely to contain groundwater due to their argillaceous nature and lower levels of fracturing. The competent rocks, such as sandstone and clastic limestones, will be more fractured than the incompetent rocks and are more likely to be porous, depending on cementation, and therefore more likely to contain groundwater. Due to the interbedded nature of the rocks in the Downpatrick Formation the formation of substantial water bearing strata is limited, both by thickness and by the movement of water through less permeable/porous strata. A crust of increased permeability bedrock is generally found in the upper zone of the bedrock, due to weathering of the rock, although this can be thin or absent in glacial formed terrains.

The GSI groundwater resource mapping, Figure 13-4, indicates that the bedrock groundwater resource beneath all elements of the proposed development is poor but might be productive in local zones (Pl). The GSI groundwater resource matrix is presented as Table 13.2. This groundwater classification would indicate that sufficient groundwater to support domestic or large abstractions may be available only in specific locations or areas. There are no wells shown on the GSI database in the general area, excepting former ESB monitoring wells.

The GSI groundwater vulnerability mapping in the area around the proposed development is shown in Figure 13-2 using the matrix presented in Table 13.1. The groundwater beneath the site is generally shown to be of moderate (M) vulnerability, although small zones of higher vulnerability (E and X) are shown.

The groundwater resource protection classification for the project footprint is typically Pl/M, this represents a relatively unimportant groundwater resource that receives reasonable natural protection from downward migration of contaminants. This indicates that little groundwater resource would be present, although perched and isolated groundwater bodies may be encountered, especially where sand and gravel deposits are present.

Table 13.2: Groundwater Resource Protection Matrix

Vulnerability Rating	Source Protection		Resource Protection					
			Regionally Important		Locally Important		Poor Aquifers	
	Inner	Outer	Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu
Extreme (E)	Sl/E	SO/E	Rk/E	Rf/E	Lm/E	Ll/E	Pl/E	Pu/E
High (H)	Sl/H	SO/H	Rk/H	Rf/H	Lm/H	Ll/H	Pl/H	Pu/H
Moderate (M)	Sl/M	SO/M	Rk/M	Rf/M	Lm/M	Ll/M	Pl/M	Pu/M
Low (L)	Sl/L	SO/L	Rk/L	Rf/L	Lm/L	Ll/L	Pl/L	Pu/L

Based on topographical information, Lough Dahybaun sits within a small basin at the head waters of the Owenmore catchment. Based on geology and location it is not expected that groundwater is a significant contributor to the water of Lough Dahybaun, and it is anticipated that water is principally derived from local surface water run-off. The designated parts of the Bellacorick Bog Complex are located at the periphery of the site and generally up gradient or across hydraulic divides from the proposed site. Therefore the designated parts of the Bellacorick Bog Complex are outside any potential zone of influence of the project with regard to groundwater.

The hydrogeology of the Bellacorick Iron Flush is considered and discussed in detail in chapter 18 of this EIS, specific potential impacts and necessary mitigation are presented therein.

13.2.4 Geological Heritage and Resources

The geology of the rock formation immediately beneath the site is not suggestive of significant economic resources, in the absence of distinctive strata, geological structure and metamorphic/igneous influence. However, there are records of some pyritic mineralisation and limited local quarrying of sandstone for flagstones.

The GSI has been consulted with regard to the presence of geoheritage within the proposed site footprint. The channel of the Oweninny River has been recommended for NHA status under the IGH 14 Fluvial and Lacustrine Geomorphology. The correspondence with the GSI is included as appendix 11.

13.2.5 Borrow Pit and Peat Repository

Investigation of the site has indicated that materials suitable to support construction are available on site. These materials will be won through the excavation of a borrow pit, as shown on Figure 2.1, to a depth of approximately 2 m by means of mechanised excavator and drag lines. It is anticipated that the borrow pit workings, although shallow may be inundated by groundwater. It is intended that the working of the pit will take place through the water table in a water filled excavation, i.e. no pumping of groundwater will take place to facilitate excavation.

The on-site winning of construction materials is beneficial to the project and the environment as it reduces the volume of material that needs to be imported to support site development. It is anticipated that the borrow pit will be partially reinstated using mineral soils excavated elsewhere on the site that cannot be reused in wind farm construction.

It is anticipated that peat will be excavated from areas that are not suitable for side casting of peat, this may be due to the depth of peat in certain locations or due to proximity to sensitive receptors. The peat that is not side cast will be placed in a peat repository that will be constructed on an area of cutover bog where risk of peat instability is minimal. This peat repository or peat disposal area will be sized in and phased to accord with peat arisings and will be contained as needed with appropriate run off controls. It is anticipated that the height of berms and thickness of peat in the repository area will not be greater than 1 m.

13.2.6 Ground Investigation and Slope Stability

13.2.6.1 Ground Investigation

ESBI have completed a site investigation across the proposed site by means of trial pits, peat probing and boreholes. This study together with earlier investigation works by Bord na Móna confirmed the general geology indicated above.

The recent investigation found that the site is covered in blanket bog peat up to 3.5 m in thickness, although over the majority of the site where construction is taking place the peat is generally less than 1 m thick. The peat overlies soft clays and or loose sands and gravels in turn overlying stiff clays and dense sands or gravels before bedrock. Bedrock was encountered in rotary boreholes at depths between 8.3m to 23.75m below ground level.

13.2.6.2 Peat and Slope Stability

The GSI web resource indicates several peat related slope stability events in the hills to the north and west of the site, but does not show any record of such events at the site.

Given that the site is relatively flat lying and that the peat across the site has generally been drained and worked, the risk of slope or peat instability associated with the proposed development is low. However, ESBI has undertaken detailed technical review of slope and peat stability risks at the proposed site; these works have been undertaken in general accordance with the Natural Scotland Scottish Executive “Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments” (2006) and supplemented by ESBI’s experience on many wind farm sites in Ireland.

The guidance gives four risk levels for peat stability, which are: insignificant, significant, substantial and serious. Development may take place on the lower three categories of peat stability risk, with increasing mitigation measures for significant and substantial categories. Development on serious risk category locations should not take place.

The site area for Phase 1 and Phase 2 only has been broken into a number of discrete sectors based on the proposed components of the development so that location specific risk can be determined. The site is found to comprise the following areas of peat risk: 60% insignificant risk, 30% significant risk, 10% substantial risk and 0% serious risk. The substantial risk areas are primarily associated with the area to the west and north of Lough Dahybaun. Generally, the low slope angles and shallow peat thickness suggest that construction on the site, outside of the substantial risk areas, pose a low risk.

The peat stability report was included in Appendix 4 of the original EIS

13.3 POTENTIAL IMPACT OF THE DEVELOPMENT

13.3.1 Construction Phase

13.3.1.1 General

The construction of the project will take place over two phases. In its entirety the project will require the construction of an extensive road network, turbine foundations, hard stands, borrow pit, peat disposal area, O&M building, substations and ancillary infrastructure, maintenance areas, overhead electricity cable and underground cables. The proposed development also includes a visitor centre and associated infrastructure, such as car parking. The electricity transmission between turbines and the project substations will be by underground cable, transmission between substations will generally be by means of overhead line, although in part of the site this connection will be made by underground cable using an overbridge crossing on the existing Bord na Móna river crossing. An option for horizontal directional drill beneath the Oweninny River to connect to the substation at the former Bellacorick Power Station is also possible.

This construction work will require the excavation, handling and storage of soil, the winning of construction aggregates on site from the proposed borrow pit and the temporary storage of materials for reuse. The construction works will also require the provision of contractor compounds and laydown areas, concrete batching plant and other ancillary facilities. As the works are located within cutover bog, it is intended that peat will be side cast, i.e. placed adjacent to works locations where safe to do so, and otherwise will be placed in a peat repository. The risks arising from the project are similar to those arising from any large infrastructure construction project.

The construction works will require access and egress to areas across soft soils, this potentially reduces the quality of the soil by compaction, may lead to the break-up of soil surface to increase sediment load in run off and during dry conditions give rise to the generation of dust.

Soil will need to be excavated to form turbine bases and soil will need to be excavated to allow the formation of roads, hard stands, substations and other structures. A focus of excavation will also take place at the borrow pit to allow the on-site production of construction aggregates. During site excavations it is expected that groundwater will be encountered and it may be necessary to remove this water to allow construction to proceed. Excavation water may have a different chemistry to those to which it is discharged or may contain elevated levels of silt, these may impact on the quality of the receiving water body. It should be noted that the borrow pit will be worked wet, i.e. the borrow pit will not be pumped and materials will be won through the water table.

The excavation of soil will give rise to spoil, peat will be side cast and other soils may be suitable for reuse at the work location or for re-use elsewhere. Excavated mineral soil will generally need to be stored for a period of time to allow assessment of the material and until it is required. Whilst in storage soils and broken rock may generate run-off with high silt levels during wet periods or dust during dry periods.

It is anticipated that some soils may not be suitable for use in construction and it is expected that some excess soil will need to be engineered, through the placement of geogrid, etc., for reuse in landscaping works.

Given the low topography of the proposed site and worked nature of the peat land it is not anticipated that slope stability issues will generally arise, although higher risk areas have been identified and will be subject to further assessment at the detailed design stage, see Appendix 4. General peat stability mitigation measures will be implemented across the site with location specific mitigation measures designed for higher risk areas.

The excavation of soil reduces the natural protection of groundwater to contaminants at or near the ground surface and makes the groundwater more vulnerable to any losses of hydrocarbons, effluents and surface water run-off during construction. Hydrocarbons may be lost to the ground and subsequently the groundwater during fuelling of plant and vehicles or leakage of transformers, prior to and during installation.

Wastewater effluents will be generated by site facilities, such as toilets, given the scale of the project it is expected that the construction phase will require the provision of foul water holding tanks at the contractor’s compound areas. These will be emptied regularly and routinely disposed of in a licensed facility. General surface water run-off from the site may contain high levels of particulate matter associated with soil disturbance.

The development will require the construction of concrete structures and foundations, given the scale of the project a concrete batching plant is proposed for the construction phase. The preparation of concrete and other cement containing products may give rise to high alkalinity waters and slurries that could reduce receiving water quality.

Given the lower productivity of the groundwater resource beneath the site and the protection provided to it by overlying soils, the development of the project is not considered to represent a significant risk to groundwater resources and risks associated with groundwater abstraction and quality are not considered further in this respect. However, changes to groundwater flow regimes and quality in near surface groundwater may impact on surface water bodies. Given the high value of the Bellacorick Iron Flush SAC, potential risks to this receptor are considered in detail in chapter 18 of this EIS.

The construction of transmission lines and cables within the site will not present any risks additional to those associated with the construction of roads and turbines, and in most respects this aspect of the work will represent lower risks. The lines and cables will require concrete pours at the locations of angle masts and jointing bays. To connect the eastern part of the site to the Bellacorick substation the cables will either be ducted across the Oweninny river on the existing Bord na Móna river crossing or horizontally directionally drilled (HDD) under the river. HDD is a well established technology, and has been successfully provided below ground crossing of roads, rail lines and rivers for many projects in Ireland. The details of the HDD if required, will be determined by the appointed Contractor, but in general terms a launch area and reception area would be required at either end of the HDD, comprising small contractors compounds. The cable bores would be formed by drilling a pilot bore and subsequent reaming of the hole and pulling of cable; the boring of the hole requires a bentonite slurry to lubricate and keep the hole open, and subsequently to allow pulling and insulation of the cable. The use of bentonite slurry presents similar risks to concrete, however when drilling beneath water bodies a small risk of escape of bentonite from the bore arises.

The only geoheritage feature within the environs of the site is the geomorphology of the banks of the Oweninny River. No works are proposed on the river banks, with the exception of the replacement or upgrading of the existing river crossing within the site. It is not anticipated that this upgrade will affect the river bank substantially beyond the extent of the existing crossing and is unlikely to present a significant risk.

13.3.2 Operational Phase

The large number of turbines at the site will mean that maintenance activities will be ongoing at the site, but the intensity of such works will vary with the type and extent of maintenance required.

Operational wind turbines include components that require oil for lubrication and cooling and substations will require transformers that utilise oil for insulation and cooling. Given the size of the wind farm, it is anticipated that permanent facilities for the fuelling of plant and generators will be required. Where oil and fuel is used and stored there is a risk of vessel failure and spillage that can impact on water and soil quality.

It is anticipated that some remote fuelling of maintenance plant will be required at the site; this presents a risk of spillage or vessel failure at locations remote from permanent containment facilities, and thus a risk to water quality.

Effluent will be generated from permanent welfare facilities which will be required at the site, located at visitors centre, substations and auxiliary buildings; such effluents may impact on water quality.

13.3.3 Decommissioning phase

Once the wind farm reaches the end of its operational life it is expected that the turbines and all above ground structures that do not have an alternative use will be dismantled to ground slab level. Roads will be left in place and below ground structures will be filled, blocked or terminated in an appropriate manner, so that site drainage mimics natural peat land drainage as far possible and so that hazards to humans and fauna are removed. In general decommissioning risks will be similar to construction, with the exception that extensive excavation, soil management or wet concrete handling will not be required.

13.4 MITIGATION OF POTENTIAL IMPACTS

13.4.1 Construction Mitigation

13.4.1.1 General

Prior to commencement of construction work the Contractor will be required to develop a Construction Environment Management Plan (CEMP). The CEMP will detail the procedures to prevent, control and mitigate potential environmental impacts from the construction of the works and shall detail procedures and method statements for the management of specific issues, e.g. the CEMP will include an oil spill response procedure.

The Contractor will be required to obtain all permits and licences from the regulatory authorities as required by environmental law or regulation and will discharge the relevant conditions of the planning permission to commence site works, or as otherwise appropriate in advance of specific site activities.

All Contractors involved in the development of the project will be required to comply with good construction practice, it is proposed that the general guidance provided by the Environment Agency for England and Wales in their publication entitled 'Pollution Prevention Guideline (PPG6) Working at Construction and Demolition Sites' will be used as a baseline for this purpose. Specific guidance published by Irish regulatory agencies will be used where available.

13.4.1.2 Soil Management

Peat soils will be either side cast on to the existing cutover bog or placed in the peat repository. Where side casting occurs, it is anticipated that the existing vegetation extensive area and existing drainage system will remove any risk from generation of silt to surface water bodies. At the large excavation locations, such as turbine bases and substations, silt control measures will be incorporated into work area drainage with the discharge onto cutover bog rather than directly to surface water, which will provide additional silt control.

It is anticipated that peat disposal to a repository area will be required, which will be designed to be fully stable, it is anticipated that deposited peat thickness will not exceed 1m. The repository will be located in a flat area away from sensitive receptors; the repository will be designed to be completed in phases and will include specific drainage and silt controls. On completion the peat repository surfaces will be stabilised by the establishment of natural peat land vegetation.

A project aim is to incorporate sustainability into the design and construction of the project as is practical. Where mineral soils are encountered in the excavation and construction of site roads, bases, etc., this material will be stockpiled for assessment and subsequent re-use. Where mineral soil is not directly suitable for construction it will be used for reinstatement works and will be geo-engineered as necessary.

Exposed soils can lead to the generation of dust in dry windy conditions or silty run-off in wet conditions. Dust generation will be controlled by wetting soil surface in dry conditions or by covering soil stockpiles with geomembrane. If long term storage is required for reusable soil, particularly where such storage will span spring and summer periods consideration will be given to vegetating the stockpile. To control generation of silt run off soil stockpiles will be surrounded by either silt fencing or toe drain or will be covered. Surface run off from across the construction site will be directed to surface water control areas that may include siltation ponds or similar.

As part of the proposed works a borrow pit is proposed to obtain materials suitable for construction, the purposes of which is to minimise the need for import of aggregates from elsewhere, reducing the project's environmental footprint. The borrow pit will be operated wet through the water table to minimise any impact on groundwater flows beneath the site. It is not intended that the borrow pit be fully reinstated, although it is expected that the borrow pit may be partially reinstated using suitable excess materials arising from the site works. The flooded borrow pit area remaining post reinstatement will be established as a wet land area to maintain and enhance biodiversity.

The majority of site construction will utilise the permanent access track network for access and egress, and this access will be constructed in advance of other ground works in a sequential manner. Where access is required off the permanent road network, primarily for overhead line construction, access will be made by the placement of bog mats or similar and bridging of drainage channels, the purpose of which is to minimise soil compaction and avoid break up and erosion of the soil.

The Contractor will be required in advance of commencement of site works to develop a Materials Management Plan (MMP). This plan will document how soil will be managed on site and will include the geotechnical criteria for re-use of materials, the design for on-site re-use and disposal options, a scheme for the tracking and recording of soil movements.

13.4.1.3 Materials and Fuels

Concrete and similar other products may give rise to alkali effluents that may impact on receiving waters. Therefore waste concrete and wash waters need to be disposed of in dedicated areas where the waste material can be neutralised and collected for appropriate disposal or reuse. Any use of crushed concrete aggregates must take into account the potential for generation of alkali run off, and such reuse must not be located in proximity to sensitive receiving waters or where conduit to such waters exist.

A concrete batching plant is proposed for the project, and a dedicated facility will be needed for the duration of the construction works. The concrete batching plant will be a purpose built plant and it will be designed in a manner to minimise water discharges and to control those that are required. Fuel storage and fuelling facilities will be required at several fixed locations and at mobile locations around the site, given the size of the project site it is impractical to track large plant to a single fixed facility. Fuel storage and any oil storage will be carried out in accordance with the Enterprise Ireland Best Practice Guide BPGCS005 Oil Storage Guidelines. Fuel and oil storage at fixed locations will be in a fixed tank, undercover and within a steel or concrete bund. A dedicated impermeable bunded refuelling area will be constructed adjacent to the fixed fuel storage areas. Double skinned plastic tanks will not be acceptable at the site for any purpose unless they are placed within fixed concrete or steel external bunds.

Each fixed fuel and oil storage bunds shall be sized to hold 110 % of the oil volume of the largest tank therein. The fixed fuel and oil storage bunds shall be blind sumped. The rainwater pumped from each bund shall be discharged to the surface water drainage system via an oil interceptor. In the event of a spill, the liquid contained in the bund shall be removed by liquid waste tanker, as will be the contents of the surface water drainage system and oil interceptor.

Where refuelling is required on site away from fixed storage locations this will only be carried out utilising steel intrinsically bunded mobile fuel bowsers. At site refuelling locations, where possible, refuelling will take place within mobile bunds, but at a minimum fuel lines from the bowser to the plant being fuelled will be contained by drip trays.

Generators and associated fuel tanks to be used at the site shall either be placed within bunds as per fuel storage tanks or shall be integrated units (i.e. fuel tank and generator in one unit) that are intrinsically bunded. No external tanks and associated fuel lines shall be permitted on site unless these are housed within a fixed bund with the generator.

The contractor’s yard/maintenance yard shall incorporate a bund for the storage of small vehicles and oil filled equipment, such as hand portable generators, pumps, etc. Storage of small volume oils or chemicals, in barrels, IBCs, etc., will be stored in a covered bunded area. Where barrels or other containers are required at work locations these shall be stored in enclosed bunded cabinets, and drip trays shall be used where distribution of the material is required.

The main storage areas for oil filled equipment, vehicles, plant, etc., shall be impermeably surface and the discharge of surface water from these areas will be via oil interceptors.

An oil spill response plan will be developed for the construction works and appropriate containment equipment will be available at work locations in the event of a spillage. Oil spill response will form part of site personnel induction and training at the site.

All wastes generated on site will be segregated so that where possible and appropriate materials are re-used on site. Residual materials will be collected by licensed waste haulier for appropriate sorting, recycling and disposal.

13.4.1.4 Water and Effluents

It is expected that groundwater will be encountered in some excavations at the site. Groundwater arising from excavations may have high levels of suspended solids. The waters from excavations will be discharged through silt control device to the cutover peat land.

Temporary welfare facilities will be located on site these will discharge to sealed sumps that will be emptied as needed by appropriately licensed contractors.

Permanent welfare facilities at the substations, O&M building and visitor centre will discharge to a proprietary treatment system and percolation area, see Chapter 2.

Where feasible, bored wells will be used to provide a source of water supply to areas of the site.

Surface water arising at the contractors' compounds, concrete batching plant and fixed fuel storage locations will be discharged in an appropriate manner via necessary controls that will include alarmed oil interceptors.

It is not anticipated that the creation of the structures and infrastructure required for the project have a significant potential to influence the general quality or quantity of groundwater available across the area. It is expected that dewatering will be required for some turbine bases and other excavations in parts of the site. It is not expected that the temporary and localised nature of the necessary dewatering works would impact on the groundwater table, except locally to the works, and therefore would not significant impact groundwater flow regime within or beyond the site.

13.4.1.5 Transmission Lines and HDD

Construction of internal electricity transmission lines and cables will present similar, but lower level risks, to the construction risks outlined above, and the same mitigation measures will be adopted as above.

If Horizontal Directional Drill (HDD) beneath the Oweninny is used then this will have its own potential risks, primarily arising from the break out of bentonite slurry used during drilling and cable installation. The risk of bentonite slurry to groundwater is not considered significant as no significant groundwater resource is present within the Downpatrick Formation bedrock or overburden and given the geology present any breakout will only impact on a limited volume of groundwater local to the bore.

Detailed site investigation will be undertaken in advance of the HDD design, if this method is adopted. this will inform the rock type and other risks, such as voids, to successful completion of the bore and cable installation. The site investigation will inform the design of the density and competence of the soil and rock strata so that a drill profile can be established so that overburden pressure is sufficient to contain the bentonite slurry and to avoid any discernible fractures or other zones of weakness thus minimising the risk of break out.

Bentonite slurry tanks required for the drilling will be bunded. Bentonite storage will be enclosed to prevent dust generation as will mixing plant. Fuel storage, etc., required at HDD launch site will meet the requirements as outlined for the construction above.

A specific emergency response procedure will be developed for the HDD and associated cable installation.

13.4.1.6 Geoheritage

No works are intended to be required as part of the development, except the upgrade or replacement of the existing river crossing within the site. However, if it is required that works are required on the banks of the Oweninny River, beyond the general footprint of the current structure, or for any other reason, the GSI will be contacted and works will be agreed to minimise the impact to geoheritage.

13.4.1.7 Slope Stability

The risk of peat stability has and will be further minimised and mitigated by optimising the design of the wind farm, by choosing a safe and controlled construction methodology, by having a rigorous documentation and quality control system during construction and by controlling construction activities carefully. Zonal Peat Stability Risk Assessments (ZPSA) will be required for the areas of substantial risk and in specific areas of significant risk identified at detailed design level.

Given the scale of the project a major consideration for the development at this site is the management of the materials excavated as part of the construction works. To this end and in order to further mitigate against any risk of peat instability, it is proposed to remove peat from areas of substantial risk and place this material in areas of insignificant risk upslope of a designed berm or solid road. Sidecasting of peat in areas of higher risk will not take place unless retained by a designed structure. A peat repository/disposal area will also form part of the peat management solution and this will be located on low risk areas of cutover bog. A full material management plan for the various phases of the development will be designed and maintained over the course of the project.

The management of peat stability will be ongoing throughout the construction and operational stages of the project and will be managed through the use of a geotechnical risk register.

13.4.2 Operational Mitigation

Operational activities at the site will focus on the maintenance of wind turbines and associated infrastructure. From time to time oil filled components of the wind turbines will need to be refurbished and replaced.

To facilitate operational activities at the site fuel and oil storage will be required, primarily in the permanent maintenance/contractors compound, although remote use of fuel and oil will be required from time to time. Fuel and oil storage and handling requirements will be as detailed for construction, with permanent fuel and oil storage located within permanent covered bunds.

Electrical apparatus, such as transformers, will be required within the substations, all such oil containing electrical apparatus shall be constructed within permanent concrete bunds that shall have been constructed and tested to provide containment. Each bund shall be sized to hold 110 % of the oil volume within the electrical apparatus it encloses. The bunds shall be blind sumped and alarmed to allow the regular removal of clean rain water by means of a pump. In the event of a spill, the liquid contained in the bund shall be removed by liquid waste tanker, as will be the contents of the surface water drainage system and oil interceptor.

Surface water discharges from contractor/maintenance compounds, permanent storage areas and substation bunds shall be to surface water via and oil interceptors. The oil interceptors at the site shall be subject to a regular inspection and de-sludging to ensure that they retain full operational efficiency.

An oil spill response plan shall be developed for the site. Site operatives shall receive appropriate training and materials shall be available on site to immediately respond to any fuel or oil spill.

The majority of the proposed development site will be accessed from the projects permanent road network, however some low maintenance project elements, principally overhead line, will require access and egress across cutaway peat bog should maintenance be required. In such event the access and egress will be undertaken using the approach outlined for construction.

Welfare facilities will be provided at the Contractor/Maintenance compound, the Visitors Centre, O&M facility and at substation locations. These welfare facilities will produce foul effluent and these effluents will be treated through the construction of proprietary waste water treatment systems. These wastewater treatment systems shall be subject to yearly inspection and maintained as required.

13.4.3 Decommissioning Mitigation

Decommissioning will comprise the removal of non-reusable power generation devices and infrastructure to ground level, it is assumed that below ground cabling, etc., would be abandoned in-situ. The risks arising from the decommissioning of the site would be less than those for construction, but mitigation measures for decommissioning would conform to those given for construction and would be anticipated to be fully protective of the environment.

13.5 Cumulative Impacts

There is potential for cumulative soil and geological impacts to arise from construction of other windfarms, uprating of 110kV Overhead line infrastructure, power plants and from the Grid West project. These are discussed below.

13.5.1 Wind Farms

13.5.1.1 Corvoderry Wind Farm

Corvoderry wind farm is located within the Oweninny site comprising a development of 10 wind turbines, access tracks and hard stands on mainly blanket peat overlying the Downpatrick Formation consisting of cross bedded sandstone and siltstone with some limestones. The entire site is afforested. The construction activities will give rise to a direct permanent localized loss on the soils and geology. This would be cumulative with loss of soil and subsoil from the Oweninny proposed development. There would also be associated potential indirect impacts on water quality from soil and silt loss during construction. Mitigation of potential impacts by avoidance during the design phase of Corvoderry was followed. With the implementation of proposed mitigation the impacts on soil and geology are described as slight negative and permanent. This would be cumulative with that of Oweninny, however, the Oweninny site was a heavily modified industrial peat harvesting site with little residual soils and the impact son spoils and geology is therefore of low significance and the cumulative impacts will be low.

13.5.1.2 Dooleeg, Bellacorick Wind Farm

This wind farm has permission to construct a single one 2 MW turbine at Dooleeg, Bellacorick. The level of impact on soils and geology will be small but permanent locally and only a minor cumulative impact with Oweninny wind farm development will occur.

13.5.1.3 Tawnanasool Wind Farm

The Tawnanasool proposed wind farm is located about 10km to the west southwest of the Oweninny site on approximately 348 hectares of blanket bog which was a former peat harvesting site and which is underlain by Pre Cambrian Quartzites, Gneisses and Schists (Chapter 14 of the Tawnanasool EIS). Construction of the wind farm would result in permanent loss of soil, subsoil and bedrock which would be a cumulative loss with Oweninny. The impact is described as slight and cumulatively the impact overall would not be significant.

13.5.1.4 Potential future development of Oweninny Phase 3

A full assessment of the potential impact of Oweninny Phases 1, 2 and 3 formed the basis for the appraisal provided in Chapter 13 Soils and Geology of the original EIS which accompanied the planning application to an Bord Pleanála in 2013. The conclusion of that assessment indicated that the principal risks associated with soil and geology at the site for all phases are the management of soils, particularly with regard to the generation of silty waters, and the loss of construction and operational materials (concrete, fuel and oil, etc.) to water. It is expected that these risks can be fully mitigated through the adoption of construction and operational good practice and it is not expected that the development of Phases 1, 2 and 3 will give rise to any significant residual impacts with regard to soil and geology.

13.5.2 Meteorological Mast

The mast will be constructed at Sheskin Townland, Bellacorick, Co Mayo within a conifer plantation on the site for the proposed mast is within conifer forest plantation on blanket peat soil underlain by the Carboniferous Downpatrick Formation. The footprint of the mast will be small with the base being constructed of sleepers in an arrangement of 2.4m^2 with stay wires. Given the small footprint of the metmast the potential for cumulative impact on soils and geology is insignificant.

13.5.3 Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410)

The planning approved uprate of the Bellacorick to Castlebar 110kV OHL will not require any additional footprint for the existing line. Tower replacement will occur at existing locations. There will be no cumulative impact on spoils and geology associated with this development

13.5.4 Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45)

The planning approved uprate of the Bellacorick to Moy 110kV OHL will not require any significant additional footprint for the existing line. Tower replacement will occur at existing locations. There will be no cumulative impact on spoils and geology associated with this development.

13.5.5 Substation Project

The works associated with the permission (Planning Reference 15/456) are all within the existing substation site at Bellacorick. The works are short term in nature with no significant impact on geology or soils are predicted as it is within a heavily modified site already. No significant cumulative impact will occur

13.5.6 Power Plants

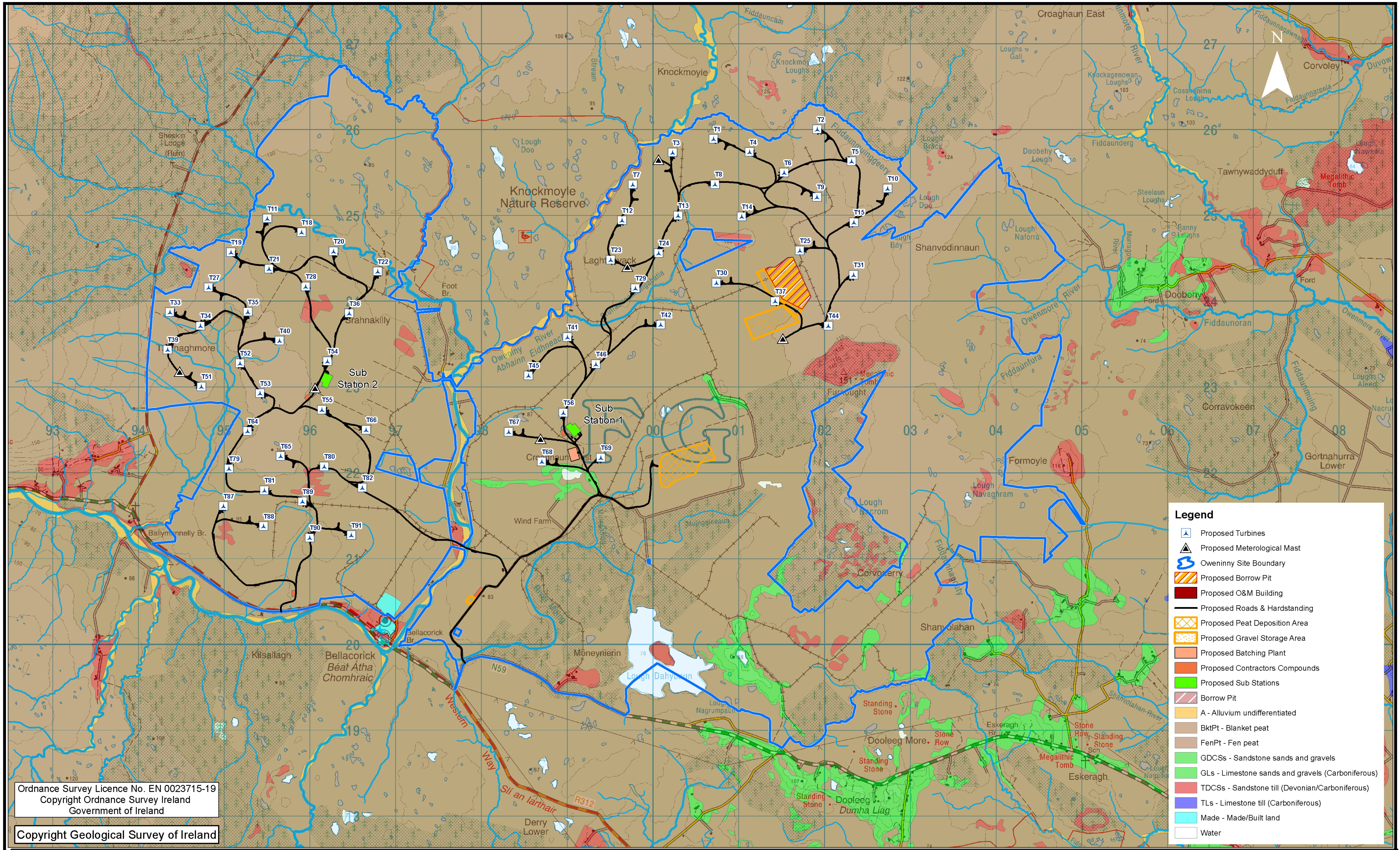
The planning documentation for the power plant projects did not identify significant adverse impacts on air quality, it can be assumed that there would be no significant cumulative effects with the Oweninny development.

13.6 CONCLUSIONS

The project site is relatively flat lying, with cutover blanket peat overlying glacial till that in turn overly sedimentary bedrock of mixed lithology. No significant groundwater resources are present at the site, although localised perched groundwater may be associated with areas of granular overburden. No significant geological resources are known at the site and geological heritage is limited to the banks of the Oweninny/Owenmore River. Due to the relatively flat, drained and cutaway nature of the site, peat stability risk is limited to discrete areas of the site. The outline design of the proposed development has sought to minimise peat stability risks and these risks will be further investigated and considered at the detail design stage.

The principal risks associated with soil and geology at the site are the management of soils, particularly with regard to the generation of silty waters, and the loss of construction and operational materials (concrete, fuel and oil, etc.) to water. It is expected that these risks can be fully mitigated through the adoption of construction and operational good practice.

It is not expected that the project will give rise to any significant residual impacts with regard to soil and geology.



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Oweninny Power Ltd.

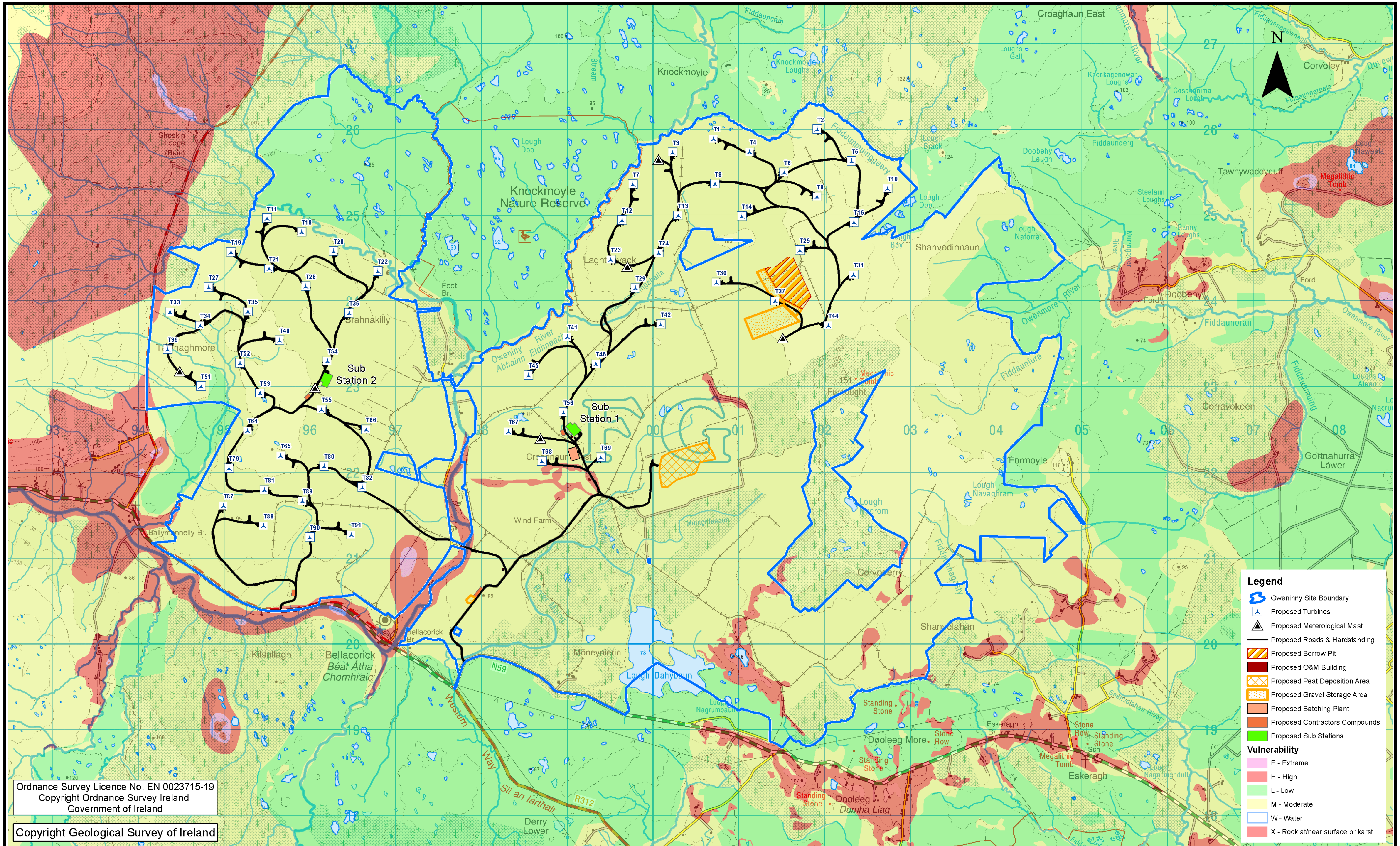
Client Oweninny Power Ltd.	**Title** Soil Formations	
Project Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	**Production Unit** Civil, Building & Environment Group	

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
C.F	C.F	P.K	N.Q	30/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:40,000

MAP REFERENCE

FIGURE 13.1



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Ground Water Vulnerability

Production Unit
Civil, Building & Environment Group

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CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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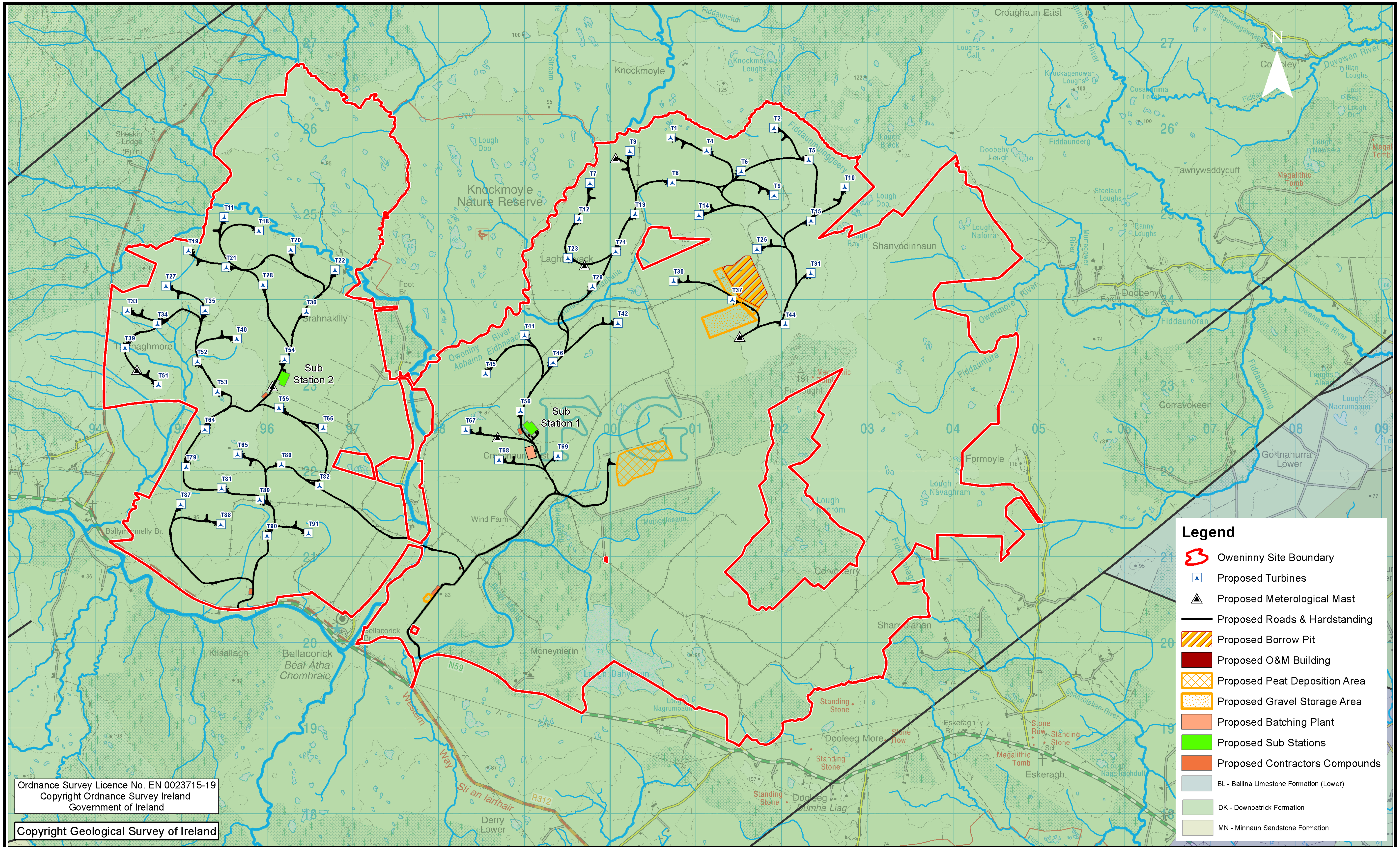
MAP REFERENCE

FIGURE 13.2



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Bedrock Formation

Project	Production Unit
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil, Building & Environment Group

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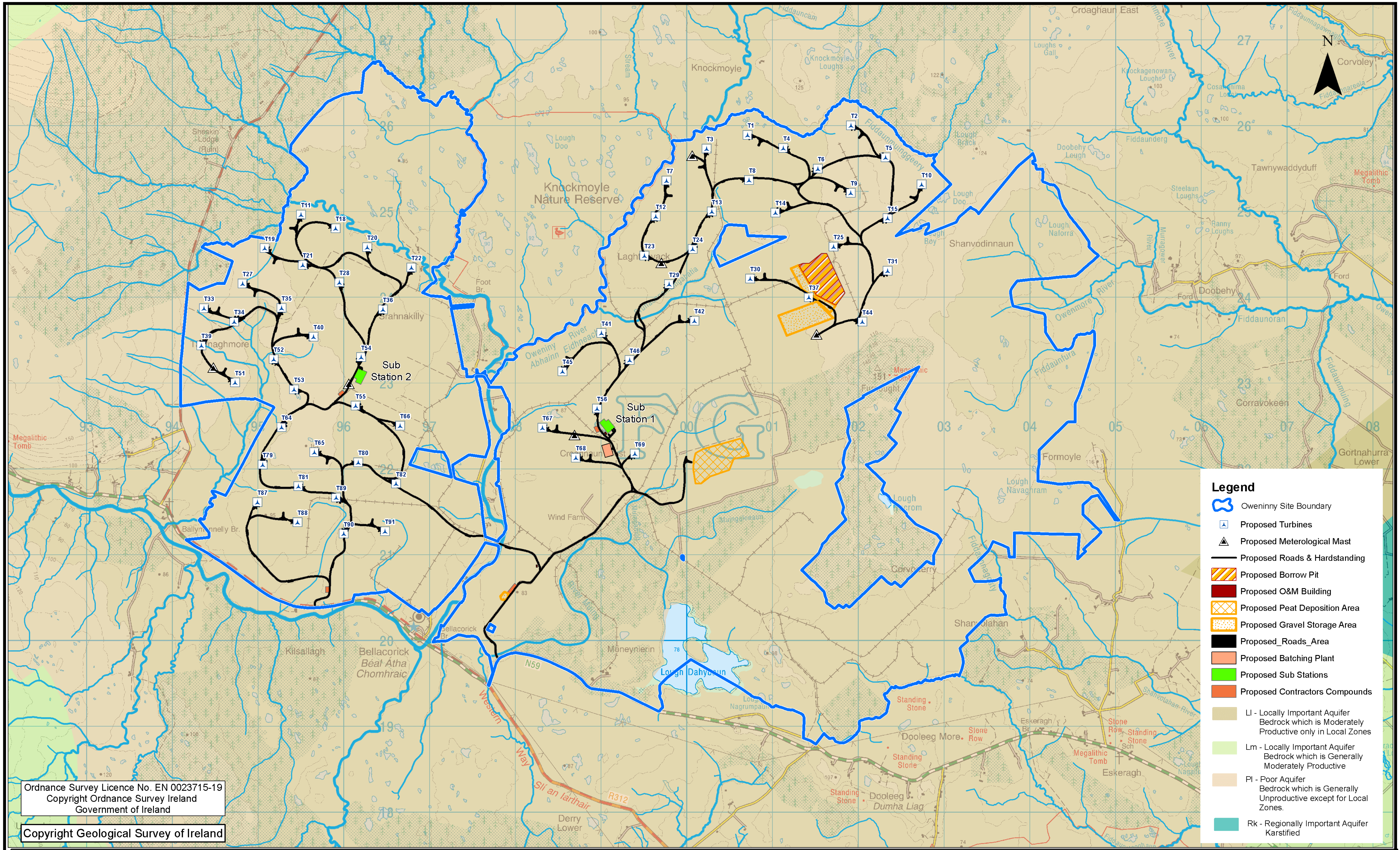
MAP REFERENCE

FIGURE 13.3



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Ground Water Resources

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
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MAP REFERENCE

FIGURE 13.4

14 TRAFFIC & TRANSPORT

14.1 INTRODUCTION

This section describes the potential haul routes for delivery of large project components and construction materials in relation to Phases 1 and 2 of the proposed Oweninny Wind Farm project and the potential impacts on prevailing traffic conditions during the construction, operational and decommissioning phases of the proposed development have been assessed. Mitigation measures are proposed, where appropriate, to address the potential impacts associated with the proposed development. Cumulative impacts with the planning approved Corvoderry wind farm and the Coillte proposed Cluddaun wind farm are also discussed.

From a Traffic Generation and Road Haulage perspective, the traffic and transport elements of the proposed (~~112~~ 61No. turbine) development are broadly in line with the development for which permission was granted by An Bord Pleanála in 2003 (An Bord Pleanála Case No. PL16.131260) for the construction of a 180 No. turbine wind farm on the same lands at Bellacorick. Both the permitted development and the proposed development propose to use the same existing access points from the strategic roads network, namely the N59 National Secondary Road, albeit upgraded in accordance with the recommendations of the Roads Safety Audit. The source of construction materials and the haul routes are also likely to be similar if not identical however the precise routes cannot be confirmed until the construction contract is at tender/award stage.

In terms of traffic impact arising from road haulage, construction traffic and the management of traffic during construction, save for the number and relative size of turbine components to be transported, and the duration of the construction, there is no significant difference in the likely daily traffic generation arising from the proposed ~~112~~ 61 turbine development and the 180 turbine development which was granted permission by An Bord Pleanála in 2003.

14.2 TURBINE COMPONENT HAUL ROUTE ASSESSMENT

Abnormal loads are generally moved in small convoys typically late at night. The proposed site requires the delivery of some 758 components over the course of the 4 year construction program (average 160 components per year). By comparison, the permitted 180 turbine development is estimated to require some 1,080 components over an estimated 5-year construction programme (average 216 components per year).

As with the determination of haul routes for general construction materials, the exact haul route for turbine components will be confirmed prior to the award of the contract to a haulier specialising in the planning and execution of abnormal load delivery. The EIS does however contain a high-level appraisal of likely haul routes and potential alternative options and has identified one feasible route for the largest blade length proposed (56m) which would represent the worst case scenario. The haul route appraisal was initially informed by a desktop study, whilst preferred potential routes were further assessed by drive-over survey. Section 14.2 of the EIS, sets out that the preferred routes are from Killybegs Harbour (2 Alternative Routes) and Dublin Port and provides further information on the identified route for transport of the 56m turbine blade. The updated desktop study is entitled 'Draft Oweninny Wind Farm Desktop Transport Study', a copy of which was submitted as part of the planning application and further copies were submitted directly to An Bord Pleanála at the Oral Hearing.

The haul route will be confirmed by the turbine supplier following a competitive tendering process. Upon confirmation of the haul route, and prior to construction, a proposed condition survey will be carried out on the preferred haul route to confirm its suitability. Improvements and road/bridge strengthening requirements will be identified as part of the condition survey. A continuing pavement condition monitoring programme will be put in place for the duration of the construction phases so that mitigation measures can be implemented not only after but during the construction program. Further details relating to the management of general construction traffic and the transportation of abnormal loads are provided in the 'Outline Transport Management Plan', a copy of which was submitted as part of the planning application and further copies were submitted directly to An Bord Pleanála at the Oral Hearing.

14.2.1 Methodology

Options for the proposed transport route of wind turbine components for the construction of the Oweninny Wind Farm in Co. Mayo were assessed. Three possible options have been identified which are feasible for turbine delivery to Oweninny. The preferred option will be finalised when the full wind turbine procurement process is complete and the selected turbine size is known.

As the turbine selection is subject to a competitive procurement process the following criteria have been assumed for the assessment:

- Blade length 56m
- Tower Section maximum length 33m and maximum diameter 4.2m
- Min road width 4.5m
- Use of transport vehicles currently available in the UK or Ireland

The assessment comprised mainly a desktop study and drive over survey using the following sources:

- Ordnance survey maps,
- Aerial photography,
- Google Maps and Google Street-view
- Previous experience of ESBI and Bord na Móna with wind development projects.

Some initial field surveys at Swinford and Crossmolina were also undertaken to assess potential pinch points along the identified haul route options.

The assessment does not address finite detail such as structural surveys of bridges, road design, road structural assessment or bridge design, land take requirements associated with engineering design, or integrity of existing public roads including the width of existing roads or swept path analysis of potential pinch points.

It has been assumed that the four main ports, Dublin, Cork, Foynes and Killybegs all have the required deep water facilities for unloading the size of component proposed. For the above ports it has been assumed that there would be no difficulty encountered with the temporary off-loading and storage for turbine blades up to 56m in length. Alternative ports such as Galway, Sligo and Moneypoint were also investigated but were determined to be unviable or to offer no identifiable advantage over any of the preferred main ports listed above.

The assessment uses the standard motorway bridge clearance in Ireland which is 5.1m. The assessment also assumes that the standard ramp accesses to and from Motorway junctions are passable for blade delivery, and that standard National Route Roundabouts are also passable with the removal and replacement of elements of street furniture.

14.2.2 Alternatives reviewed

As part of the overall assessment the possibility of using rail freight transport was investigated as an option. Irish Rail operate a freight service from Dublin Port to Ballina but a height restriction of 9’ 6” (2.9m) on all their bridges ruled this option unviable.

The road infrastructure through the towns of Castlebar and Westport and the route approaching the site using the N59 from Westport or the R112 from Castlebar were examined at a high level and are also deemed unviable due to the amount of buildings that impact on the route and the amount of road widening and land take that would be required. The cost and the physical number of landowner agreements that would need to be negotiated for either of these options was considered reason enough to discount them from further investigation at this time.

The route from Foynes Port was deemed not to have any significant advantages over Dublin Port or Killybegs and would involve passing through either the Limerick Tunnel at 4.65m high (similar to Dublin Port Tunnel) or along the quays with the towns of Clarinbridge, Claregalway and Tuam to be negotiated before merging with the same route as proposed from Dublin and Killybegs on the N5 near Charlestown.

The option of using Cork Port was also deemed not to have significant advantages over the alternative ports with both potential route options from Cork using the Jack Lynch Tunnel of 4.6m height and merging with the route from Dublin Port at the M50 and was therefore not examined in detail.

14.2.3 Potential haul route options

Based on the initial assessment, three possible route options were identified (see

Table ***14.1***).

Table 14.1: Potential Turbine Component Haul Routes

Haul Route	Route Map
Route1. Delivery of components to Dublin Port with delivery by road via the M50/N4/M4 out of Dublin City towards Longford Town. The route continues onto the N5 passing through Strokestown and Ballaghadereen where it continues towards Charlestown and turning onto the N26 towards Swinford and Foxford. The route continues on the N26 turning onto the N59 at Ballina and onwards towards Crossmolina and the Windfarm site entrance at Bellacorick.	
Route 2: Delivery of components to the port of Killybegs and by road on the N56 towards Donegal Town, turning onto the N15 south towards Sligo Town bypassing Ballyshannon, Bundoran and Sligo Town. The route turns westwards south of Sligo Town onto the N17 where it passes through Tubbercurry and continues on the N17 towards Charlestown turning onto the N5 where the delivery would continue as per the route from Dublin Port (Route 1).	
Route 3: The third potential route involves delivery to the port of Killybegs and by road on the N56 towards Donegal Town, turning onto the N15 south towards Sligo Town bypassing Ballyshannon, Bundoran and Sligo Town. The route then turns westwards south of Sligo Town onto the N59 through Ballisodare and continues towards Ballina where the delivery would turn over Ham bridge on the River Moy, continue through the town in a contraflow direction and onwards through Crossmolina and towards the Windfarm site entrance at Bellacorick.	

14.2.4 Assessment of Potential Routes

The initial assessment identifies three route options that are feasible as haul routes, from port facilities capable of handling turbine components to the Oweninny wind farm site, subject to some additional study and modification.

Of these, Haul Route No. 2 is initially assessed as the most viable and cost effective option for component delivery and this route will be confirmed for its full potential once the final turbine blade length is known. This route originates at Killybegs and proceeds via the N56 towards Donegal Town, turning onto the N15 south towards Sligo Town (a distance of 64km and bypassing Ballyshannon, Bundoran and Sligo Town itself) where it joins the N4. It follows the N4 for 12km and joins the N17 south of Colloney for a distance of 36km passing through Tubbercurry and Charletown. It subsequently joins the N5 and then the N26 after 10km and continues on the N26 for 30km passing through Swinford and Foxford. It joins the N59 in Ballina and continues westwards for 29km to the Oweninny site access.

This assessment is based on the maximum turbine blade length of 56 metres, however, the actual blade lengths will not be known until a turbine supplier is selected through competitive tendering and could vary between 45 metres and 56 metres.

Detailed confirmatory haul route assessment can only be completed once the turbine supplier and the turbine dimensions are finalised. The landing port, detailed confirmatory haul route assessment and any modification requirements will be determined by the wind turbine supplier following contracting. The proposed haul route and any modifications required will be agreed with the relevant local authorities along the route.

14.3 TRAFFIC AND TRANSPORT ASSESSMENT

14.3.1 Methodology

An initial review of the broad potential traffic impacts was conducted to estimate the study scope. This review or scoping study was informed by the detailed evaluation undertaken by Mayo County Council and An Bord Pleanála in determining the traffic impacts arising from the earlier planning application and appeal which culminated in the 2003 permission for a similar wind farm development consisting of 180-turbines (An Bord Pleanála Case No. PL16.131260). The purpose of the scoping study was to determine the data to be collected, the study area and the appropriate traffic appraisal methodology to be employed. The Traffic and Transport assessment was undertaken following further pre-planning consultation with Mayo County Council Road Department and reference to the following documents:

- The Chartered Institution of Highways and Transportation (CIHT) Guidelines for Traffic Impact Assessment (January 1999);
- National Roads Authority (NRA) Traffic and Transport Assessment Guidelines (September 2007);
- The Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Assessment of Road Traffic (1993);
- NRA Design Manual for Roads and Bridges (DMRB) (January 2009); and

- The NRA Project Appraisal Guidelines Unit 5.5 Link-Based Traffic Growth Forecasting.

Existing traffic flows were established from classified traffic counts which were undertaken at two locations on the N59 national secondary road in June/July 2012 by National Data Collection consultants. The equipment used was a metrocount MC5600 ATC. As is part of the standard short term traffic survey data validation process, long term traffic data was also obtained from the NRA permanent traffic counter on the N59 located 6km outside Mulranny.

14.3.2 Receiving Environment

The principle road in the proposed development area is the N59 Ballina to Bangor national secondary road. The N59 National Secondary Road runs east to west immediately south of the proposed wind farm site. The N59 links Ballina to Westport via Crossmolina, Bangor Erris, Mulranny, and Newport. It also provides access to Belmullet The N59 is typically 6.0 metres wide with edge of carriageway and centreline markings the road surface is in good condition.

Figure 14-1 highlights the immediate receiving road network. Assigned local roads numbers have been provided by Mayo County Council. The L52926 provides access from the N59 to houses and farmland located in the Tawnaghmore area. The L52925, commonly known as the Srahnakilly road runs north from the N59 through the central areas of the site effectively dividing the site in two. The L5292 runs north from the N59 to the Shanvolahan area.

The R312 Regional Road runs northwest southwest linking the R311 from Castlebar to Bellacorick.

The R315 Regional Road runs north-south approximately 2.3km east of the proposed wind farm site. The R315 is a rural intertown route which links Crossmolina to the south with the R314 Regional Road to the north. The R315 intersects the N59 at Crossmolina.

14.3.3 Traffic Volumes

14.3.3.1 Traffic Counts

Traffic surveys using ATC's (Automatic Traffic Counters) were undertaken by Nationwide Data Collection (NDC) at the following locations agreed with Mayo County Council road section as part of the initial assessment scoping study:

- N59 - approximately 450 metres north of the R312 junction with the N59
- N59 - approximately 1.1km west of Srahnakilla

Traffic survey locations can be seen in Figure 14-2. A summary of the count results is presented in Table 14-2.

Table 14-2: Summary of ATC Results June/July 2012*

Site	Count Location	Count date	Direction	5 day average	7 day average	HGV 5 Day Average %	HGV 7 Day Average %	85%ile Speed km/h

Site	Count Location	Count date	Direction	5 day average	7 day average	HGV 5 Day Average %	HGV 7 Day Average %	85%ile Speed km/h
1	450 metres northeast of the R312	26th June to 10th July	Eastbound	796	748	-	-	-
			Westbound	813	752	-	-	-
			Dual	1609	1500	20	17	84.6
2	N59 1.1km west of Shranakilla Rd	27th June to 11th July	Eastbound	1123	1089	-	-	-
			Westbound	1164	1111	-	-	-
			Dual	2287	2200	25	22	105.5

**National Data Collection*

The traffic count data indicates that passenger cars generally make up about 83% of traffic on the N59, with 0.25% being short vehicles (bicycle or motor bike) and 1.6% short towing vehicles (car and trailer). Small trucks and buses made up about 9.5% of the vehicles with the remainder 7% being heavy goods vehicles. The NRA also acknowledges that significant seasonal fluctuations in traffic movements can occur particularly on national secondary roads in counties with high tourism levels such as Mayo. Count data indicates an almost equal flow of traffic in either direction at both locations. The difference in total traffic counts between the western count location and the eastern count location is attributable to traffic using the R312 regional road. Traffic counts were also undertaken on the N59 approximately 160m north of the R312 junction with the N59 as part of the proposed Cluddaun wind farm development. Traffic flows recorded in the Cluddaun counts are provided in Table 14-3. The Cluddaun counts show a similar traffic flow to those site specific flows recorded by NDC at the Oweninny count location and are considered to confirm or somewhat validate the base data as representative of typical traffic flows.

Table 14-3: Summary of ATC Results July 2012 (Cluddaun)

Site	Count Location	Count date	Direction	5 day average	7 day average	HGV 5 Day Average %	HGV 7 Day Average %	85%ile Speed km/h
1	160 metres north of the R312	20th July to 27th July	Eastbound	791	777	-	-	-

Site	Count Location	Count date	Direction	5 day average	7 day average	HGV 5 Day Average %	HGV 7 Day Average %	85%ile Speed km/h
			Westbound	808	778	-	-	-
			Dual	1599	1555	20	17	84.6

Form the recoded traffic flows Friday represented the busiest day of the week with a recorded volume of 1,698 two-way vehicles. The average weekday (Monday to Friday) traffic volumes were of the order of 1,609 two-way vehicles. The recorded weekday peak hour occurred from 5:00 to 6:00 p.m. on Friday with a peak volume of 169 two-way vehicles. During the period Monday to Friday the speed limit on the N59 at the Oweninny location was exceeded by 5 km/hour by 0.4% of traffic and by 10 km per hour by 0.1% of traffic.

14.3.3.2 Annual Average Daily Traffic (AADT) Counter Mulranny

AADT refers to average 24-hour two way traffic flows per day (vehicles). Existing Annual Average Daily Traffic (AADT) volumes were estimated for the N59 in the vicinity of the proposed development site, on the basis of recorded traffic flows, and the nearest National Roads Authority's (NRA) permanent traffic counter data at Mulranny.

Annual Average Daily Traffic (AADT) counts are available from the NRA. The nearest permanent NRA traffic counter "Mulranny N59-6" is located on the N59, approximately 6kms east of Mulranny.

A summary of the recorded peak weekday volumes, peak weekend volumes, average weekday volumes and the estimated AADT volumes, for 2012 on the N59 is detailed in Table 14-4 below[150]. HGVs account for 4.0 % of the AADT volumes on the N59

It has been assumed that the traffic along the N59 adjacent to the proposed development site has similar expansion factors to the traffic measured at the NRA permanent traffic counter on the N59. The recorded traffic volumes were expanded to represent AADT volumes at the Oweninny site accordingly. On the basis of the recorded traffic flows and using the expansion factor applied as per the NRA permanent traffic counter, AADT for the N59 at this location is estimated to be of the order of 1,181 two-way vehicles with

[150] http://nraextra.nra.ie/CurrentTrafficCounterData/html/N59-6.htm

HGV's accounting for 4.0 percent.

Table 14-4. Existing Mulranny (2012) Two Way Traffic Volumes Summary

Day of week	Peak Daily Traffic Flows (HGV)	Average Daily Traffic Flows (HGV)
Monday	4,105 (158)	2,734 (122)
Tuesday	3,658 (137)	2,761 (99)
Wednesday	4,051 (154)	2,880 (113)
Thursday	4,106 (153)	2,915 (116)
Friday	4,617 (140)	3,230 (97)
Saturday	4,772 (95)	2,999 (65)
Sunday	4,326 (71)	2,853 (29)

Note Table 14-4 provides average and peak daily two-way traffic flows recorded at the NRA counter site for the period January to July 2012 inclusive.

Figures in brackets refer to HGV numbers. Heavy commercial vehicles are taken to include trucks, articulated vehicles, buses, agricultural vehicles and miscellaneous goods vehicles

The peak recorded daily traffic occurs on a Friday with peak weekend traffic on a Sunday.

The NRA provides an estimated AADT for Mulranny as 2,851 with HGV comprising 3.2% of this total, that is 91HGV per day.

14.3.4 Project Appraisal Guidelines (AADT Estimation)

The corridor upon which development generated traffic will have the greatest impact is the N59. NRA Project Management Guidelines Unit 16.2 Expansion Factors for Short Period Traffic Counts (August 2012) can be used to derive a value for AADT from the ATC traffic surveys undertaken near the site access. Using the NRA published traffic flow profiles provided in Unit 16.2 the Monthly Flow Index of Unit 16.2 Annex C for February is 0.94 accordingly the estimated AADT on the N59 to the west of the site access is 2,200x0.94 = 2,068 whilst the AADT to the east of the site access is estimated to be in the order of 1,410 vehicles.

14.3.5 Existing Road Capacity

An assessment of the existing flow capacity on the proposed haulage route, the N59 national secondary road, was undertaken. The estimated capacity was obtained using the NRA's Design Manual for Roads and Bridges document Road Link Design TD 9/12 (2012). Estimated capacities for rural road layouts are provided in Table 6/1 of Recommended Rural Road Layouts of the Design Manual. The Manual provides estimated capacities for a number of different rural road types, as an approximation of Level of Service D. The level of traffic representing the practical capacity of a road link is routinely taken to be Level of Service D. At this level significant impact on traffic flow will occur.

The smallest road type provided by the Manual is the reduced single (7.0m) carriageway S2 which gives an estimated capacity of 8,600 AADT. The typical carriageway width of the N59 is approximately 6.0m and a correction to the 7.0m estimated AADT is required to reflect this.

To establish the correction factor the NRA's publication RT. 180 Geometric Design Guidelines (1986) was used. Two-way link capacities for Level of Service D represented in passenger car units (pcu's) are provided in Table C4.2 (b) Design Capacities for Undivided Rural Roads of the NRA document. For the 7.0m wide and 6.0m wide road the following passenger car units are provided

- 7.0m – 1,500 pcu's/ hour; and
- 6.0m – 1,250 pcu's/ hour.

The calculated ratio between the 7.0m carriageway and the 6.0m carriageway road width is 0.833. Applying this ratio to the N59 the estimated AADT capacity is 7,163 AADT.

To allow for pinch points on the rural route a further reduction of 20% of the estimated capacity has been applied. Hence the AADT capacity of the N59 is estimated at 5,731.

The percentage link capacity on the N59 has been estimated using the reduced capacity estimations and the recorded AADT volumes. Table 14-5 outlines the estimated two-way link capacities for the N59.

Table 14-5. Estimated Available Capacity on the N59

Road Link	Estimated Capacity (AADT)	Estimated Existing Demand (AADT)	Available Capacity
N59 (East of Site)	5,731	1,410	75%
N59 (West of Site)	5,731	2,068	64%

The N59 rural secondary road operates well within the capacity of the Level of Service D.

14.3.6 Public Transport

Bus operators provide a service from Blacksod to Ballina, via Crossmolina on a regular basis. Bellacorick is one of the stops on this service.

14.3.7 Accident Record

The Road Safety Authority's collision data[151] shows a number of minor collisions and a few serious collisions along the N59 route from Crossmolina to Bangor between 2005 and 2009. The Road Safety Authority online Collstats database has been consulted for the period currently available (2005 to 2011 inclusive) and indicates that a single vehicle collision resulting in minor injury was recorded on a Sunday evening in 2011, in Bellacorick village. The collision was not in the vicinity of any of the proposed site accesses. Other collisions recorded were at least 3.5 km from the proposed site entrances. This data is summarised in Table 14-6.

Table 14-6: Summary Results for Fatal and Injury Collisions

Road	Year	Type of Injury Sustained			Total
		Fatal	Serious	Minor	
N59	2005	0	1	1	
Crossmolina to Bangor	2006	0	0	1	
	2007	0	0	1	
	2008	0	1	3	15
	2009	0	0	3	
	2010	0	0	4	
	2011	0	0	2	

14.3.8 Proposed Site Access

Three existing site entrances are proposed as access locations to the Oweninny Wind Farm site as follows:

- Access Point 1 - the existing entrance to the Bord na Móna Bellacorick wind farm located approximately 260 metres east from the junction with the R312. This access will be utilised mainly during Phase 1 of the construction and also for Phase 2.
- Access Point 2 - the existing entrance to the Bord na Móna lands located approximately 1.4 kilometres west of the local road (LR002) to Srahnakilly.

[151] Road Safety Authority, Road Collision Facts Ireland 2009, December 2010

This access point will be used mainly during Phase 2 of the wind farm construction.

- Access Point 3 - the existing entrance to the Bord na Móna Workshops located 1.5 km east of the junction with the R312. This access is available but it is not at present programmed to be used in the construction of Phase 1 or Phase 2.

The locations of the access points are shown on Figure 14-3.

14.3.8.1 Site Access Road Safety Audit

A Stage 1/2 Road Safety Audit at the three proposed site entrances was prepared for Oweninny Power Ltd, see Appendix 12, by Traffic Transport and Road Safety Associates Ltd. in accordance with the requirements of National Roads Authority (NRA) Design Manual for Roads and Bridges Volume 5 Section 2 Part 2 - NRA HD 19/12 Road Safety Audit. A site visit was undertaken on 29th April 2013. During the site visit the weather was dry and the road surface was dry.

The characteristics of the N59 at the location of site accesses include:

- At Site Entrance No. 1, the surfaced carriageway is 7.7m in width, demarcated as a 3.4m wide westbound lane and 3.6m wide eastbound lane. The existing junction bell mouth is 24.5m in width at the stopline. The existing visibility splay to the west is in excess of 215m, as is eastbound forward visibility to the access. The existing visibility splay to the east is 180m, as is westbound forward visibility. Increasing the visibility splay to the east and westbound forward visibility, to 215m, is achievable
- At Site Entrance No. 2, the surfaced carriageway is 6.3m in width, demarcated as two 2.85m wide lanes. The existing junction bell mouth is 45m in width at the stopline. The existing visibility splay to the west is approximately 90m, as is eastbound forward visibility to the access. The existing visibility splay to the east is in excess of 215m, as is westbound forward visibility. Increasing the visibility splay to the west and eastbound forward visibility, to 215m, is achievable.
- At Site Entrance No. 3, the surfaced carriageway is 6.9m in width, demarcated as a 3.0m wide westbound lane and 3.2m wide eastbound lane. The existing junction bell mouth is 36.5m in width at the stopline. The existing visibility splay to the west is approximately 90m, with eastbound forward visibility to the access being approximately 100m. The existing visibility splay to the east is approximately 134m, whilst westbound forward visibility is in excess of 215m. Increasing the visibility splay to the west and eastbound forward visibility, to 215m, is achievable;
- At all of the locations the carriageway is marked with a solid centreline and dashed edge-lining, both with retro-reflective road studs. The verges are soft and surface water drainage is limited to grips aligning the carriageway;
- Chevron signing is present in the immediate vicinity of site entrances 1 and 3;
- The posted speed limit for this section of the N59 is 100 kph; and,
- There is no street lighting.

The audit focused on the upgrading of three existing site accesses off the N59 national road, to form entrances for the construction of the Oweninny Wind Farm Development at Bellacorick, Co. Mayo. Abnormal loads are assumed to travel from east to west along the N59 to the site with a blade length of 56m and a maximum tower section length 33m.

The audit, in summary, recommended the following:

- Provide full clear visibility splays for all site entrances through land gradient re-profiling and vegetation clearance
- Relocate existing highway warning sign (with the approval of the highway authority)
- Ensure site entrance designed and constructed for the loading and swept path for all types of vehicles accessing the site, taking full account of the tie-in with the existing edge of the N59 carriageway and surface water drainage within the design and construction.
- Ensure sufficient gradient or dwell area to permit the safe access to or egress
- At site entrance number 1 the dual use of this proposed site entrance for site construction and public access to a visitor centre should be taken into full account within the design. The junction bellmouth of the site entrance should be reduced in width with a stop control priority junction markings and signage when open for public access, but for example incorporating removable fencing or bollards upon completion of the site construction in order to retain access for large/long vehicles as wind farm maintenance is required.
- Advance highway or local signs indicating the junction to the visitor centre should be provided with the approval of the highway authority and should not be positioned within the visibility splays of this entrance.
- Site Entrance No. 1 should accommodate two-way traffic,
- Ensure repairs to existing N59 carriageway to allow appropriate tie in of site roads.

The recommendations of the audit have been incorporated into the design drawings for the proposed access locations.

14.3.9 Trip Generation and Distribution

14.3.9.1 Construction Phase

The wind farm project will be constructed in phases as indicated in Chapter 2. Phase 1 is likely to commence in 2015 with completion at the end 2016 or early 2017. Phase 2 will commence in 2016 and will be completed in 2018. A preliminary assessment of the construction traffic generation has been conducted based on the current construction plan, experience of similar schemes and first engineering principles. It is acknowledged that the timescales for the commencement of construction have slipped from the initial estimate of 2015. It can nevertheless be appreciated from yearly records of flows along the N59 that the delay of perhaps one year is highly unlikely to result in significant increases in the base N59 traffic flows and thus a delay of one year is accordingly highly likely to have a negligible impact upon the results of the capacity analyses provided in this assessment of the proposed wind farm development. Typically traffic assessments are based upon 'robust' figures in order to account for many parameters including such typical variation in base traffic flow figures as might arise due to unforeseen delays in the planning process. Despite this assertion the traffic capacity assessments provided in the original EIS have been revised to take into account a 2 year slippage in the construction timetable (Construction assumed to commence in 2017).. For this study, extreme worst case conditions have been based on the following assumptions:

- Individual deliveries of abnormal loads comprising wind turbine tower components (five per tower), nacelles (one per turbine), turbine blades (three per turbine), turbine transformers and substation transformers (two per substation) via the N59 to the site;
- Import of fill material (rock and gravel fill) from external quarry sources via the N59. A conservative estimate of 10 m3 per delivery vehicle has been used to estimate the vehicle movements; articulated HGV have a greater capacity and would be likely to be used on large scale projects.
- Import of all concrete material to the site via the N59. Concrete is assumed to be required for both turbine piling and turbine foundation construction. A conservative estimate of 8 m3 per concrete delivery vehicle has been used to estimate the vehicle movements; articulated concrete wagons have a greater capacity (10m3) and would be likely to be used on large scale projects.
- Import of all reinforcing steel bar to the site;
- Miscellaneous construction traffic is assumed to equate to 10% of the total vehicle movements;
- The duration of Phase 1 is estimated at 24 months and is likely to comprise construction of approximately thirty (30) wind turbines and associated crane stands, one substation, three meteorological masts, the Visitor Centre, the O&M building, the overhead line and approximately 26km of access tracks.
- The duration of Phase 2 is estimated to be 24 months and is likely to comprise construction of approximately thirty one (31) wind turbines and associated crane stands, one substation, three meteorological masts, the overhead line and approximately 20km of access tracks;
- Maximum of 150 construction workers on site at any one time;

- A 10% overall contingency has been included in traffic numbers

Based on the above assumptions the projected traffic movements for each phase are provided in Table 14-7 – Table 14-9

Table 14-7: Phase 1 - Forecast Traffic Movements

Type	Vehicle numbers	Contingency +10%	Predicted Vehicle Movements
Fill (10m^3 per veh.)	19,615	21,557	43,154
Concrete (8m^3 per veh.)	4,153	4,568	9,136
Rebar	151	166	331
Miscellaneous	2,561	2817	5,634
Abnormal Loads	373	-	746
Total	26,853	29,411	59,001

Table 14-8: Phase 2 - Forecast Traffic Movements

Type	Vehicle numbers	Contingency +10%	Predicted Vehicle Movements
Fill (10m^3 per veh.)	20,617	22,679	45,358
Concrete (8m^3 per veh.)	3,773	4,150	8,300
Rebar	135	148	296
Miscellaneous	2,620	2,882	5,764
Abnormal Loads	385	-	770
Total	27,437	30,151	60,488

14.4 IMPACT OF THE DEVELOPMENT

The Institute of Environmental Management and Assessment's (IEMA) Guidelines for the Environmental Assessment of Road Traffic (1993) recommends that assessments should consider the period at which the impact is greatest and the period at which the impacts exhibit the greatest change.

Subject to planning permission, it is envisaged that:

Phase 1 construction work on site would commence in 2017 with a 24 month construction period. Phase 1 would become operational in 2018.

Phase 2 construction work on site would commence in 2016 2018 a 24 month construction period. Phase 2 would become operational in 2020

In the original EIS it was assumed likely that peak construction of the Cluddaun and Corvoderry Wind will coincide with peak construction of the proposed Oweninny Wind Farm in 2018, as a cumulative worst case scenario. This assumption was based upon developments that were in the planning stages being granted permission however this is not the case since the Cluddaun development was refused planning permission by An Bord Pleanála.

14.4.1 Future Background Traffic Flows

Future traffic volumes have been estimated based on predictions outlined in the NRA publications Project Appraisal Guidelines (PAG) Unit 5.3: Traffic Forecasting, and PAG Unit 5.5: Link-Based Traffic Growth Forecasting (January 2011). These have been predicted on the basis of a medium growth scenario.

The NRA's National Traffic Forecasts, in their Project Appraisal Guidelines Unit 5.5 (2011) envisage that passenger car traffic on National Roads will increase the factors shown in Table 14-10 in the west region of Ireland.

Table 14-10: NRA Derived Traffic Expansion Factors

Year	Expansion Factor Light Vehicles LV	Expansion Factor Heavy Goods Vehicles HGV
2013	1.012	1.007
2014	1.024	1.014
2015	1.036	1.021
2016	1.049	1.028
2017	1.061	1.035
2018	1.074	1.043
2019	1.087	1.050
2020	1.100	1.057
2021	1.113	1.065
2022	1.127	1.072
2023	1.140	1.135
2024	1.154	1.148

These factors were used to predict the 2012 to 2022 forecast year background traffic volumes and remaining capacity on the N59 both east and west of the R312 junction located along the southern site boundary, see Table 14.2 below.

Table 14.2: Forecast N59 Future Year AADT

Year	Predicted AADT		Reserve Capacity%	
	West	East	West	East
2012	2068	1410	64%	75%
2013	2092	1427	63%	75%
2014	2118	1444	63%	75%
2015	2143	1461	63%	75%
2016	2169	1479	62%	74%
2017	2195	1496	62%	74%
2018	2221	1514	61%	74%
2019	2248	1532	61%	73%
2020	2275	1551	60%	73%
2021	2302	1569	60%	73%
2022	2330	1588	59%	72%
2023	2357	1607	59%	72%
2024	2386	1627	58%	72%

14.4.2 Project Construction

Traffic associated with the construction phase essentially comprises five types, as follows:

14.4.2.1 Miscellaneous Construction Vehicles

The vehicles requiring access during the civil engineering and earthworks phase will include tracked excavators, dump trucks, fixed or articulated haulage trucks and mobile cranes. Commercial traffic movements are likely to be spread throughout the working day and there will be a small increase in private car movements at the beginning and end of the day as the workforce arrives at and departs from the site. A total of 100 miscellaneous vehicles have been assumed for a project of this size. The forecast is considered robust on account of the fact that once much of the plant is brought to the site it will remain there for the duration of the works. It is unlikely that plant will be hauled to and from the site with any great regularity and certainly not on a daily basis.

14.4.2.2 Concrete Foundations and Piles

The major requirement for ready mixed concrete will be for construction of the turbine bases, foundation piling, fencing bases, transformer bases and bunds at the Electrical Substation and for the Control Building within it, for the O&M building foundation and flooring, for the Visitor Centre foundation and flooring and for the meteorological mast foundations.

In the extreme worst case scenario all concrete required will be imported to the site from external suppliers. Concrete deliveries will be determined by potential journey time to the site from an external concrete supplier, vehicle turnaround time and production capacity of the concrete supplier. From experience on other wind farm construction sites it is expected that 6 to 8 concrete vehicles per hour would be the maximum number of deliveries associated with any single turbine foundation construction that would be practical from a construction aspect. This would equate to an additional 16 HGV movements associated with concrete deliveries on the N59 per hour. Foundation concrete pours must be completed in one day to ensure structural integrity of the concrete, hence on such days the duration of increased traffic movements would extend from between 10 – 14 hours. Increased traffic movements associated with foundation concrete pouring would occur for a total of:

- 30 days in phase 1 (24 month construction period – 15 days per year),
- 31 days in phase 2 (24month construction period – 15.5 days per year) and

It has been assumed as a worst case that concrete piles will be required for each wind turbine. Approximately 30 concrete piles up to 17m in depth will be required to support a wind turbine foundation requiring two HGV concrete deliveries per pile. Again experience indicates that a maximum of 6 HGV concrete deliveries per hour would be the practical limit for such construction. This would equate to an additional 12 HGV movements on the N59 per hour. A maximum of 10 concrete piles per day can be installed requiring 20 concrete deliveries over the working day and three days to complete piling operations. Increased traffic movements associated with concrete pile pouring would occur for a total of:

- 90 days in Phase 1 (24 month construction period – 45 days per year),
- 93 days in Phase 2 (24month construction period – 46.5 days per year)

Concrete piles will be allowed to cure for a period of up to 35 days before turbine foundation formwork and foundation base pour occurs. The foundation base will be allowed to cure for a period of between 45 and 55 days before the turbine plinth is poured and turbine components erected.

Should piling construction and turbine foundation base pour occur on the same day it would result in additional 28 HGV movements per hour but over a lesser number of days in each phase. It should be noted nonetheless that the turbine foundation bases need to be poured must be completed in a single day by continuous pour. Given the importance of the continuous pour it is ordinarily the case that no other works requiring readymix concrete are undertaken at the same time as this reserves concrete plant capacity for the critical activity.

As set out in Section 14.5.3.2 the proposed development includes for a concrete batching plant. The original EIS traffic assessment nonetheless assumes that all concrete will be transported to the site from external plants and thus the original EIS ignores the reduction in HGV traffic flows that would result from the batching plant at the site. Whilst a batching plant on the site would generate vehicles associated with the import of the concrete constituents, given the sourcing of water on site clearly the batching plant has the potential to significantly reduce traffic impact. The transportation of materials to feed the on-site plant can be spread out and the materials stockpiled. Thus the primary advantage of the on-site batching plant would be to reduce the relatively concentrated demand for the import of concrete during the pouring of turbine base foundations.

14.4.2.3 Track Construction & Turbine Hardstands

Crushed stone fill material will be required for construction of access tracks and crane hard stands. As a worst case scenario it is envisaged that all fill required will be imported from external licensed quarries to the site for access track and crane stand construction. Additionally all the fill is assumed to be imported from either the western or eastern road direction but not from both. The rate of import of fill material will be dependent on distance from the quarry source to the site, vehicle turnaround time, quarry production capacity and access track development. Initially, fill utilisation will be low as a single access track is developed, however, this will increase when branch points occur on the track allowing more than one active working face. Based on previous experience in wind farm construction it is envisaged that a maximum of 8 HGV per hour is a practical limit on the N59 for a given direction. This would result in an additional 16 HGV movements per hour on the N59. Based on a 10 hour working day this would equate to the following predicted number of days of increased traffic movements associated with fill material:

- 269 days in Phase 1 (24 month construction period),
- 285 days in Phase 2 (24month construction period) and

In reality access track and crane stands will be constructed on a continuous basis over a period of 14 months for Phase 1 and 16 months for Phase 2.

Section 14.5.3.1 relates to the proposed extraction of aggregates and estimates that the proposed on-site borrow pit has the potential to yield 340,000m^3 of suitable materials for the construction of access tracks and hardstanding areas for cranes. Based upon the estimated yield figure the borrow pit has the potential to reduce the number of vehicles importing aggregates by approximately 46% which equates to some 88 HGV traffic movements per day.

14.4.2.4 Abnormal Loads

It is expected that delivery of each turbine will involve about 10 loads using articulated haulage trucks. Deliveries will comprise towers (5), blades (3), nacelle (1), hub (2), transformer (1) and small parts. Typical composition of the significant components for a potential turbine at Oweninny is presented in Table 14.3.

A typical delivery of wind turbine tower components is shown in Figure 14-4.

The total number of abnormal loads was calculated on the basis of the installation of 112 turbines. Abnormal loads include turbine tower components, turbine blades, nacelle, turbine transformers, cranes and ballast and substation transformers. The estimated number of abnormal loads for each phase is predicted to be as follows:

- Phase 1 - 373 (38 days)
- Phase 2 – 385 (39 days)

Experience indicates that 10 abnormal loads per day would be expected for each wind turbine delivery.

Table 14.3: Typical Wind Turbine Components*

Component	Weight (t)	Dimension (m)
1st Section (Base tower)	73	12.96 x 4.28
2nd Section	70	19.3 x 3.94 diameter
3rd section	72.5	25.5 x 3.93 diameter
4th Section	58	28.8 x 3.9 2
5th section (Top section)	42	23.2 m x 2.7m diameter
Nacelle	60-80 t	30 m x 3.66 m
Blades (3)	10 t	56 m x 3.5 m at Root

**Based on a Vestas V112/3000 kW turbine - Data courtesy of Vestas*

14.4.2.5 Electrical Equipment & Building Materials

Miscellaneous building materials will be required for the construction of the four substations, O&M building and Visitor Centre notably blockwork, shuttering, glass, timber and other typical building construction materials

Miscellaneous electrical equipment such as transformers and switchgear will be needed in the substation and electrical cabling will be required for the underground connection of individual turbines to the substation.

Deliveries of miscellaneous other items will also arise and a total of about 500 additional deliveries is assumed.

14.4.2.6 Cranes

It will be a matter for the contractor, selected on the basis of open competitive tendering, to determine the number and type of cranes that will be employed on the site for turbine erection. However, based on experience in the construction of other wind farms, it is envisaged that a heavy lifting capacity (approximately 1,200t) main crane and a smaller capacity (approximately 350t) crane will work in tandem. It is likely that two smaller cranes will be engaged in assembly of the heavy lifting capacity main crane. The cranes are also likely to stay on site during each phase until wind farm turbine erection is completed.

14.4.2.7 Worst Case Traffic Scenarios

An 'Extreme' Worst Case traffic scenario would arise during construction of the wind farm if simultaneous construction of turbine piles, foundations, access tracks and crane stands were to occur on the same day. This is Scenario A and is a highly unlikely construction programming scenario since concrete piling and foundation pours are typically exclusive activities. Scenario A is provided in order to show an extreme scenario which although unlikely is nonetheless possible.

Construction traffic movement scenarios are also presented in Table 14.4 for days when concrete piling only, fill import and turbine component delivery coincide and also where no concrete delivery occurs, i.e. piling and foundations pours have been completed. It should be noted that a vehicle movement is either a movement of a vehicle into the site or a movement from the site, a vehicle servicing the site with building materials will accordingly undertake two separate movements which constitute a vehicle 'trip'.

Table 14.4: Forecast Traffic Generation Scenarios - All Vehicle Movements

Construction Activity	Approximate Two-way Vehicle Movements				
		Scenario A	Scenario B	Scenario C	Scenario D
	HGV Trips Per Hour	Extreme Worst Case Coincident Concrete Works	Forecast Upper Value No Concrete Piling	Forecast Middle Value No Foundation Pour	Forecast Lower Value No Concrete Works
Miscellaneous		200	200	200	200
Concrete Piling	6	144	-	144	-

Construction Activity	Approximate Two-way Vehicle Movements				
		Scenario A	Scenario B	Scenario C	Scenario D
	HGV Trips Per Hour	Extreme Worst Case Coincident Concrete Works	Forecast Upper Value No Concrete Piling	Forecast Middle Value No Foundation Pour	Forecast Lower Value No Concrete Works
Concrete Foundation Pour	8	192	192	-	-
Access Track and Crane Stand	8	192	192	192	192
Abnormal Load		10	10	10	10
Total Daily Movements		**738**	**594**	**546**	**402**
Hourly HGV Movements		22 In / 22 Out	17 In / 17 Out	15 In / 15 Out	9 In / 9 Out

It is envisaged that the Visitor Centre will be open to the public post construction of Phase 1 of the development in 2018 adding an estimated 126 additional vehicle movements per day at peak tourist season to the totals in Table 14.4, (see Section 14.4 below).

The above Table 14.4 represents extremely robust scenarios which in practice is not likely to occur. The extreme scenario assumes no concrete will be produced on site, assumes that no aggregates will be won from the proposed borrow pit and assumes coincident piling and foundation concrete pours which is not typically done as foundation is one continuous pour and other concrete activities may compromise concrete supply. The following series of tables show the HGV traffic generation of the site under less extreme scenarios which are nonetheless still robust.

Table 14.5: Peak Daily HGV Traffic Generation Scenarios (No Borrow Pit – No Concrete Batching Plant)

Construction Activity	Approximate Two-way Vehicle Movements			
	Scenario A	Scenario B	Scenario C	Scenario D

	HGV Trips Per Hour	Extreme Worst Case Coincident Concrete Works	Forecast Upper Value No Concrete Piling	Forecast Middle Value No Foundation Pour	Forecast Lower Value No Concrete Works
Concrete Piling	6	144	-	144	-
Concrete Foundation Pour	8	192	192	-	-
Access Track and Crane Stand	8	192	192	192	192
Abnormal Load		10	10	10	10
Total Daily Movements		**538**	**394**	**346**	**202**
Hourly HGV Movements		22 In / 22 Out	17 In / 17 Out	15 In / 15 Out	9 In / 9 Out

Table 14.6: Peak Daily HGV Traffic Generation Scenarios (Including Borrow Pit – Not Including Concrete Batching Plant)

Construction Activity	Approximate Two-way Vehicle Movements				
		Scenario A	Scenario B	Scenario C	Scenario D
	HGV Trips Per Hour	Extreme Worst Case Coincident Concrete Works	Forecast Upper Value No Concrete Piling	Forecast Middle Value No Foundation Pour	Forecast Lower Value No Concrete Works
Concrete Piling	6	144	-	144	-
Concrete Foundation Pour	8	192	192	-	-
Access Track and Crane Stand	5	104	104	104	104
Abnormal Load		10	10	10	10
Total Daily Movements		**450**	**306**	**258**	**114**
Hourly HGV Movements		19 In / 19 Out	13 In / 13 Out	11 In / 11 Out	5 In / 5 Out

As can be appreciated from 14.4.2.2. above, those construction activities involving concrete are not the normal everyday activity at the site. On average, concrete foundation pours will occur for only 15 days of the year whilst concrete piling operations are forecast to occur on 45 days per year or less over the course of the construction phases. The typical average daily HGV traffic generation is clearly represented by Scenario D where no concrete is poured. It is standard practice in traffic assessments to use generation rates that reflect the average and also a higher value. The higher value which has been commonly used for the past 20 years is the 85th percentile. Scenario C is considered representative of the typical 85th percentile figure in this instance whilst Scenario B can be considered the 100th percentile or absolute worst case. The Chartered Institution of Highways and Transportation guidelines recommend that traffic assessments should consider the average and 85th percentile traffic generation scenarios.

As with other strategically significant developments, such as motorway construction, it is not possible prior to the award of the contract to provide definitive sources of construction materials and thus it is not possible to definitively identify haul routes to the development site.

There are suitable sources of materials located both east and west of the three site accesses. The calculations in the original EIS nonetheless include another compounding worst case factor since traffic is assumed not to distribute east/west at the site accesses and all construction traffic is assumed to arrive and depart from one direction only. Considering this factor, together with the other robust assumptions made in the original EIS evaluation (such as no contribution from the on-site borrow pit and concrete batching plant), it can be readily appreciated that the traffic generation figures used in the original EIS in relation to the capacity of the receiving road are extraordinarily robust, in fact so robust as to be infeasible.

Further in this regard, Table 14-13c below provides an estimate of the increase in all traffic arising from the forecast 85th percentile value traffic generation Scenario C set out above together with the average value traffic generation of Scenario D.

Scenario C is representative of higher that average peak traffic flows generated by the development construction and is considered to reflect a realistic approximate 85th percentile traffic generation scenario which is robust and in line with industry standard practice in the appraisal of traffic impact and traffic flows.

The figures in Table 14.7 below are based upon various potential traffic flow distribution assumptions at the site accesses. In the interest of a comprehensive evaluation the figures exclude consideration of winning any aggregates from the borrow pit for which permission has been sought and similarly exclude the traffic mitigation effects of the proposed on-site batching plant.

Table 14.7: Traffic Distribution Potential (Excluding Borrow Pit)

Traffic Scenario	N59	Original EIS Appraisal 100% West 0% East HGV	Original EIS Appraisal 100% West 0% East Car Van	70% West 30% East HGV	70% West 30% East Car Van	60% West 40% East HGV	60% West 40% East Car Van	50% West 50% East HGV	50% West 50% East Car Van
C (85th Percentile)	West	**346**[152]	**200**	242	140	208	120	173	100
	East	Nil	Nil	104	60	138	80	173	100
D (Average)	West	**202**	**200**	141	140	121	120	101	100
	East	Nil	Nil	61	60	81	80	101	100

Table 14.8 below shows the same potential trip distribution situations as Table 14.7 above but differs in that it includes for the reduction in traffic generation rates derived from the current proposal to win significant quantities of aggregate from the on-site borrow pit. The figures in Table 14.8 do not take into account the traffic benefits that will arise from the manufacture of concrete at the proposed on-site batching plant and assumes that all concrete is imported as readymix in concrete wagons of $8m^3$ capacity.

Table 14.8: Traffic Distribution Potential (Including Borrow Pit)

Traffic Scenario	N59	Original EIS Appraisal 100% West 0% East HGV	Original EIS Appraisal 100% West 0% East Car Van	70% West 30% East HGV	70% West 30% East Car Van	60% West 40% East HGV	60% West 40% East Car Van	50% West 50% East HGV	50% West 50% East Car Van
C (85th Percentile)	West	**258**	**200**	181	140	155	120	129	100
	East	Nil	Nil	77	60	103	80	129	100
D (Average)	West	**114**	**200**	80	140	68	120	57	100

[152] Total HGV traffic movement generation of proposed development (Total Number of HGV trips 346÷2=173)

Traffic Scenario	N59	Original EIS Appraisal		Distribution Scenarios					
		100% West 0% East		70% West 30% East		60% West 40% East		50% West 50% East	
		HGV	Car Van	HGV	Car Van	HGV	Car Van	HGV	Car Van
	East	Nil	Nil	34	60	46	80	57	100

It can be seen from the above upper appraisal value figures that the forecast increase in traffic on the N59 is likely to be significantly less than the 'extreme worst case' scenario originally used for the purposes of the capacity appraisal in the original EIS (which was based upon a compound series of robust assumptions). The original EIS forecast maximum traffic flow on the N59 was 538 HGV and 200 car/van movements per day. The upper value equivalent figures are 181 HGV and 140 car/van. This represents a reduction in the maximum forecast HGV traffic generation arising on the N59 in the order of 73%. The vast majority of this reduction is attributable to the use of the proposed on-site borrow pit.

85th Percentile Upper Value Assessment

In the upper value or 85th percentile appraisal Scenario C in which the benefits of sourcing a significant quantity of aggregates from the proposed borrow pit are considered (Table 14-13d), the potential peak increase in two-way HGV traffic movements on any part of the N59 based upon a 70/30 distribution is 181 HGV movements and 140 car/van movements per day. Under Scenario C where no materials whatsoever will be won in site (Table 14-13c) the potential peak two-way HGV traffic generation rate is 242 movements.

Over the course of say a 12 hour working day, the 85th percentile Scenario C where the borrow pit materials are included equates to approximately 1 No. HGV every 8 minutes to and from the west of the site (Bangor direction) and 1 No. HGV every 19 minutes to and from the east of the site (Crossmolina direction). Were the use of the borrow pit is excluded from the calculations then Scenario C equates to approximately 1 No. HGV every 6 minutes to and from the west and 1 No. HGV every 14 minutes to and from the east.

Average Value Assessment

Scenario D is representative of the typical daily traffic generation scenario at the development site. Under the Scenario D appraisal where it is assumed that aggregates will be won from the proposed borrow pit (Table 14-13d), the potential daily increase in two-way HGV traffic movements on any part of the N59 based upon a 70/30 distribution is 80 HGV movements and 140 car/van movements per day. Under Scenario C where no materials whatsoever will be won in site (Table 14-13c) the potential peak two-way HGV traffic generation rate is 141 movements.

Over the course of say a 12 hour working day, the 85th percentile Scenario C where the borrow pit materials are included equates to approximately 1 No. HGV every 18 minutes to and from the west of the site (Bangor direction) and 1 No. HGV every 40 minutes to and from the east of the site (Crossmolina direction). Were the use of the borrow pit is excluded from the calculations then Scenario C equates to approximately 1 No. HGV every 10 minutes to and from the west and 1 No. HGV every 24 minutes to and from the east.

By comparison, it can be readily appreciated that the 'extreme scenario' set out in the original EIS is extraordinarily robust and, whilst such a robust approach may demonstrate that the receiving road network has sufficient capacity to cater for multiples of the ordinary every day traffic generation of the site, it does not provide the average and 85th percentile scenarios typically considered in the determination of traffic impact on the receiving road network during the construction period. From the above refinement of the original assessment it can be appreciated that the peak increase (Scenario C) in HGV traffic on the N59 is likely to be less than half that figure presented in the original EIS. The average increase on a day to day basis (Scenario D) is considerably less than half and closer to one quarter where the sourcing of aggregates from the proposed borrow pit is considered.

14.4.3 Assessment of Potential Traffic Routes – Wind Turbine Components

The assessment of a suitable delivery route for wind turbine components involves the following:

- Identification of suitable port facilities – principally the availability of off-loading equipment and sizeable laydown area.
- Assessment of the delivery route from port to site entrance in relation to vertical and horizontal road alignment.
- Assessment of the delivery route from port to site entrance in relation to road (and bridge / culvert) strength and running width.

Delivery of components of the nacelle is likely to involve the heaviest loads with delivery of turbine blades being the longest loads.

Although the turbine blades are relatively light it is the blade delivery that typically defines both vertical and horizontal alignment requirements. Blade trailers are extendable and invariably have rear wheel steer with the capability of being operated automatically during regular road use, or manually during slow walking pace manoeuvring.

While multiple blade load trailers may be preferred, this means that blades can have no overhang and the trailer unit must extend to the full length of the blade. In this instance, the possibility of tighter turning circles and avoidance of grounding indicate the use of a trailer with shortened wheel base and blade overhang.

The project is currently at a stage where the contracts for the supply of materials and for construction of the project are not yet in place. In accordance with EU procurement rules for utilities, the contract to supply and construct the wind farm will be open to international competition. It will be a matter for the chosen contractor to determine the most suitable haulage route to the site. In such circumstances, definitive details with regard to proposed haulage route for heavy vehicles cannot be provided at this time.

However, it is likely to be one of the three haul routes identified in Section 14.2.3 above.

14.4.4 Assessment of Construction Impacts (Extreme Worst Case Scenario)

The original EIS estimated maximum number of vehicle movements per day at peak construction will be approximately 738, assuming concrete pouring for piles, and foundations occur simultaneously and also fill material and turbine components are being delivered to the site on the same day, and assuming all traffic arrives from one direction. The predicted contribution to the AADT on the N59 from the Oweninny construction phase and the remaining capacity is set out in Table 14.9. The predicted AADT during all construction phases is well within the capacity of the Level of Service D for this link road. When concrete pour is completed the main construction traffic will be related to the import of fill material to the site. The estimated traffic movements associated with this will be 402 per day and the remaining capacity on the N59 will increase accordingly.

Table 14.9: Forecast Capacity in AADT during construction period (Extreme Worst Case Scenario of Original EIS)

Year	Estimated AADT	Oweninny Construction Abs. Max. AADT	Total AADT	Remaining capacity on the N59
2012	2068	0	2068	64%
2013	2092	0	2092	63%
2014	2118	0	2118	63%
2015	2143	0	2143	63%
2016	2169	0	2169	62%
2017	2195	738	2933	49%
2018	2221	738	2959	48%
2019	2248	738	2986	48%
2020	2275	738	3013	47%
2021	2302	0	2302	60%
2022	2330	0	2330	59%

The following Table 14.10 is derived from the above Table 14.9 but reflects the 85th Percentile upper value Scenario C assessment figures of Table 14.7and Table 14.8. Table 14.10 provides an assessment of the carrying capacity and relative impact of the development on the section of the N59 to the west of the site access whilst

Table ***14.11*** shows the same information on the N59 to the east of the site access (Crossmolina Side).

Table 14.10: Forecast Capacity in AADT West of Site During Construction Period (85th Percentile Scenario C with and without Borrow Pit)

Year	**Estimated N59 AADT**	**Oweninny Wind Farm**				**N59 Reserve Capacity (See 14.3.4)**		
		Dev. AADT Generation		**Increase N59 Flow**		No Dev.	Development	
		No Borrow Pit	With Borrow Pit	No Borrow Pit	With Borrow Pit		No Borrow Pit	With Borrow Pit
2012	2068	0	0	0%	0%	64%	NA	NA
2013	2092	0	0	0%	0%	63%	NA	NA
2014	2118	0	0	0%	0%	63%	NA	NA
2015	2143	0	0	0%	0%	63%	NA	NA
2016	2169	0	0	0%	0%	62%	NA	NA
2017	2195	**382**	**321**	**17%**	**15%**	**62%**	**55%**	**56%**
2018	2221	**382**	**321**	**17%**	**14%**	**61%**	**55%**	**56%**
2019	2248	**382**	**321**	**17%**	**14%**	**61%**	**54%**	**55%**
2020	2275	**382**	**321**	**17%**	**14%**	**60%**	**54%**	**55%**
2021	2302	0	0	0%	0%	60%	60%	60%
2022	2330	0	0	0%	0%	59%	NA	NA
2023	2357	0	0	0%	0%	59%	NA	NA
2024	2386	0	0	0%	0%	58%	NA	NA

Table 14.11: Forecast Capacity in AADT East of Site During Construction Period (85th Percentile Scenario C with and without Borrow Pit)

Year	Estimated N59 AADT	Oweninny Wind Farm: Dev. AADT Generation		Oweninny Wind Farm: Increase N59 Flow		N59 Reserve Capacity (See 14.3.4)		
							Development	
		No Borrow Pit	With Borrow Pit	No Borrow Pit	With Borrow Pit	No Dev.	No Borrow Pit	With Borrow Pit
2012	1410	0	0	0%	0%	75%	NA	NA
2013	1427	0	0	0%	0%	75%	NA	NA
2014	1444	0	0	0%	0%	75%	NA	NA
2015	1461	0	0	0%	0%	75%	NA	NA
2016	1479	0	0	0%	0%	74%	NA	NA
2017	1496	**164**	**137**	**11%**	**9%**	**74%**	**71%**	**72%**
2018	1514	**164**	**137**	**11%**	**9%**	**74%**	**71%**	**71%**
2019	1532	**164**	**137**	**11%**	**9%**	**73%**	**70%**	**71%**
2020	1551	**164**	**137**	**11%**	**9%**	**73%**	**70%**	**71%**
2021	1569	0	0	0%	0%	73%	NA	NA
2022	1588	0	0	0%	0%	72%	NA	NA
2023	1607	0	0	0%	0%	72%	NA	NA
2024	1627	0	0	0%	0%	72%	NA	NA

The following Table 14.12 and Table 14.13 are derived from the above Table 14.9 but reflect the average traffic generation Scenario D assessment figures of Table 14.7 and Table 14.8.

Table 14.12: Forecast Capacity in AADT West of Site During Construction Period (Average Scenario D with and without Borrow Pit)

Year	Estimated N59 AADT	Oweninny Wind Farm: Dev. AADT Generation		Oweninny Wind Farm: Increase N59 Flow		N59 Reserve Capacity (See 14.3.4)		
							Development	
		No Borrow Pit	With Borrow Pit	No Borrow Pit	With Borrow Pit	No Dev.	No Borrow Pit	With Borrow Pit
2012	2068	0	0	0%	0%	64%	NA	NA
2013	2092	0	0	0%	0%	63%	NA	NA
2014	2118	0	0	0%	0%	63%	NA	NA
2015	2143	0	0	0%	0%	63%	NA	NA
2016	2169	0	0	0%	0%	62%	NA	NA
2017	2195	**281**	**220**	**13%**	**10%**	**62%**	**57%**	**58%**

Year	Estimated N59 AADT	Oweninny Wind Farm Dev. AADT Generation: No Borrow Pit	Oweninny Wind Farm Dev. AADT Generation: With Borrow Pit	Increase N59 Flow: No Borrow Pit	Increase N59 Flow: With Borrow Pit	N59 Reserve Capacity (See 14.3.4): No Dev.	N59 Reserve Capacity (See 14.3.4): Development: No Borrow Pit	N59 Reserve Capacity (See 14.3.4): Development: With Borrow Pit
2018	2221	**281**	**220**	**13%**	**10%**	**61%**	**56%**	**57%**
2019	2248	**281**	**220**	**13%**	**10%**	**61%**	**56%**	**57%**
2020	2275	**281**	**220**	**12%**	**10%**	**60%**	**55%**	**56%**
2021	2302	0	0	0%	0%	60%	NA	NA
2022	2330	0	0	0%	0%	59%	NA	NA
2023	2357	0	0	0%	0%	59%	NA	NA
2024	2386	0	0	0%	0%	58%	NA	NA

Table 14.13: Forecast Capacity in AADT East of Site During Construction Period (Average Scenario D with and without Borrow Pit)

Year	Estimated N59 AADT	Oweninny Wind Farm Dev. AADT Generation: No Borrow Pit	Oweninny Wind Farm Dev. AADT Generation: With Borrow Pit	Increase N59 Flow: No Borrow Pit	Increase N59 Flow: With Borrow Pit	N59 Reserve Capacity (See 14.3.4): No Dev.	N59 Reserve Capacity (See 14.3.4): Development: No Borrow Pit	N59 Reserve Capacity (See 14.3.4): Development: With Borrow Pit
2012	1410	0	0	0%	0%	75%	NA	NA
2013	1427	0	0	0%	0%	75%	NA	NA
2014	1444	0	0	0%	0%	75%	NA	NA
2015	1461	0	0	0%	0%	75%	NA	NA
2016	1479	0	0	0%	0%	74%	NA	NA
2017	1496	**121**	**94**	**8%**	**6%**	**74%**	**72%**	**72%**
2018	1514	**121**	**94**	**8%**	**6%**	**74%**	**71%**	**72%**
2019	1532	**121**	**94**	**8%**	**6%**	**73%**	**71%**	**72%**
2020	1551	**121**	**94**	**8%**	**6%**	**73%**	**71%**	**71%**
2021	1569	0	0	0%	0%	73%	NA	NA
2022	1588	0	0	0%	0%	72%	NA	NA
2023	1607	0	0	0%	0%	72%	NA	NA
2024	1627	0	0	0%	0%	72%	NA	NA

There is adequate carrying capacity on the N59 at peak construction periods with a residual capacity of greater than 50% under either the upper value 85th percentile traffic generation or average traffic generation scenarios at the proposed development. In practical terms under the day to day figures of Scenario D show that the level of impact on the carrying capacity of the N59 is likely to be in the order of 6% to the east and 12% to the west which is a significant (more than 50%) reduction over the impact forecast in the original EIS Table 14.9 above. Albeit that the road network has sufficient capacity and the reduction in capacity is relatively modest it is acknowledged that the forecast in traffic flows on the N59 resulting from the proposed development is likely to be in the order of 6-12% on a day to day basis and up to 17% on days where traffic generation is above average (during concrete pours for instance). Albeit that the level of service on the road may remain relatively high it is acknowledged that a 17% increase in traffic flows is likely to result in an incre4ase in journey times for users of the N59 and will also result in increased delay at junctions. It follows that the influences of development traffic diminish with increasing distance from the site and clearly the greatest influence of construction traffic will be at the construction accesses.

In addition to the above the following potential impacts associated with the construction period may occur:

- Damage to the N59 and other road pavement may occur due to the increased traffic movements associated with HGVs over the construction period
- Damage to road bridges along construction routes could occur from the increased traffic movements of HGVs. This will be dependent on the construction delivery routes selected by the construction contractor.
- There is a potential for increase in traffic accidents during the construction period due to the increased traffic movements and turning requirements at the three site entrances.
- Some temporary inconvenience during the construction period to other road users will be created by the increased level of traffic movements on the N59. However, the relatively low level of current use of the roads surrounding the site means that only a limited number of existing road users will be impacted.
- The increased vehicle movements will lead to a degree of temporary increased traffic noise at residences situated on the delivery routes. This will primarily result from increases in use by conventional HGVs carrying concrete and stone as opposed to the exceptional load traffic.

14.4.5 Project Operation

14.4.5.1 Wind Farm Maintenance

Normally each turbine will have its own in-built supervision and control system that will be capable of starting the turbine, monitoring its operation and shutting down the turbine in the case of fault conditions.

Supervisory operational and monitoring activities will be carried out remotely from the O&M building with the aid of computers connected via a telephone modem link. It is anticipated that the wind farm will be manned during the operational phase with an estimated twelve full time employees on site. This will generate up to 24 light vehicle movements per day peaking in the early morning and evening periods which will have insignificant impact on the N59.

In the unlikely event of a major component failure, a mobile crane will be required on site.

14.4.5.2 Road Safety

By their very nature wind turbines are significant features in the landscape and the turbines at Oweninny will be visible intermittently from the N59, from the R312 and from local roads. However, there is no evidence from Ireland or elsewhere to indicate that wind farm turbine towers or moving wind turbine blades endanger public safety by reason of traffic hazard.

Fast moving objects in the field of view or on the horizon are much more likely to cause distraction to motorists than wind turbine blades. These move slowly and steadily, rotating at a speed of one revolution every 3 – 5 seconds. Instances of fast moving objects include views from the public road of aircraft take-offs and landings at airports; trains crossing roads at bridges or running on tracks parallel to roadways; traffic crossing road over bridges and on parallel, higher, lower or crossing roads at sophisticated motorway interchanges. Horses and other animals are also liable to move quickly in the field of view. There is no indication that such phenomena impact adversely on road safety.

There is no recorded instance where the presence of a wind turbine in the field of vision was cited as a contributory factor in a road accident. Nor is there any recorded instance where the presence of a wind turbine in the field of vision was cited as having a negative impact on road safety.

Delivery of large wind turbine components poses special road traffic risks and there have been a number of road accidents associated with collisions involving wind turbine component delivery. These accidents can be avoided by undertaking comprehensive route surveys with deliveries accompanied by a Garda escort and should the need arise the temporary closure of roads to traffic.

Any local road improvements that are necessary for delivery of wind turbine components will improve overall road safety in the long term.

There is no potential for a wind turbine to impact directly on the N59 in the event of a turbine collapse as the nearest turbine to the N59 is located some 400 metres away.

14.4.5.3 Visitor Centre traffic

It is anticipated that the proposed Visitor Centre will have the potential to attract large numbers of visitors when it becomes fully operational. It is located in the general area of the Céide Fields Visitor Centre in Ballycastle and Bellmullet town in County Mayo both tourist venues. The Céide Fields has attracted large numbers of visitors, peaking at 28,253 in 2009 and with a recorded 25,885 visitors in 2011,[153] and it would be expected that a proportion of visitors to the general area would avail of the opportunity to visit the proposed centre at Bellacorick.

The Oweninny Visitor Centre will be open to visitors post construction of phase 1 of the project. During peak season, the centre could have five to ten people employed on a full and part time basis. This could generate up to twenty car vehicle movements daily in peak season.

It is anticipated that an additional 300 visitors per day on average including tour groups could be envisaged at peak tourism activity periods. Assuming this would include three tour buses with sixty visitors each and the remainder as cars with two passengers This would give rise to an additional 3 commercial vehicles and 60 cars on the N59, that is an additional 126 vehicle movements per day during peak construction. This would result in remaining capacity being reduced on the N59 to between 64% and 62%. Should visitor numbers increase at the Visitor Centre during the construction of Phase 2 there will still be adequate capacity remaining on the N59 link road. These figures are based upon the original extreme EIS scenario.

14.4.6 Project Decommissioning

Short-term effects will arise during decommissioning. Any impact that does arise will be temporary and very short lived.

Vehicle movements over the decommissioning period will be much less than those of the construction period, given that the major elements of traffic movements involving stone and concrete deliveries will not arise. It is envisaged that access tracks and crane hard stands would not be removed from the site. Concrete foundations would be left in situ.

The dismantling of the wind turbines will involve the use of mobile cranes and their removal will entail a similar number of loads to turbine delivery during construction. Alternatively, turbine blades, for example, may be cut into shorter sections before being loaded onto conventional flatbed trucks.

[153] http://debates.oireachtas.ie/dail/2012/01/31/00172.asp

Dismantling of substations would involve removal of transformers and other electrical equipment from the site which would involve a small number of abnormal loads for the transformers.

14.5 MITIGATION OF POTENTIAL IMPACTS

14.5.1 Delivery of Wind Turbine Components

With regard to deliveries of turbine components, the appropriate authorities will be notified of the movement of long and abnormal loads. Appropriate traffic management measures will be agreed in advance and it is expected that these will include the following:

- Delivery of wind turbine components will use special transporter vehicles with rear wheel steering to assist safe transportation and manoeuvrability on the roads.
- Placing warning notices to advise other road users of the presence of slow moving vehicles.
- Notification of residents along the route prior to deliveries
- Using lead warning vehicles and using Garda escorts where required.
- Undertaking deliveries at times that minimise the impact on other road users and resting in safe lay-bys to reduce any traffic congestion.
- Closing extendable transporter vehicles on return journeys.
- Closing short sections of road if this proves necessary

The movement of the abnormal loads by road will be the subject of an application requesting permission to move the goods. This 'Permit for Specialised Vehicles' form, when signed by the Garda Síochána Permits Officer, grants permission to move abnormal loads as defined under *Road Traffic (Permits for Specialised Vehicles) Regulations, 2009*, on inter-urban routes. These Regulations introduce a streamlined permit system for the movement of wide and long vehicles (including loads) not exceeding 27.4 m in length and 4.3 m in width.

Inter urban routes are identified in the schedule of Designated Roads governed in *Road Traffic (Specialised Vehicle Permits) (Amendments) Regulations 2010*. The Regulations state that any deviations from the Schedule of Designated Roads requires independent authorisation from the Local Authority concerned and or Minister for Transport. This subsequent process is covered under the *Road Traffic (Specialised Permits for Particular Vehicles) Regulations, 2007*.

14.5.2 Maximising use of existing ground conditions and existing on site tracks

Maximising the use of the existing ground conditions and existing access trackways is intrinsic to the design process and is essential to mitigation by design. The Oweninny site is former raised bog area which has been extensively worked in the past leaving areas of bare subsoil and reduced peat depth. The site also has an existing network of access trackways leading to the existing Bellacorick wind farm and trackways associated with the former railway network used in peat harvesting. The design of the access trackway has minimized the requirement for cut and fills operations to the extent possible by routing along ridge lines and areas of minimum peat depth. This has minimised the volume of fill material required for access track construction and consequently helped to minimize the transport requirements. Additionally, 6 km of existing access trackways have been incorporated into the design and although these will be upgraded this has also reduced the requirement for imported fill and the associated transport.

14.5.3 Potential Reduction in the traffic movements

14.5.3.1 On-site borrow pit

A borrow pit, 17 hectares in area, has been identified on site which could yield up to 340,000m^3 of material suitable for access track and crane hardstand construction. The use of this borrow pit would lead to a substantial reduction of vehicle traffic on the N59 road. Based on a full load of 10m^3 per vehicle, a reduction of the overall vehicle movements on the N59 by 68,000 could be achieved as these movements would be internal to the site.

14.5.3.2 On site Concrete Batching Plant

An on-site concrete batching plant is proposed to provide a continuous supply of concrete for pile and foundation works. The provision of the concrete batching plant would not significantly reduce the overall traffic movements associated with the construction as aggregate, sand and cement would have to be delivered to site for concrete production. However, delivery of such materials would be scheduled over a more prolonged period with stockpiling at the batching plant well in advance of concrete requirements. This would then lead to a reduction in peak traffic movements associated with concrete deliveries on the N59 as a proportion of the concrete required would be batched internal to the site.

14.5.4 General Construction Traffic

It is proposed that a joint condition survey of public roads be carried out by Oweninny Power Ltd. and Mayo County Council prior to commencement of the project. This will form the basis for agreeing:

- Local road improvements in the vicinity of the site to minimise impacts on other road users.
- Any remedial works that may be necessary following completion of the construction.

Trucks used in deliveries of fill and concrete will be regular road going vehicles having no special constraints in relation to width or alignment. However, it is recognised that public roads will be affected by these deliveries. For the delivery route from concrete source to the site entrance, the assessment will focus on road strength and in particular on the quality of the running surface.

This is likely to include the following:

- Pavement Condition Index (PCI) survey. A visual inspection, incorporating a video survey of the access roads is normally conducted prior to movement of construction traffic to record road condition.

- Alignment and Width Survey. A full width and road alignment survey is conducted by an appropriately qualified transport company, in conjunction with both the turbine manufacturer and the site project engineer. Prior to delivery it would also be standard practice to complete a dry run with an unladen tractor and extendable trailer unit.
- Structural Survey (Falling Weight Deflection). A full structural survey may be undertaken over any sections of road which appear particularly weak or liable to subside.

Liaison will be maintained with the residents along local access routes and they will be advised of any particularly busy periods.

14.5.5 Traffic Management Plan

A number of measures are proposed to ensure road safety and to minimise inconvenience to other road users. A Traffic Management Plan will be developed and agreed with Mayo County Council's Roads Engineering Department prior to commencement of works and this will include the following specific mitigation measures:

- Construction and delivery vehicles will be instructed to use only the approved and agreed means of access and movement of construction vehicles will be restricted to these designated routes
- Appropriate vehicles will be used to minimise environmental impacts from transporting construction materials, for example the use of dust covers on trucks carrying dust producing material.
- Temporary traffic lights and/or road or lane closures will be provided as required to ensure traffic safety.
- Parking of site vehicles on the public highway will not be permitted.
- A road sweeper and/or wheel washing facilities will be utilised to clean the public roads of any mud that may be introduced from the site roads.
- All vehicles will be properly serviced and maintained to avoid any leaks or spillage of oil, petrol or diesel. All scheduled maintenance will be carried out off site.

14.5.6 Landtake

Where road improvements involve landtake, the following approach will be adopted:

- Upon grant of planning permission and following full evaluation of any conditions in the permission relating to turbine deliveries, Oweninny Power Limited will meet with the landowners concerned, to provide detail of the works required and negotiate compensation arrangements.
- As part of this process, the Landowners will complete a Deed of Dedication. This will provide permission for takeover by the relevant Local Authority of the amended road area where applicable.
- Oweninny Power Limited will remain engaged with the Council at all stages through construction work and will remain so until the completion of works and the final takeover by the local authority of amended road sections.

14.5.7 Access points

The recommendations of the Road Safety Audit prepared for the access points will be implemented in the detailed design of the project.

14.6 CUMULATIVE IMPACTS

14.6.1 General

There are a number of other infrastructure and wind farm projects that have or may have the potential during construction to have an impact upon the receiving roads and haul routes associated with the proposed Oweninny Wind Farm and thus have the potential to give rise to a cumulative impact. The following projects are considered:

- Corvoderry Wind Farm (10 Turbines)
- Sheskin Wind Farm (6 Turbines)
- Cluddaun Wind Farm (48 Turbines)
- Tawnanasool Wind Farm (8 Turbines)
- Bellacorick – Castlebar 110kV Overhead Line Upgrade
- Bellacorick – Moy 110kV Overhead Line Upgrade

14.7 Wind Farm Developments

Corvoderry Wind Farm, which is located within the Oweninny site, has been granted planning permission by Mayo County Council for the construction of 10 wind turbines. This wind farm is not likely to be connected to the national grid until the EirGrid Grid West project has been constructed, hence construction of Corvoderry is unlikely to occur prior to the completion of Phase 2 of the Oweninny Project. The Corvoderry site has a right of way along the existing Bellacorick wind farm access track. A reasonable basis upon which to estimate traffic arising from the construction of Corvoderry Wind Farm would be using a generation rate based upon the number of turbines since there is a relatively proportional relationship between the number of turbines and the quantum of construction materials, access tracks, concrete foundations, workforce etc. Based upon the Corvoderry EIS it is expected that the 10 turbine wind farm could be completed with one year. Table 14.7 Scenario D provides day to day construction traffic generation of the proposed Oweninny Wind Farm. The calculations for Oweninny are based upon a rate of construction equating to 15 turbines per year. A reasonable estimate of the daily traffic generation to the N59 is considered to be two thirds of the daily average estimate for Oweninny. From Table 14.7 this equates to a daily increase in HGV in the order of 94 to the west of the site and 41 to the east and an increase in light vehicle traffic equating to 93 cars/vans to the west and 40 to the east.

In addition, 19.3 hectares of the existing private forest plantation will be clearfelled to facilitate the Corvoderry Wind Farm development. This plantation is semi mature and the clearfell requirement will generate approximately 16 timber transport vehicle loads per hectare or 309 timber loads equating to an additional 618 timber transport vehicle movements. This clearfell would take place in advance of construction works on the

Corvoderry site. Traffic generation during this period of timber harvesting will clearly be less than during the construction programme proper.

The potential impact arising from the construction of the Cluddaun Wind Farm by Coillte had been considered in the original EIS traffic section. The planning application for the Coillte Wind Farm proposal at Cluddaun which comprised 48 wind turbines has been refused planning permission by An Bord Pleanála and will therefore not contribute to cumulative impact.

Tawnanasool Wind Farm is an 8 turbine facility which it is proposed will be accessed directly from N59 between Bangor and Ballycroy at a location west of the Oweninny Wind Farm. The cumulative impact of Tawnanasool arising on the N59 will be from the construction traffic. It is considered likely that the majority of fill materials would be sourced from a local supply in Bangor. As per the round estimates associated with Corvoderry the traffic generation associated with the construction of the wind farm is expected to be in the order of 75 HGV to the east of the site and 33 to the west (directions reversed as source of materials predominantly expected to be Bangor). The forecast increase in light vehicle traffic on the N59 equates 75 cars/vans to the east and 33 to the west.

In addition the Tawnanasool Wind Farm proposes a grid connection that would involve the construction of an underground cable generally running in the N59 carriageway between the site and Bangor. There is an impact that arises from the transportation of materials for such a cable construction but by far the greatest impact arises from the management of traffic during the cable laying project. Cables are typically places in 100-150m sections using a programme of rolling lane closure and one-way working. It is not considered likely that cable construction would be undertaken on the N59 at the same time as wind farm construction since the N59 is the primary haulage route. It is also unlikely that Mayo County Council would permit the cable works to be undertaken at the same time as perhaps other cable construction elsewhere on the N59 as may be associated with Phase 3 of the Oweninny Wind Farm project. Clearly there is likely to be an element of coordination between the various projects that involve traffic management measures that have a direct impact upon the operation of the N59. In the context of potential cumulative impacts it is not considered reasonable to investigate a crisis type uncontrolled scenario where the worst combination of all projects operating at 100th percentile together with all the worst impact arising from poor programming of traffic management works along the N59. This assessment instead focuses on the typical day-to-day scenario where all sites are assumed to coincidently operate at typical daily traffic generation rates. This is a reasonable scenario since there is a finite capacity of local resources such as stone and concrete and it is unlikely that all sites could progress intensive concrete works simultaneously.

It is assumed for the purposes of the traffic assessment that Corvoderry could be constructed in 2020. The Tawnanasool Wind Farm EIS predicts that construction would be carried out in 2017 and the site operational in 2018.

The following Table 14.14 and Table 14.15 are based upon Table 14.12 and Table 14.13 respectively and include for the cumulative impact of the various potential wind farm construction projects.

Table 14.14: Forecast Capacity in AADT West of Site During Construction Period (Average Scenario D with and without Borrow Pit)

Year	Estimated N59 AADT	Oweninny Wind Farm + Corvoderry + Tawnanasool: Dev. AADT Generation		Oweninny Wind Farm + Corvoderry + Tawnanasool: Increase N59 Flow		N59 Reserve Capacity (See 14.3.4)		
							Development	
		No Borrow Pit	With Borrow Pit	No Borrow Pit	With Borrow Pit	No Dev.	No Borrow Pit	With Borrow Pit
2013	2092	0	0	0%	0%	63%	NA	NA
2014	2118	0	0	0%	0%	63%	NA	NA
2015	2143	0	0	0%	0%	63%	NA	NA
2016	2169	0	0	0%	0%	62%	NA	NA
2017	2195	**281 +66**	**220 +66**	**16%**	**13%**	**62%**	**56%**	**57%**
2018	2221	**281**	**220**	**13%**	**10%**	**61%**	**56%**	**57%**
2019	2248	**281**	**220**	**13%**	**10%**	**61%**	**56%**	**57%**
2020	2275	**281 +187**	**220 +187**	**21%**	**18%**	**60%**	**52%**	**53%**
2021	2302	**0**	**0**	**3%**	**3%**	**60%**	**58%**	**58%**
2022	2330	0	0	0%	0%	59%	NA	NA
2023	2357	0	0	0%	0%	59%	NA	NA
2024	2386	0	0	0%	0%	58%	NA	NA

Table 14.15: Forecast Capacity in AADT East of Site During Construction Period (Average Scenario D with and without Borrow Pit)

Year	Estimated	Oweninny Wind Farm	N59

	N59 AADT	+ Corvoderry + Tawnanasool Dev. AADT Generation		+ Corvoderry + Tawnanasool Increase N59 Flow		Reserve Capacity (See 14.3.4)		
		No Borrow Pit	With Borrow Pit	No Borrow Pit	With Borrow Pit	No Dev.	Development No Borrow Pit	Development With Borrow Pit
2013	1427	0	0	0%	0%	75%	NA	NA
2014	1444	0	0	0%	0%	75%	NA	NA
2015	1461	0	0	0%	0%	75%	NA	NA
2016	1479	0	0	0%	0%	74%	NA	NA
2017	1496	**121** +66	**94** +66	**13%**	**11%**	**74%**	**71%**	**71%**
2018	1514	**121**	**94**	**8%**	**6%**	**74%**	**71%**	**72%**
2019	1532	**121**	**94**	**8%**	**6%**	**73%**	**71%**	**72%**
2020	1551	**121** **+ 187**	**94** **+ 187**	**20%**	**18%**	**73%**	**68%**	**68%**
2021	1569	**0**	**0**	**5%**	**5%**	**73%**	**71%**	**71%**
2022	1588	0	0	0%	0%	72%	NA	NA
2023	1607	0	0	0%	0%	72%	NA	NA
2024	1627	0	0	0%	0%	72%	NA	NA

There is adequate carrying capacity on the N59 at peak construction periods when the cumulative effects of Oweninny wind farm together with the other permitted and potential wind farm projects are taken into account. The cumulative increase in N59 traffic is robustly estimated to be approximately 20% during the construction of the Corvoderry Wind Farm in 2020 when the N59 mainline is forecast to have a least reserve capacity of 52% to the west of the site and 68% to the east. At the peak in 2020 the forecast traffic generation of the combined projects equates to approximately 8% of the carrying capacity of the N59 to the west of the site and 5% to the east.

14.7.1.1 Potential future development of Oweninny Phase 3

Should the development of Oweninny Phase 3 proceed at a future date then this would increase the duration of traffic increase and hence impact on the N59 national road. Phase 3 would be constructed post the construction of Phase 1 and 2 and hence there would be no cumulative traffic impacts in terms of increased volume of construction related traffic of Phase 1 and Phase 2 during the construction period. There would be some cumulative impact with maintenance activities of Phase 1 and 2 with the construction of Phase 3 but this would be insignificant. Cumulative impact could also occur with traffic generated by visitors to the proposed Visitor Centre which would be developed during Phase 1 and 2. However, as the Phase 1 and 2 construction will be completed before Phase 3 there will still be adequate spare carrying capacity on the N59. Cumulative operational impacts will be low and as described in the original EIS Chapter 14 Traffic and Transport submitted with the planning application to An Bord Pleanála in 2013.

14.7.2 110kV Overhead Line Upgrade

Given that overhead line (OHL) construction is typically carried out at locations remote from the public road network, the potential impact upon public road traffic is generally associated with the requirement to transport both construction machinery and materials.

Traffic generation can reasonably be categorised into construction and operations staff traffic and commercial construction traffic. The workforce required and the need to transport machinery and materials depends upon the complexity of the works. In comparison to underground cable installation or wind farm construction works the workforce is modest as is the quantum of materials required to be transported to or from the various sites of towers and polesets. The upgrade of existing OHL is generally less demanding upon the receiving road network than new build. The OHL upgrade works will be accessed from the R312, the only cumulative impact arising from the works would be the transport needs along the N59. Given the modest transport demands of the upgrade works it is considered unlikely that these OHL projects would give rise to a significantly increases cumulative impact. Given the generally robust nature of the traffic generation and impacts arising from the proposed wind farm development it is likely that the additional impact of the OHL upgrade works if undertaken in concert with the wind farm construction would be practically negligible in the context of the N59 shared construction access route

Other traffic related impacts during the construction phase arises from the potential need for traffic management measures to ensure tower and poleset sites are accessible. These measures, if required, will be very short term in nature and should not have a long term appreciable impact upon road network capacity or level of service. All such traffic management relating to the OHL upgrade is remote from the N59.

14.8 CONCLUSION

Albeit on a larger scale, the construction of the wind farm at Oweninny is similar to many other wind farms in Ireland and will generate a number of abnormal loads for wind turbine component delivery and will generate significant HGV movements associated with construction traffic.

Three potential haul routes for abnormal loads have been identified and an initial assessment of these has been made. Final haul route selection will be the responsibility of the turbine supplier and the final route and any modifications will be agreed with local authorities along the selected route.

Traffic and transport impacts will occur mainly during the construction phase of the project. The worst case scenario assumes that all fill material and concrete will be imported to the site from local suppliers along the N59. This will generate increased traffic movements to the site along the N59 at each phase of construction. However the existing capacity of the N59 is adequate to cater for the additional traffic movements generated by Oweninny wind farm with a residual capacity in excess of 50% throughout the construction. Construction will take place in phases over a 7-8 year period with potential for impact spread across this period.

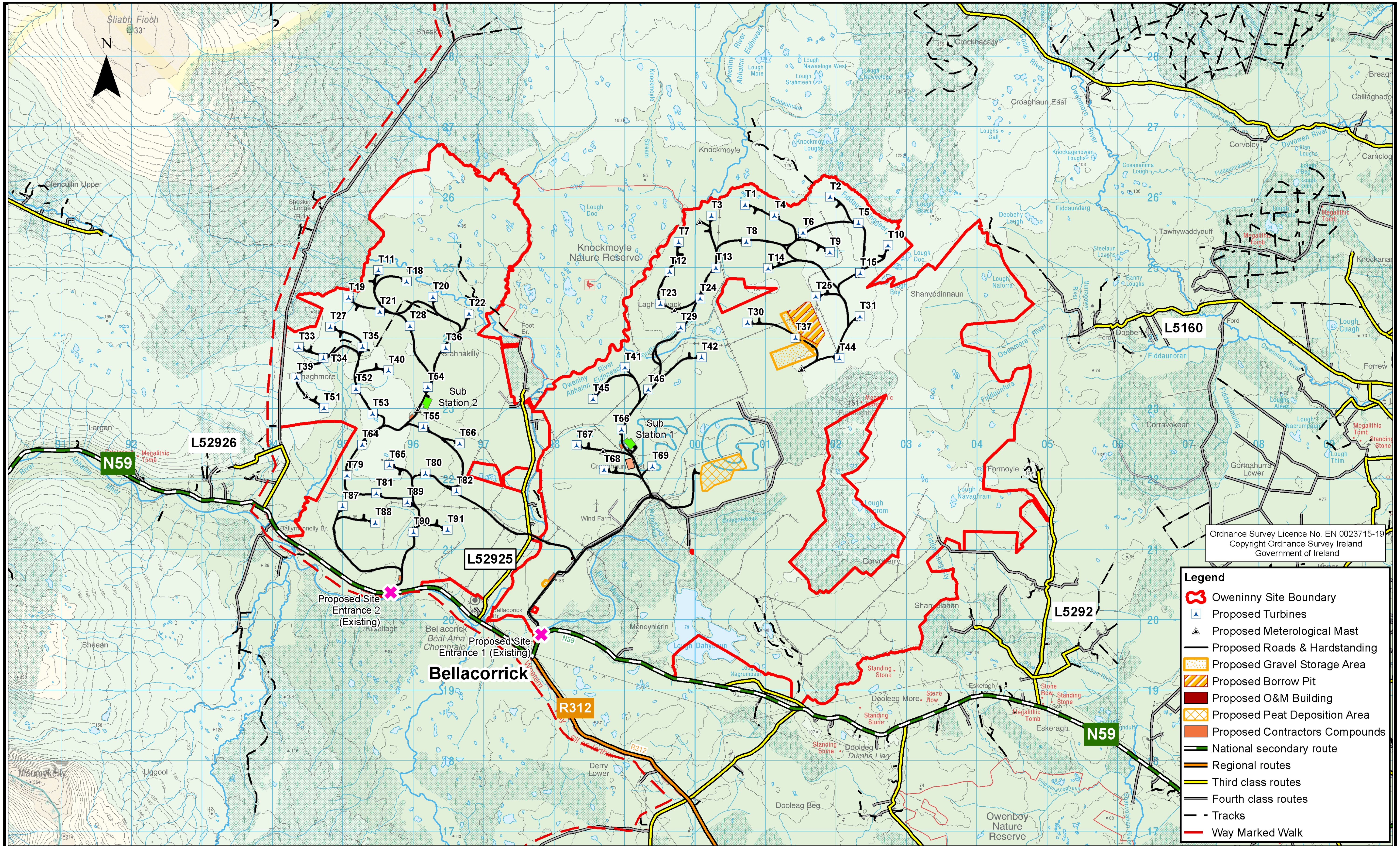
In the case where Corvoderry wind farm could potentially be constructed at the same time as Phase 2 of Oweninny wind farm a worst case scenario where all construction materials are imported via the N59 would still leave adequate capacity on the N59 secondary road with an estimated 50% reserve capacity during the peak construction period in 2020.

Potential impacts during construction can be mitigated significantly by on-site concrete batching and by developing an on-site borrow pit. Concrete batching will not reduce the required import of materials but would reduce peak traffic by spreading out delivery of concrete batching materials over a prolonged period. The on-site borrow pit if developed would substantially reduce the requirement for imported fill in the latter part of Phase 1 and for subsequent phases. This updated EIS shows the various scenarios which include calculations of traffic generation both with and without the borrow pit.

A condition survey of the N59 will be undertaken prior to construction and any strengthening works agreed with the local authority. Post construction surveys will be undertaken and any required remedial works agreed with the local authority also.

Abnormal load deliveries will be accompanied by safety vehicles and a Garda escort and the timing of delivery will be notified to the County Council and local residents along the transport route.

A traffic management plan will be developed and agreed with Mayo County Council to manage potential impacts from the site. With implementation of the mitigation measures no residual significant impact is predicted.



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Oweninny Primary Roads

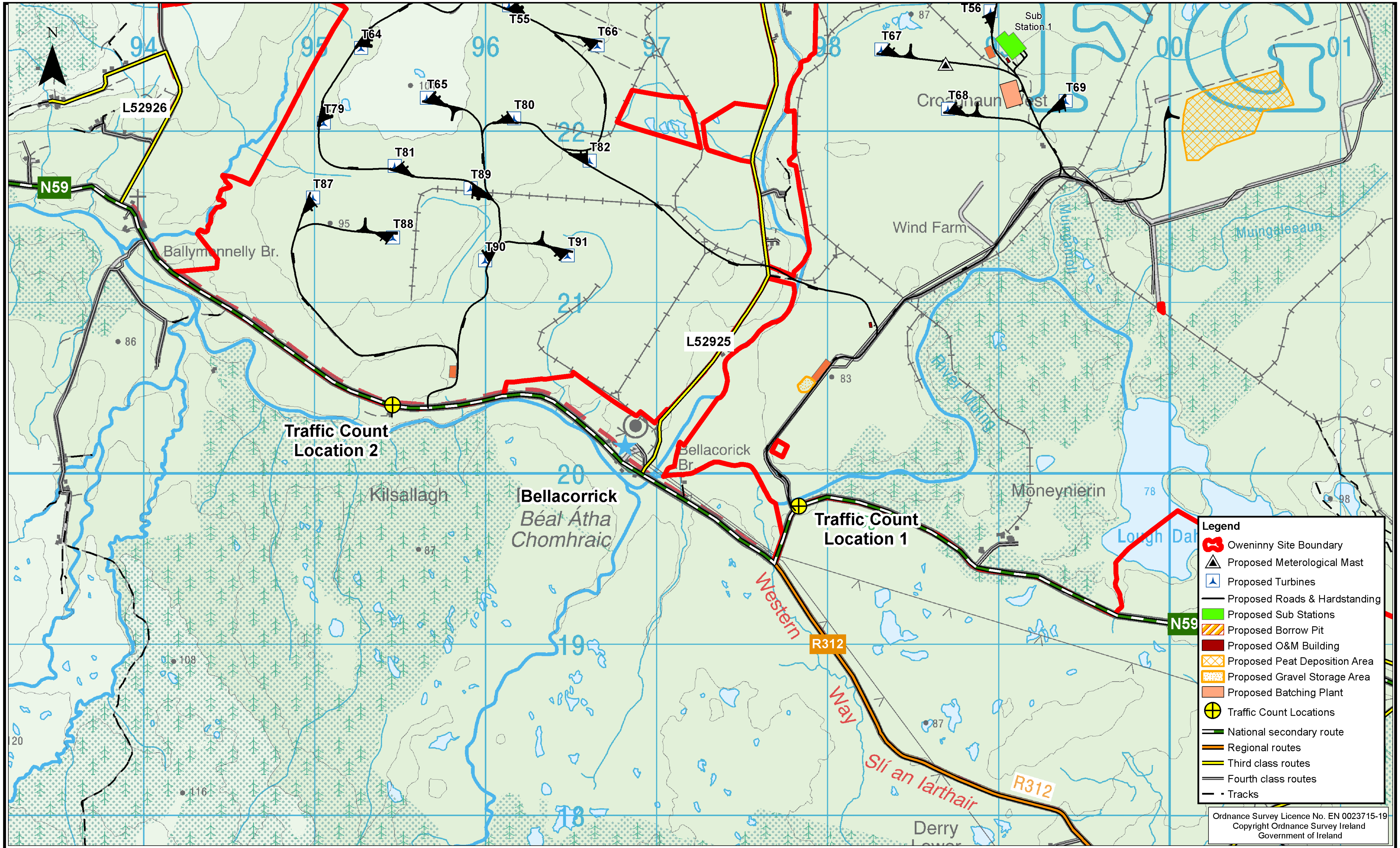
Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	29/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:50,000

MAP REFERENCE

FIGURE 14.1



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Traffic Count Locations

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	29/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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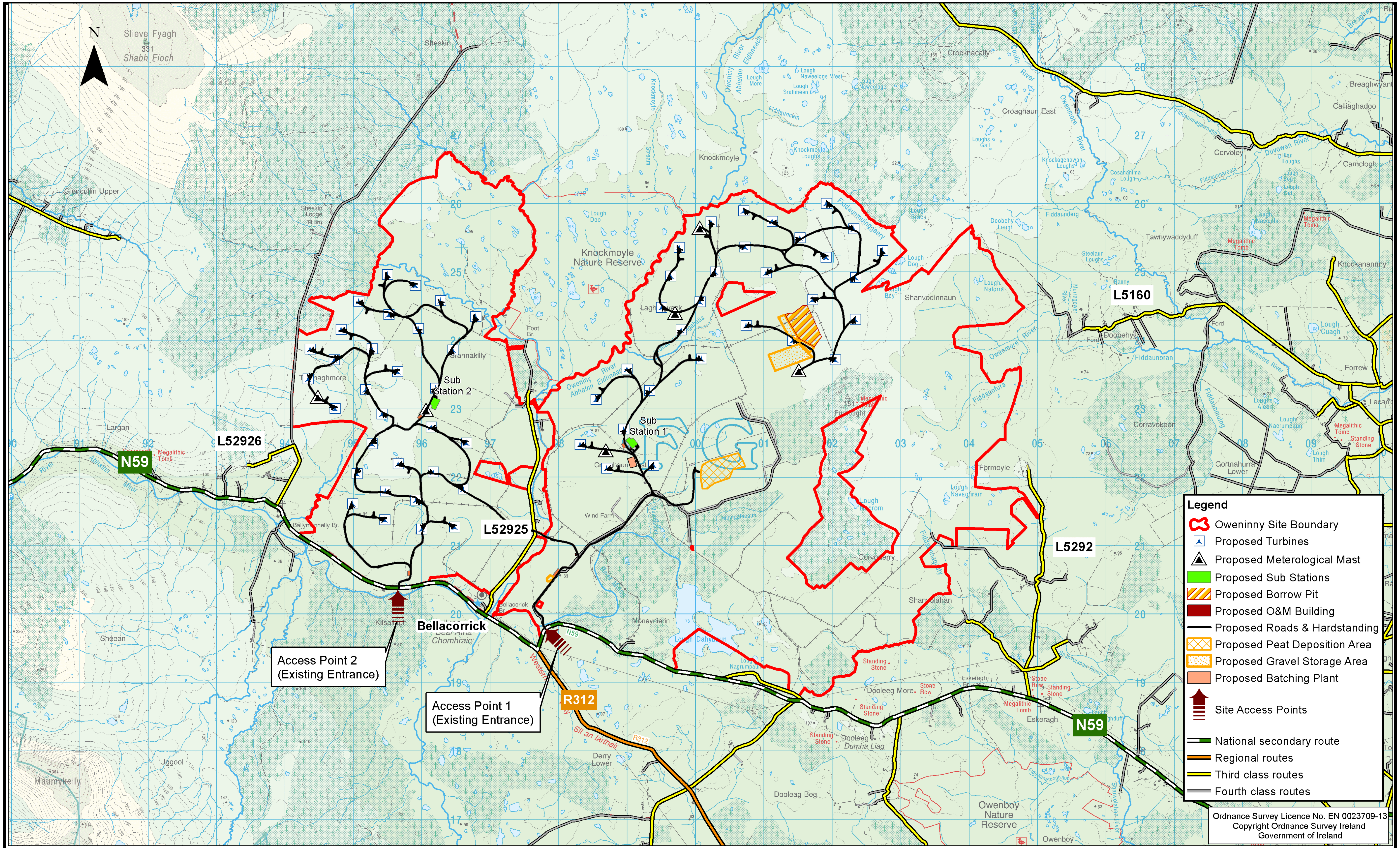
MAP REFERENCE

FIGURE 14.2



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Oweninny Site Access Points
Project	**Production Unit**
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	J.C	29/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
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MAP REFERENCE

FIGURE 14.3

Figure 14-4: Turbine Blade in transportation

15 FORESTRY

15.1 INTRODUCTION

Forest plantation within the Oweninny site is owned by Coillte Teoranta Ltd and by private individuals (Corvoderry area mainly). Coillte forests within the site boundary are located on lands owned by Bord na Móna. The development of the Oweninny wind farm will require some key hole and linear clearfelling of Coillte forest plantation along proposed access trackways and around wind turbine foundation and crane hardstands. There will be no requirement for clear felling of private forest plantation within the site. This section has been prepared by ESBI in consultation with Coillte and reviews the potential impact of the development on forest plantation within the Oweninny site and also the potential impacts and mitigation associated with forest clear felling.

15.2 APPROACH AND METHODOLOGY

Data and information has been extracted from the Coillte Shannetra Forest Management Plan which covers forest management in the Oweninny area.

Consultation has taken place with Coillte and data has been provided by Coillte with respect to species and year of planting.

The following documents were also consulted:

- Western river Basin District River Basin Management Plan River 2009 - 2015154.
- Forest and Water Programme of Measures, 2008155.

15.3 RECEIVING ENVIRONMENT

15.3.1 Forest Management Plans

Coillte's estate is divided into forests for management purposes. Each forest has a forest management plan (FMP) that summarises the management plans for the forest in

[154] Western River Basin District, River Basin Management Plan 2009 – 2015, 30th April 2010 http://www.wfdireland.ie/docs/1_River%20Basin%20Management%20Plans%202009%20-%202015/WRBD%20RBMP%202010/

[155] Forest and Water Programme of Measures, 23/12/2008. http://www.wfdireland.ie/docs/22_ForestAndWater/

question over a five year period. The current plans cover the period 2011 – 2015. These plans outline the criteria under which each forest will be managed, such as the proportion of the forest assigned to timber production or biodiversity purposes and details on the harvesting, restocking, species diversification and crop restructuring plans over the stated period.

- Forest plantation within the proposed Oweninny wind farm is within the Coillte Management Plan - MO05- Shannetra[156]. The current FMP for this area covering the period 2011 to 2015 can be obtained from the Coillte website (http://www.coillte.ie/index.php?id=1875).

Coillte's estate is managed on a multi-objective basis, where a balance is sought between the pursuit of economic returns, environmental protection and enhancement and social returns like landscape protection and employment. Rather than attempting to achieve a perfect balance on every site it is recognised that some sites have a greater potential than others in pursuing different objectives. To this end, a principal objective is nominated for each site.

Approximately 82% of the total Shannetra plantation area has a timber production management objective. However, approximately 18% of the total Shannetra forest area is managed for biodiversity. Much of this biodiversity relates to the blanket bog restoration project, at Corravokeen and Shanvolahan properties which are outside the Oweninny site area and which was completed in 2007. The aim of the forest management in Shannetra is to remove all conifers from the riparian zones within the forest, and restore to a more natural zone, dominated by a mixture of open peatland habitat, natural scrub and planted native broadleaves. ***Table 15-1*** shows the areas by management objectives for Shannetra Forest.

Table 15-1: Areas by Management Objectives for Shannetra Forest

Biodiversity (hectares)	Timber Production (hectares)	Total (hectares)
611	2529 ha	3140 ha

[156] Coillte, Forest Management Plan, Shanetra Forest, Forest Code MO05 Period covered 2011 - 2015

15.3.2 Local Context

The proposed development lies within Coillte's MO05 Shannetra forest management area, which is situated in North Mayo between the N59 in the south and Shannetra Hill in the North and east along the R315. The southern boundary lies from the town of Crossmolina to the east and the village of Bellacorick to the west. Forest plantations within Shannetra extend to approximately 3,140 ha. Shannetra is made up of 18 forest properties, four of which are within the Oweninny wind farm boundary and include Shanvodinnaun, Corvoderry, Croaghaun and Moneynierin, see **Figure 15-1**. Note that Coillte forest property names do not always follow townland names.

Shannetra forest is dominated by commercial conifer plantation of Sitka Spruce (*Picea sitchensis*) and Lodgepole pine (*Pinus contorta*). The forest properties within the Oweninny site were planted between 1974 and 1998, see Table 15-2.

Table 15-2: Planting year and area

Planting Year	Area (hectares)
1974	6.1
1984	47.1
1985	20.3
1989	132.2
1990	100.5
1991	33.3
1998	12.4
Total	351.9

The FMP indicates that a felling licence is required prior to any harvesting operations and consultation with key stakeholders such as NPWS and Inland Fisheries Ireland will be undertaken. Replanting by the conventional cultivation technique- mounding/drainage - will, it is hoped, be carried out on only 50% of area for the next rotation. The cultivation for the remainder, which produces lodgepole pine crops will consist only of windrowing the brash from the previous crop. No fertilizer will be applied, ensuring minimum impact on fish life and general water quality in the river catchments. Native broadleaves such as birch, rowan, alder and the conifer Japanese Larch will be planted in riparian zones in the next rotation.

According to the current FMP 19 hectares of forest plantation will be felled between 2016 and 2020 in the Corvoderry area. Further felling within the forest properties inside the Oweninny site boundary is not scheduled to take place until after 2020. Predicted felling within these areas is shown in Table 15-3.

Table 15-3: Coillte felling schedule

Coillte forest plantation	Indicative areas to be felled post 2020 (hectares)
Croaghaun	104

Moneynierin	126
Shanvodinnaun	75
Total	**329**

Source: Coillte Forest Management Plan Shannettra 2011 to 2015

Note: Not all forest plantation within the Oweninny boundary will be felled under the proposed felling schedule

15.3.3 Sustainable Forest Management

The forest at Oweninny, like all of Coillte's forests, is being managed under the principles of Sustainable Forest Management (SFM) and is certified by the Forest Stewardship Council (FSC), which along with the Programme for the Endorsement of Forest Certification Schemes (Pan-European Forest Certification -PEFC) is one of Europe's two most active forest certification schemes. FSC is an international, non-profit association whose membership includes environmental and social groups and progressive forestry and retail companies working in partnership to improve forest management. Coillte's forests and forest operations have been FSC certified since 2001, demonstrating that they are managed in accordance with strict environmental, social and economic criteria. The FSC certificate is issued for a duration of five years and in 2011, Coillte successfully retained its FSC certificate following a full audit for a subsequent five year period. In the interim years, an annual supervisory audit is conducted by the FSC to ensure compliance with FSC standards.

Coillte's commitment to FSC principles and criteria is further demonstrated by its active participation in the developing of a new Irish forest certification standard. This initiative has resulted in the adoption of a new FSC national standard for Ireland that comes into force from the start of 2013 onwards.

As a strong advocate and practitioner of SFM, Coillte is committed to:

- Developing its forests in a way that is environmentally sensitive, socially beneficial and economically sustainable.
- Choosing to independently verify that SFM is being practised in its forests through the Forest Certification Process.
- Undertaking to work, with its stakeholders, towards full compliance with Irish Forestry standards.
- Complying with applicable legal requirements and the FSC's International Principles and Criteria as embodied in the FSC Irish Forestry Standard.
- Striving to achieve full compliance with the Standard at the earliest possible date with the resources available.
- Abiding by the Forest Service Code of Best Forest Practice and related guidelines on Archaeology, Fisheries, Landscape, Biodiversity among others.
- Striving for continuous improvement of forestry practices.

Coillte demonstrates its commitment to responsible forest management throughout its estate, which now offers the following:

- Approximately 15% (88,000 ha) of Coillte's estate is managed with biodiversity as the primary objective.

- Over 2,000 km of walking and cycling trails across some of the most beautiful Irish landscape.
- More than 150 recreation sites and 10 forest parks maintained by the company.
- Habitat restoration projects (blanket bog, raised bog and priority woodland - EU LIFE co-funded projects, more than 3,000 ha of SAC successfully restored to date).

15.3.4 Effect of Trees

The presence of trees in close proximity to the wind turbines can in general impact on performance and reduce their efficacy but this is dependent on turbine hub height, spacing of wind turbines and forest height and density. Potential effects of trees can occur as follows:

- The fact that trees sway in the wind indicates that they are absorbing energy from the wind, energy that could otherwise be available for turbine operation.
- Where wind turbines are sited in mature forestry and where the canopy is closed, the canopy height creates a false ground level that effectively reduces the hub height of the turbine by the height of the trees. There is a consequent reduction in energy yield.
- The above effect is compounded by the fact that the surface of the tree canopy is not smooth or uniform, leading to increased roughness. The result of this is a thicker boundary layer of disturbed airflow over the canopy than would otherwise occur over more open ground (such as grass or moorland). This increased roughness has a consequent negative impact on energy outputs from the wind farm.
- On sites where trees are not all clear felled at the same time, as is the case in most Irish commercial forests, the copse edges can create substantial edge effects with large wind eddies and even reverse circulations. These can both create larger still boundary layers and also induce turbulence. These can affect both turbine yield and blade and power train life.

In the case of Oweninny only 10% of wind turbines are located within forest plantations or close to their boundaries. The effect of trees on the performance of these turbines will be minimal given that the hub heights will be up to 120m which is almost 6 times the height of the conifer plantations.

15.3.5 Forest Management at Oweninny

15.3.5.1 Tree Felling Methodology

At Oweninny new access tracks will pass through forest plantation areas which will require clear felling of a corridor through Coillte plantation areas and around turbine bases and hardstands. A harvester or processor, as shown in Plate 15-1, will be used for harvesting operations, which incorporates the felling of trees, de-branching, and cutting them into required lengths. Processing is the term used to describe de-branching and cross-cutting. The harvesting machine operator controls the harvesting head which is located on the front arm of the machine. The harvesting head contains the saw, wheels for moving and de-branching the tree, measuring devices for measuring the length and diameter along the tree, and the urea applicator.

The harvester will fell four rows of trees at each side of the machine, resulting in a total of 8 rows of trees within the reach of the machine, being cut. As the rows of trees are generally planted 2 m apart, a harvester can cut up to a 16 m wide strip through the standing forest. Therefore, the harvesting routes (otherwise known as racks), laid down as the harvester moves forward, can be up to 16 m apart.

Plate 15-1: Typical example of a Forest Harvester (Courtesy of Coillte)

The harvesting or extraction rack is the path used by timber harvesting and extraction machinery. It is normally formed by the harvesting machine during the cutting of the timber using the branches and crown of the tree (otherwise known as lop and top). The covering of branches on the extraction rack is also called a brash mat. Brash mats are used to protect the underlying soil from damage and will be well maintained and functional throughout the harvesting operation. Double-wheeled machinery and close poling (laying timber or logs side by side perpendicular to the direction of travel) to spread the load across a low bearing surface will be used as necessary where the bearing capacity of the ground is poor.

Each tree is normally cut at its butt as close to the ground as possible. The tree will then be de-branched and processed into a number of lengths of log which are dependent on the tree diameter and its length. Timber will be sawn into different lengths based on its diameter and quality. These categories are standard across the timber industry. Each category or product size is segregated and stacked at roadside for removal by lorry and crane. The minimum useable diameter is generally 7 cm. The harvesting machine is calibrated to make maximum use of each tree to avoid unnecessary wastage. Tree roots are generally left in situ and the area subsequently replanted.

The processed logs will be dropped in piles beside the extraction rack, the different categories of logs being grouped together to facilitate forwarder extraction.

A forwarder, a typical example of which is shown in **Plate 15-2** is a mechanically propelled machine which uses a hydraulic arm to gather timber logs before stacking them onto the body of the machine. It has a rotating operating area which allows it to be operated efficiently going forward or backward along the racks previously laid down by the harvester.

The forwarder will transport the timber logs from the forest to a predetermined roadside stacking area.

Plate 15-2:Typical example of a forest forwarder (Courtesy of Coillte)

Each category of logs will be separately transported (otherwise known as forwarding) and stacked at a collection area in separate piles in a stable and safe condition. The timber is then transported to a sawmill for processing into wood products dependent on its size and quality. All marketable timber felled to facilitate the development will be used commercially.

Before any harvesting works commence on site, all personnel, particularly machine operators, will be made aware of the following and have copies of relevant documentation:

- The felling plan, surface water management plan, construction management plan, emergency and any contingency plans.
- Environmental issues relating to the site.
- The outer perimeter of all buffer and exclusion zones.

- All health & safety issues relating to the site.

The harvester represents the first point of contact between machinery and the ground and therefore the layout of the extraction racks is critical. The racks laid down by the harvester will be the extraction racks that are travelled many times by the forwarder. The layout of extraction racks or routes will follow the proposed access track routes and will:

- Avoid streams or other watercourses.
- Be as short as possible.
- Avoid any areas of poor crop or bare areas where brash to carry the machine is in short supply.
- Generally extract to existing site access track with the extraction racks laid out at right angles to the road to prevent water flowing down wheel ruts.

Dense, fresh brash mats are the most important part of a felling site as they serve to avoid soil damage, erosion and sedimentation. They will be replenished where they become heavily used or worn. Where damage or serious rutting has started to occur, extraction will be suspended immediately. Relocation of the extraction rack or additional brashing will be used to remedy the situation. Operation of all machinery will be suspended during and following heavy rainfall periods.

Post harvesting and during wind farm access track, turbine foundation and crane hardstand construction in deep peat areas surface brash together with excavated peat material will be removed to the proposed peat repository area where deemed necessary by the geotechnical engineer or construction supervising engineer.

15.4 IMPACT OF THE DEVELOPMENT

15.4.1 Timber harvesting

Forest harvesting along proposed access roads and proposed turbine locations will begin ahead of the wind farm construction. Clean cut-off drains will be installed at the same time as the timber harvesting operations. The wind farm drainage system along the site access roads will be constructed in advance of road construction.

Pre-construction site works will be as follows:

- In advance of access track construction, a 50 m wide corridor will be cleared of trees.
- The trees will be removed by forming racks which will be located at approximately 16m apart.
- Trees will be cut ahead of the track construction and extracted along the racks.
- Clean cut off drains are proposed to divert runoff around areas disturbed during construction. These drains are designed to replicate the natural drainage patterns and will discharge within the same catchments allowing runoff to ultimately drain to the same watercourses as per existing pre development conditions.

The proposed extent of tree felling for this development will be the minimum necessary to construct the turbines and associated infrastructure and will follow a keyhole felling pattern. A clearfell corridor 50m in width will be required for access track development (25m each side of the centre line of the proposed access track). Additionally, an area extending 50m around the turbine foundation base and the crane stand area will also be clearfelled.

The approximate area of tree clearing required for the wind farm will be 1.05 ha. This represents less than 1% of the forest plantation within these property areas. None of the 61 proposed turbines are situated within areas of commercial forest plantation.

Tree felling will be subject to a felling licence from the Forest Service and will be in accordance with the conditions of such a licence. A limited Felling Licence will be put in place prior to any works commencing on site.

To ensure the forest harvesting reduces the potential for sediment and nutrient runoff, the construction methodology will adhere to the Forest Service Forestry and Water Quality Guidelines (2000) and Forestry Harvesting and Environmental Guidelines (2000).

The loss of 1.05ha of forest plantation is of minimal significance in the context of the site area and the Coillte Shannetra Forest Management Plan area, with 2,529 hectares of forest managed for timber production.

There will be no impact on private forest plantation areas.

The various wind turbine manufacturers have different requirements with respect to the area of forest harvesting required around turbine locations; primarily related to commercial considerations including equipment performance warranties. It will be a matter for the chosen turbine supplier to determine exact felling requirements at Oweninny but that indicated is representative of typical requirements. However, the extent of tree felling undertaken will be the minimum necessary to construct the turbines and associated infrastructure.

15.4.2 Replanting

The area clear felled to facilitate the development will be replanted with the exception of the infrastructure footprint. The replanting will occur in accordance with the relevant Shannetra FMP prevailing at the time and will be in a similar manner to silvicultural clear fells which have occurred in the area.

15.4.3 Potential Site Impacts

The key potential impacts from the proposed development relate to changes in the hydrological regime of forested catchments, water quality and ecology and are associated with the felling and construction of the proposed wind farm.

15.4.4 Change in Local Hydrology

The rate of absorption of rainfall on a felled site, and therefore the rate of run-off, is slightly higher than that of a forested site. Mature forest has a high evapo-transpiration rate due to interception of rainfall by the forest canopy, increased evaporation due to roughness of the canopy and transpiration losses due to the deep root system. The removal of mature forest plantation results in more rainfall reaching the surface and running off directly into local watercourses, thereby causing both increased potential for soil erosion and high sediment loadings within those watercourses. This can lead to reduced flow capacity, can create the potential for sediment blockages and can increase the consequential risk of flooding. Deposition of coarse woody debris from the mechanised felling into these channels can also have major effects on channel geomorphology and maximum flow rates. Given the limited amount of mature forest that will or could potentially be removed, any changes to local hydrology due to any felling that may take place are however likely to be extremely small.

15.4.5 Water quality - nutrient enrichment

Decaying brash and tree stumps arising from the felling have the potential to lead to an increase in nutrients, particularly phosphorus in surface water run-off, which could impact on the water quality and aquatic ecology of the Muing River and its tributaries. This river drains the Moneynierin and Croaghaun forest properties. It is likely that forest plantation drainage in these areas has direct connectivity to the river system due to the establishment years of the plantation. Post 1995 water quality mitigation measures, such as introducing riparian buffer strips and drainage curtailment, were included in establishment operations. Water quality issues arising from clear felling in the Corvoderry and Shanvodinnaun properties are less likely to occur as there is no major river system draining these areas. The potential impacts on water quality are discussed in detail in Chapter 10.

15.4.6 Water quality - increase in suspended matter

Felling operations, if not properly managed, can lead to increases in silt runoff and harvesting debris entering waters leading to increased suspended solids. However, the risk of soil and harvesting debris entering watercourses arising from the wind farm development is no different to that arising from the regular harvesting of these stands. Provided the appropriate guidelines are employed and their use enforced during harvesting and extraction, there should be no additional problems associated with any felling that may take place. Again potential impacts are discussed in Chapter 10.

15.4.7 Loss (or Change) of Habitat

The effects on loss or change of habitat are considered in Chapter 6 – Terrestrial Ecology. However, the following observations are made:

- The trees at the site are a commercial stock whose lifecycle comprises felling and replanting for commercial exploitation. Earlier felling of areas is a temporal change, rather than a fundamental change of use.
- The total area removed from existing land use within the forestry will be a small proportion of the available forestry habitat in the vicinity of the site and in the region.

15.4.8 Noise Disturbance During Felling

Areas that may be identified to be cleared of trees are a minimum of 800m distance from the nearest properties. Noise disturbance that may arise is not considered to be a significant issue, given that it will be temporary, short-lived and will occur only during daytime. In addition, any noise impacts resulting from the felling of trees would have occurred at some point during the commercial operation of the forest site.

15.4.9 Increase of Extraction Road Traffic

Forest harvesting will require timber lorries to remove the timber off site. The volume of additional traffic is likely to be low and the increase on that arising from any existing felling plans is likely to be minimal and the impacts insignificant. It is noted that in reality these are not additional traffic movements, since they would take place in any event, albeit at another time.

15.5 CUMULATIVE IMPACTS

The following sets out the cumulative impacts of forestry with the identified projects in the area.

15.5.1 Wind Farms

15.5.1.1 Corvoderry Wind Farm

The planning approved Corvoderry wind farm is located within the eastern section of the Oweninny site and is entirely within a private forest commercial pine plantation. The EIS for the wind farm indicates that a total of 160 hectares will be clear felled to facilitate this development. Within the Oweninny site the total cumulative area of forest plantation to be clearfelled, combining Corvoderry and Oweninny, will be 161.05 hectares. The forest plantation clearfell will be subject to a Forest Service Felling Licence.

15.5.1.2 Dooleeg Wind turbine

There is no forest felling requirement associated with this wind turbine and no cumulative impact with Oweninny wind farm will occur.

15.5.1.3 Tawnanasool Wind Farm

There is no forest felling requirement associated with this wind farm and no cumulative impact with Oweninny wind farm will occur.

15.5.1.4 Potential future development of Oweninny Phase 3

The potential impacts on forestry from all three Phases of the Oweninny wind farm were described in Chapter 15 of the EIS which accompanied the planning application to An Bord Pleanála in 2013. That assessment concluded that with the implementation of the mitigation measures as outlined, and considering that the level of forest harvesting required to facilitate the proposed development was small, no significant residual impacts are expected from forestry associated with all three phases.

15.5.2 Overhead Line Projects

15.5.2.1 Bellacorick to Castlebar 110kV OHL Uprate

There is no forest felling requirement associated with this line uprate and no cumulative impact with Oweninny wind farm will occur.

15.5.2.2 Bellacorick to Moy 110kV OHL Uprate

There is no forest felling requirement associated with this line uprate and no cumulative impact with Oweninny wind farm will occur.

15.5.2.3 Bellacorick to Bangor Erris 38 kV OHL Uprate

There is no forest felling requirement associated with this line uprate and no cumulative impact with Oweninny wind farm Phase 1 and 2 will occur.

15.5.3 Meteorological Mast at Sheskin

The planning approved meteorological mast at Sheskin is located adjacent to an existing access track and only limited forest clearfelling will be required. No significant cumulative impact with the Oweninny wind farm will occur.

15.5.4 Grid West

Potential impacts on forestry are discussed in Section 5.6.10 of the IEP Report which deals with Material Assets and Land use. The following information has been extracted from that report.

The proposed underground cable route would pass through approximately 140m – 160m of forest plantation requiring clearfelling of a corridor to allow construction and access for future maintenance. In the context of the overall Grid West cable route the impact on forestry is described as imperceptible.

In terms of the overhead line routes, either 400kV or 220kV some towers would be located within forest plantation areas and a corridor along the line route oversailing forest plantation areas would be required as stated in the report;

“Approximately 11% (12.2km) of the indicative OHL over-sails forestry plantations. While forestry tends to be located on poor quality soils (often reclaimed bogs), it is classified as very high sensitivity because when a 400kV OHL crosses a forest, the trees within 37m of the centre of the OHL are cleared - therefore forest plantations are highly sensitive to OHL developments.”

The potential impacts on forest plantations are described as being “in the permanent, slight adverse to major adverse range along approximately 11% of the OHL”.

There will be significant loss of forest plantation associated with the Grid West overhead line route options should one of these be adopted. However, in terms of cumulative impact with Oweninny an area equivalent to 110% of that clearfelled for the wind farm would be replanted as required by the Forestry Act of 1946 and subsequent regulations. In the long term therefore there would be no net loss of forest plantation arising from Oweninny and the cumulative impacts with the Grid West would be short term in nature.

15.6 MITIGATION

Although the changes in felling and replanting plans are considered not to be significant, a number of steps will be taken to minimise any potential adverse impacts, including:

- Felling and extraction of timber will, as far as possible, be undertaken at the same time as licensed extraction activities in order to minimise traffic and noise disturbance.
- Harvesting extraction routes will be the shortest possible and avoid the crossing of watercourses where possible. Felling and extraction of timber will only be permitted by experienced and fully trained operators.

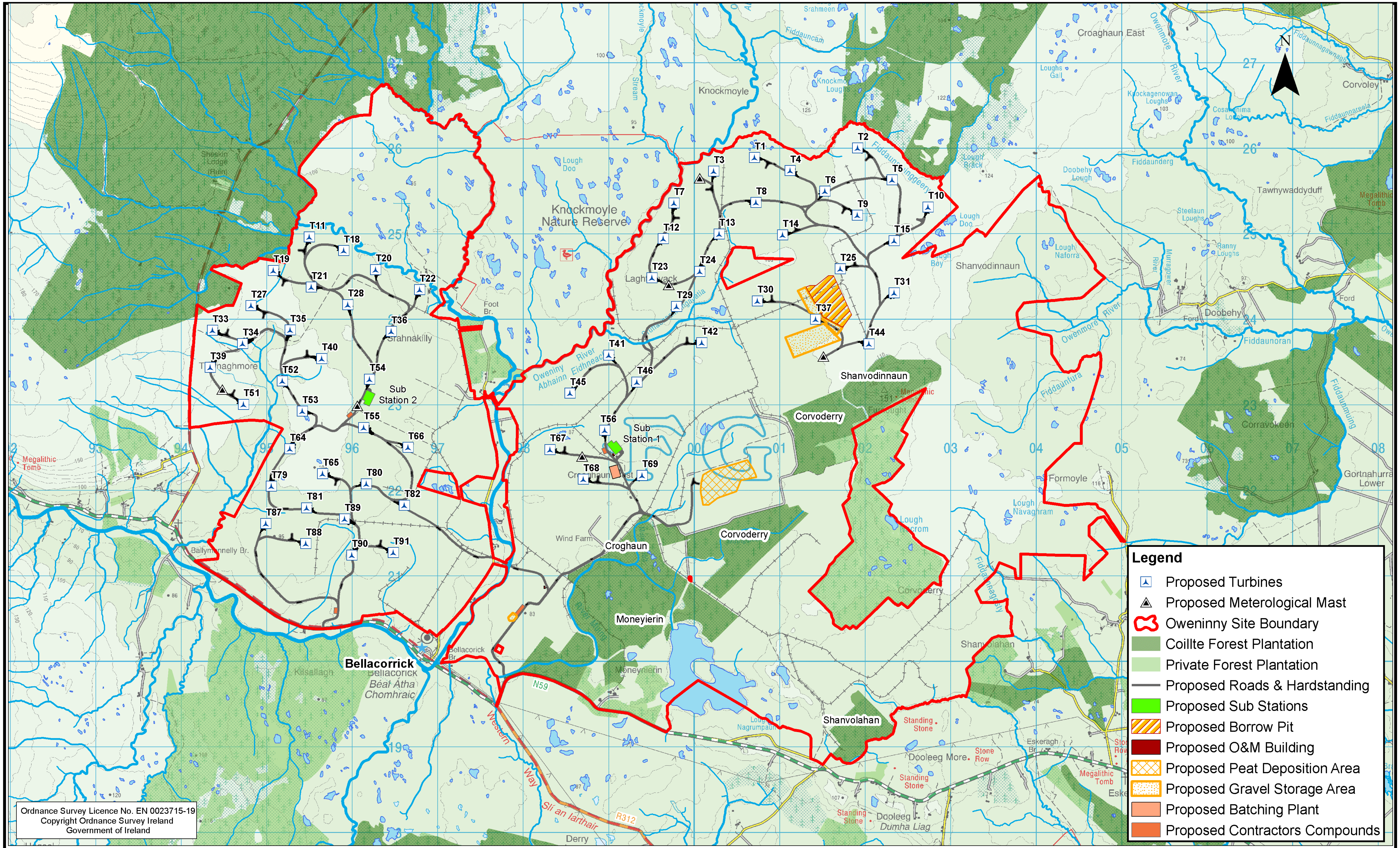
- Where feasible, felling and extraction will be undertaken outside of the bird breeding season.
- Physical exclusion techniques will be employed where deemed necessary by the designated site ornithologist to prevent colonisation of potential nest site areas prior to forest harvesting extraction and construction.
- Brash mats will be used as necessary on any off-road harvesting routes to minimise soil damage and disturbance and will either be removed and transported to the peat repository area for the Muing river area or windrowed at least 20m from any watercourse.
- Branches, logs or debris will not be allowed to accumulate in aquatic zones (permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map) and will be removed as soon as possible.
- It is proposed to provide clean water cut off drains to stop water running across construction areas and to discharge these to local water courses. Drainage channels will collect runoff from the construction and development areas. These drainage channels will discharge to dedicated Sedimentation Ponds or Settlement Ponds throughout the site. These ponds will hold water in order to reduce turbulence thus allowing solid particles of sediment or silt to settle out.

Further to the above, all construction of forest roads, including the creation of buffer zones and roadside drainage, will adhere to Forest Service Guidelines:

- Forestry and Water Quality Guidelines
- Forest Harvesting and Environmental Guidelines

15.7 CONCLUSIONS

With the implementation of the mitigation measures as outlined and considering that the level of forest harvesting required to facilitate the proposed development is small, no significant residual impacts are expected.



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Oweninny Power Ltd.

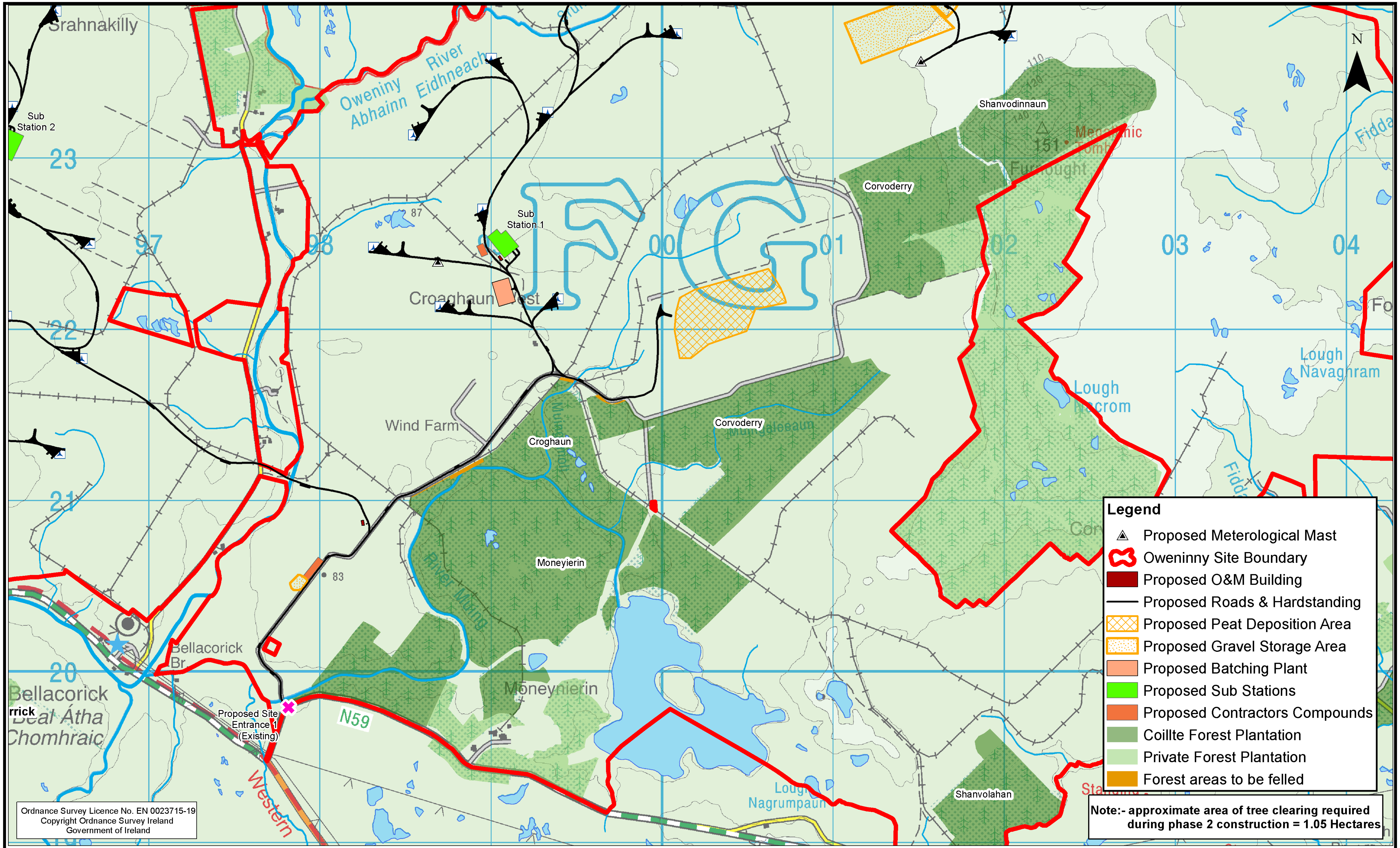
Client	Oweninny Power Ltd.
Title	Oweninny Coillte & Private Forest Plantation
Project	Wind Farm Project at Oweninny, Bellacorick, Co. Mayo
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	29/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:40,000

MAP REFERENCE

FIGURE 15.1



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Project	Wind Farm Project at Oweninny, Bellacorick, Co. Mayo
Title	Areas of forest plantation to be felled during phase 2 construction
Production Unit	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	29/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:20,000

MAP REFERENCE

FIGURE 15.2

16 MATERIAL ASSETS

16.1 INTRODUCTION

Material assets comprise resources that are valued and intrinsic to specific places. In this chapter the key issues of tourism, important to north Mayo, local energy supply, air navigation, television, telecommunications and property prices are discussed. Cultural heritage including architectural heritage, air quality, soils and geology which are also considered as material assets are dealt with specifically in separate chapters.

16.2 TOURISM & AMENITY

16.2.1 Approach and methodology

Data and statistics on tourism nationally have been obtained from the

- Central Statistics Office Statistical Yearbook of Ireland 2012,
- Fáilte Ireland, Tourism Facts 2011,
- Fáilte Ireland, Overseas Visitors to Ireland, 2012
- Fáilte Ireland Tourism Barometer 2012

and from other published sources.

16.2.2 Receiving Environment

16.2.2.1 General

Tourism is a vital component of the national economy and is now regarded as one of the greatest potential wealth creators and employers at national level. It is estimated that the tourism and hospitality industry supports over 180,000 jobs in the over 20,000 enterprises that make up the tourism industry[157].

Its importance and the employment it can generate are particularly relevant in areas that lack opportunity for other kinds of development. As presented in

Table ***16-1***, the number of tourists visiting Ireland increased rapidly for much of the past decade. This trend was reversed between 2008 and 2010 with the onset of the global recession. Figures for 2011 indicate numbers increasing with a slight increase (0.2%) between 2011 and 2012.

[157] Irish Tourist Industry Confederation, Year End Report 2012 Press Release, http://www.itic.ie/fileadmin/docs/Press_Release_-_ITIC_YE_Review_2012.pdf

Table 16-1: Overseas Visits (Thousands) to Ireland

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number	6,369	6,574	6,977	7,709	8,012	7,839	6,928	6,037	6,505	6,517	6,986	7,105

In 2014, out-of-state tourist expenditure, including spending by visitors from Northern Ireland, amounted to €3.9 billion. With a further €1 billion spent by overseas visitors on fares to Irish carriers, total foreign exchange earnings were €5.1 billion. Domestic tourism expenditure amounted to approximately €1.8 billion, making tourism in total a €5.7 billion industry and indicating that tourism has continued to be one of the country's most important indigenous industries in recent years[158].

The CSO's official count[159] of direct employment in 'Hotels and Restaurants', a category which includes hotels, other short-stay accommodation, restaurants, bars, canteens and catering, was 121,686 nationally in 2011 (approximately 5.8% of total employment). Direct employment in 'Hotels and Restaurants' in Mayo was 3,481 in 2011(approximately 5.7% of total employment in Mayo). Direct employment in the accommodation and food services sector reached 136,000 by quarter 2 of 20157 reflecting increasing tourism in Ireland.

Further potential is anticipated and tourism is a priority sector for development by the Government. Maximising the potential of the tourism sector and economic diversification are recognised as key steps in helping to achieve the critical mass of population in rural areas that have been suffering from population decline.

16.2.2.2 Local

Growth in tourism in Ireland has not been uniform across the country. The majority of the growth has occurred in a number of the larger urban centres, being partly due to the emergence of convenient, frequent and affordable air access to these centres. This in turn has resulted in a fundamental shift in consumer preferences towards short city breaks at the expense of more long-stay rural-based holidays.

County Mayo is the third largest county in Ireland and has richly varied scenery in its mountains, plains, river valleys and extensive coastal areas and islands. It is rich in heritage and has a large number of visitor attractions, see **Figure 16-1**, including

[158] Fáilte Ireland, Tourism Facts 2014, August 2015
[159] *Profile 3 – At Work*, Official CSO Publication, July 2012

Ballintober Abbey, Ballycroy National Park and Visitor Centre, Croagh Patrick Centre, the Céide Fields, Foxford Woolen Mills, the Museum of Country Life, the North Mayo Heritage Centre, Westport House and country Park and the Jackie Clarke Collection in Ballina. The Céide Fields for example attracted in excess of 25,886 visitors in 2011[160].

Heritage is a significant factor in attracting visitors to Ireland, and Mayo is ideally placed to take advantage of the benefits that will accrue from heritage tourism. The Heritage Council's Strategic Plan 2012 – 2016 identifies 16 objectives focused on supporting employment, education and awareness, and heritage-based tourism. Supporting employment through investment in heritage infrastructure will focus in particular on innovative and new approaches to the understanding, maintenance, enjoyment and quality of our natural and cultural heritage. The Heritage Council Strategic Plan aims to build year-on-year on tourist numbers while also maintaining the 4:1 ratio of return on investment. Mayo's heritage centres are well placed to benefit from the strategic plan.

Angling tourism is an important aspect of Mayo's economy. The River Moy is a renowned salmon river attracting visitors nationally and internationally. Of local importance is the Owenmore River flowing through Bangor Erris and into which the Oweninny feeds. It provides good salmon and trout fishing. Bangor Erris Angling club was established in 1970 and the club's waters include a stretch of the Owenmore River and also Carrowmore Lake.

Tourism is also a key industry sector in the Erris area. There are many fine beaches in the vicinity within a short distance from Belmullet which are frequented by local, national and international visitors. The varying coastline allows for multiple recreational activities such as fishing, walking and water sports.

Recreation is an important component of modern living and has a valuable social, economic and educational role to play in modern society. Walking routes adjacent to the study area, have been discussed in Chapter 11 and include the Western Way, the Bangor Trail, the Burrishoole Loops, the Crossmolina Loop Walks, the Achill Spur, the Enniscoe House Loop, the Keenagh Loop, the Letterkeen, Bothy, the Lough Aroher Loops, the Ceathrú Thaidhg Loop Walks, the Belleek Nature Trail, the Sralagagh Loop Walk, the Inishbiggle Loop Walks, The Great Western Greenway, the Foxford Way and 'Slí na Sláinte' walking routes.

Cycle routes are also frequented in the general area and have also been discussed in Chapter 11. The North Mayo Cycle Network, using Belmullet as a hub, has a number of

[160] Number of visitors recorded when OPW staff were present on site which was not at all times.

marked cycling trails ranging in distance from 37km – 72km, including, the Carrowmore Loop (37km), the Pullathomas Loop (50km). The Glinsk & Rossport Linear Route (72km), the North Mayo Linear Route – Belmullet – Ballycastle (49km) and the Carrowmore Lake Loop. The latter, at an approximate 11km distance, is located closest to the proposed wind farm site. The Great Western Greenway is also used as a cycling route.

16.2.3 Impact of the Development

16.2.3.1 General

Ireland's scenic beauty has been a cornerstone of international tourism marketing campaigns for decades. The Fáilte Ireland port survey of overseas holiday makers in 2011 indicated that 85% ranked the beauty of Ireland's scenery and the range of natural attractions (85% each) as key drivers for holidaying in Ireland. Additionally 83% ranked Ireland's interesting history and culture as another key component.

The future sustainability of Ireland's tourism industry is, therefore, inextricably linked to the maintenance of the character and scenic qualities of the Irish landscape.

Various tourism strategies highlight the importance of showcasing Ireland as an environmentally clean country. Wind farms contribute to this by demonstrating Ireland's commitment to renewable energy and a cleaner environment. Public attitude is that the presence of a wind farm adds interest to an area, associates the area with clean, green energy or presents the area as progressive and sustainable.

The principal impact on tourism which can occur from wind farm developments relate to that on visual amenity of the area although secondary impacts such as disruption to traffic flows during construction and construction noise can also impact.

16.2.3.2 Cumulative Impacts

Tawnanasool wind farm

With regard to the Tawnanasool wind farm the EIS concluded in Chapter 10 as follows:

"It is the policy of Fáilte Ireland to support the development of sustainable and renewable energy generation facilities at appropriate locations and in accordance with proper planning and development. In this instance, the proposal would appear to comply with the Council's policy by developing in a Tier 1 location. There seems to be a conflict with the Landscape Sensitivity Matrix which notes that windfarms have a high potential to create an adverse impact in Policy Area 2.

Additionally, we would have concerns that the planned grid upgrade by EirGrid at Bellacorick and the potential number of future windfarms in this area could result in the wilderness area being diminished."

Oweninny is a Priority area for wind farm development whereas Tawnanasool is located in Tier 1. Tourists travelling along the N59 would see sequentially Oweninny wind farm and then Tawnanasool. This type of cumulative impact is discussed in more detail in the section on Landscape above.

Corvoderry wind farm

This wind farm is located within the Oweninny site and can be viewed from the cumulative impact on tourism in the same way as that of the Oweninny wind farm. It is also located in a Priority Area for wind energy development. Tourists travelling on the N59 would see the Corvoderry site in combination with the Oweninny site and this is dealt with in greater detail in Chapter 11 above.

Potential future development of Oweninny Phase 3

The potential impact of all three phases on tourism was fully assessed in the EIS submitted as part of the planning application to An Bord Pleanála in 2013. No significant impacts were identified.

Grid West Project

Potential tourism impacts are discussed in the Grid West IEP report in Sections 5.6.11, 6.4.11 and 6.5.1.10 relating to the underground cable, 400kV overhead line and 220kV/underground cable hybrid.

For the underground cable route recreation and tourism impacts are identified as arising primarily from the landscape and visual impacts of the converter stations and the disruption during construction of the cable and the stations. The visual impacts of the converter station sites, which are not located in tourist areas, will be mitigated through landscaping and screening. Traffic disruption will be mitigated by planning and management, taking cognisance of local tourism and recreation events such as sporting occasions, fairs, and parades.

The two OHL crossings of the River Moy have the potential to impact on tourism and recreational fishing; this can be mitigated to some extent by sensitive tower location. Traffic disruption will be mitigated by planning and management, taking cognisance of local tourism and recreation events such as sporting occasions, fairs, and parades.

There will be some potential for cumulative impact on tourist traffic but with the implementation of traffic management plans the impact should be insignificant. It should be noted that Oweninny construction works will take place internal to the site whereas the Grid West underground cable route is linear and will require road closures along some stretches as it will be constructed within the road structure. Careful planning of turbine delivery schedules will ensure that these do not coincide with Grid West road closures avoiding cumulative impacts.

Ireland 2002

Sustainable Energy Ireland (SEI and now the Sustainable Energy Authority of Ireland) commissioned a survey aimed at identifying public attitudes to renewable energy and to wind energy in Ireland[161]. The survey found that, in general, Irish people are positively disposed towards the development of wind farms. One of the main findings was that those with direct experience of wind farms in their locality do not in general consider that they have had any adverse impact on the scenic beauty of the area or on tourism.

However, the survey also indicated that people will not accept wind farms everywhere and that special care should be taken to ensure that wind farms respond to contextual landscape characteristics.

Ireland 2007

Fáilte Ireland, in association with the Northern Ireland Tourist Board (NITB), commissioned a survey of both domestic and overseas holidaymakers to Ireland to determine their attitudes to wind farms[162]. The purpose of the survey, which involved face-to face interviews with a total of 1,300 domestic and overseas tourists throughout Ireland, was to assess whether or not the development of wind farms would impact on the enjoyment of the Irish scenery by holidaymakers.

Interviews indicated that most visitors are broadly positive towards the idea of building more wind farms on the island, although a sizeable minority (14%) exists who are negative towards wind farms in any context.

Despite the fact that almost half of the tourists interviewed had seen at least one wind farm on their holiday, most felt that their presence did not detract from the quality of their sightseeing, with the largest proportion (45%, Strong positive and Slight positive) saying that the presence of the wind farm had a positive impact on their enjoyment of sightseeing, with 15% claiming that they had a negative impact (see **Figure 16-1**). Compared with other types of development in the Irish landscape, wind farms elicited a positive response with compared with some other prominent developments.

More than three quarters of respondents claim that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or have a strong or fairly strong positive impact on future visits to the island of Ireland (see **Figure 16-2**).

[161] SEAI, Attitudes towards Wind Farms in Ireland
[162] Fáilte Ireland, Visitor Attitudes on the Environment - Wind Farms, 2008/ No 3

Of those who feel that a potentially greater number of wind farms would positively impact on their likelihood to visit, the key driver is their support for renewable energy and potential decreased carbon emissions. Those who are negatively disposed are more likely to cite that wind farms look ugly, are noisy and can frighten or damage wildlife. A small number also claim they have preference for other forms of renewable energy.

Scotland 2011

A recent independent study carried out on behalf of VisitScotland, (Scotland's National Tourism Organisation), demonstrated that the presence of a wind farm would have little impact on tourists deciding where to holiday[163].

In 2011 VisitScotland commissioned omnibus research to learn more about consumer attitudes to wind farms and their effect on tourism, in order to inform VisitScotland policy.

In the study 2,000 interviews were undertaken with a nationally representative UK sample and a further 1,000 interviews conducted with a Scotland representative sample (both samples being asked very similar questions).

In general the majority (86%) were in agreement that the natural landscape and countryside scenery were important factors to them when taking holidays or short breaks in the UK with only 4% stating that scenery and landscape weren't important.

Of those surveyed almost two thirds of UK respondents (67%) claimed that they had seen a wind farm whilst on a break in Scotland with 22% stating they had not. A higher percentage of Scotland respondents (77%) claimed to have seen a wind farm whilst on a holiday or short break in Scotland with 16% stating they had not.

UK respondents were asked whether the presence of a wind farm would affect their decision about where to visit or where to stay on a UK holiday or short break. 80% stated their decision would not be affected with 20% claiming that it would be affected. For the Scotland residents, 83% stated their decision would not be affected by the presence of a wind farm with 17% claiming that it would affect their choices over which area to visit/where to stay whilst on a Scottish break.

In response to the question as to whether wind farms spoil the look of the UK (Scottish) countryside 90% disagreed that this was the case, see Table 16-2.

[163] Visit Scotland, Wind Farm Consumer Research, 2012. http://www.visitscotland.org/research_and_statistics/tourism_topics/wind_farms.aspx

Table 16-2: Response to question as to whether wind farms spoil the look of the countryside

Sample Country	Strongly Disagree	Slightly Disagree	Neither agree or disagree	Slightly agree	Strongly agree
UK	28.2%	23.9%	29.3%	0.4%%	8.3%
Scotland	27.5%	24.6%	28.3%	0.6%	9.0%

The research also demonstrated that a high proportion, some 83%, of Scotland respondents wouldn't tend to avoid an area if there was a wind farm present. Almost half of all those surveyed expressed an interest in visiting a wind farm development if it included a visitor centre.

16.2.3.3 Local Interest

North Mayo offers many tourist attractions particularly in its coastal areas and regional towns. Most notable of these within the vicinity of Oweninny wind farm are the Céide Fields located directly north on the coast of Mayo, the Enniscoe Museum located near Crossmolina and Ionad Deirbhle located on the Iorrais peninsula south of Béal an Mhuirthead. Generally, there is concern regarding the intrusion of this type of development within landscapes that attract visitors for their scenic beauty. However, there are no scenic views as described in the Mayo County Development Plan 2008 - 2011 looking north from the N59 towards the Oweninny site.

The proposed visitor centre at Oweninny will be an added attraction to the area. This centre will provide information on the cultural heritage of the area, particularly the history of peat harvesting and power generation on the site, the development of renewable energy generation on the site and the story of the bog rehabilitation programme. The visitor centre will also provide a hub for specialist groups, Bord na Móna for example, maintains a carbon restore research site at Oweninny as part of the Environmental Protection Agency's Climate Change Research Programme demonstrating the value of bog rehabilitation[164]. The internal access track network within the wind farm site, comprising some 49 kilometres, provides an opportunity to develop walking routes in some areas. Facilities for the more adventurous tourists will be provided at Coillte's wind farm administration building.

[164] EPA Climate Change Research Programme 2007–2013, *Carbon Restore* – The Potential of Restored Irish Peatlands for Carbon Uptake and Storage (2007-CCRP-1.6)

Based on experience with wind farms elsewhere, the development could attract additional visitors to the area, given that it will be one of the largest in the country when constructed. However, it is recognised that other wind farms were unique at the time of their development and that the presence of a wind farm at Oweninny will not have the novelty value that was attached to other wind farm developments that attracted substantial numbers of visitors.

Renewable energy projects can assist with the diversification of the rural economy and, in addition to providing employment and satisfying energy needs, increase the tourist attraction of an area.

Walking: Part of the Western way is located to the west of the site, (forms the site boundary in the townland of Tawnaghmore) and passes through Coillte's Sheskin forest which stretches from Bellacorick to near Ballycastle south. It is a major trail at this location, starting near Ballymonnelly Bridge and traversing some of the wildest and remotest forests in the west of Ireland with a walking time of about 10 hours. The trail passes through a large area of conifer forest established on the boglands of north Mayo and leads to rolling hills north of the site. Although no habitation is encountered the walking route passes Sheskin Lodge, a former hunting lodge, and also many old walls of former homesteads indicating previous occupation of the area.

Coillte's Open Forest policy will not be affected by the wind farm development and free access for walkers and other visitors to the Western Way will continue throughout the construction and operational phases.

16.2.4 Mitigation

The Oweninny Visitor Centre will provide a hub location for walkers who wish to use the Western Way and the walking trail will be promoted by Oweninny Power Limited through provision of additional signage directing walkers to the route. This will provide facilities to encourage walking in the area by those who may otherwise regard the wind farm site as an industrial area.

16.2.5 Conclusions

Surveys of tourist attitudes to wind farms conducted by Fáilte Ireland and more recently by VisitScotland indicate that wind farms are not incompatible with tourism, with the majority of those surveyed indicating that they would not avoid areas where wind farms were located. Additionally, in the case of Scotland almost half of those surveyed indicated that the presence of a visitor centre at the wind farm would attract them to it.

The Oweninny Visitor Centre will thus serve as an added attraction and will provide an additional tourist hub on the north Mayo tourist trail providing the historic background to the site, its development and its integration with the natural ecology of the area. It will provide an educational centre on renewable energy.

There is no evidence that the public is deterred from using walks, for example, resulting from the presence of wind farms and in fact wind turbines become features of interest. The interim guide to the Miners Way and Historical Trail[165] national long-distance walk route cites as follows: "*An outstanding feature of this Corry Mountain section is the recently erected wind farm*".

The proposed development will support the regional tourist industry providing added attraction and will have an overall significant positive benefit on tourism to the area.

16.3 ENERGY SUPPLY

16.3.1 Receiving Environment

Sustained economic growth requires that additional electricity generating capacity be installed on a continuing basis. The transformation of Irish society and its economy, as in the case of many other countries, relied heavily on the exploitation of apparently abundant, affordable and widely available energy supplies and the services they provide. Such services are intrinsic to the operation of a modern economy with its needs for warmth and comfort, power and light, and mobility and communications.

Peak demand refers to a period in which electrical power is expected to be provided for an instantaneous period at a significantly higher than average supply level. Peak demand fluctuations may occur on daily, weekly, monthly, seasonal and yearly cycles. The actual point of peak demand is a period which represents the highest point of customer consumption of electricity, see Table 16-3 for typical values.

The trend in weekly peak demand for each year demonstrates a characteristic shape, with high demand in the early weeks of the year, lower demand in the summer months and higher demand as winter returns[166].

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[165] The Miners Way (41km) and Historical Trail (72 km) are combined long distance walking routes that take in the rolling hills and valleys of counties Roscommon, Leitrim and Sligo, Ireland. The entire walking route is a moderate National Waymarked Trail taking on average 6 days to complete and is approximately 113 km long

[166] http://www.eirgrid.com/operations/systemperformancedata/systemrecords/

Table 16-3: Electricity System Records

Parameter	Value	Effective Date
Winter Night Valley	2,928 MW	December 2010
Summer Night Valley	1,786 MW	August 2008
Mid-day Peak	4,410 MW	December 2010
Evening Peak	5,090 MW	December 2010
Saturday Peak	4,524 MW	January 2010
Sunday Peak	4,335 MW	January 2010
Maximum Wind	1,967 MW	January 2015

The last two decades have seen significant growth in demand for energy in Ireland and for electricity as a component of overall energy demand.

The total amount of primary energy (TPER) used by the residential sector was 3,688 ktoe (42,889 GWh) in 2011. While the residential sector's energy usage has increased by 26% since 1990, its share of total primary energy usage fell from 32% in 1990 to 27% in 2011.

On a weather corrected basis, the "average" dwelling in Ireland consumed almost 20,000 kWh of energy in 2011. This comprised approximately 5,000 kWh of electricity and almost 15,000 kWh of non-electrical consumption.

The proposed Oweninny wind farm is capable of providing power up to the equivalent of approximately 90,000 households, a significant contribution to meeting the energy needs.

Despite a significant growth in the number of one person households, by international standards the average household size in Ireland remains high (at 2.81 persons per household in 2006). This partly accounts for climate corrected electricity consumption per dwelling in Ireland being above the average for the UK and for the EU.

The annual electricity demand in Ireland over the period 1989 to 2011 is shown **Figure 16-4**.. This shows a peak period of electricity demand, in kilotons of oil equivalent, between 2006 and 2008 with a subsequent decrease towards 2005 levels in 2011. An econometric process is used to forecast the future demand for electricity. The energy forecast model is a multiple linear regression model which predicts electricity sales based on changes in Gross Domestic Product (GDP), Personal Consumption of Goods and Services (PCGS), and population. Relating the electricity demand of a country to its economic performance is standard international practice.

Three main electricity sales forecasts (high, median and low) are produced for Ireland for the next seven years. Forecasts provided by the Central Bank and the Economic and Social Research Institute (ESRI) are used as inputs to the model.

Table 16-4 presents the forecasts of transmission demand for the years 2013 to 2017, which may be taken as indicative of a general trend in demand growth. These figures are available on the EirGrid website.

Table 16-4: Transmission Demand Forecast (MW)[167]

Year	Ireland	Northern Ireland	All-Island
2014	4774	1728	6473
2015	4806	1733	6510
2016	4861	1739	6571
2017	4911	1746	6628
2018	4971	1755	6696
2019	5030	1764	6765
2020	5104	1775	6849
2021	5169	1786	6925
2022	5236	1797	7002
2023	5301	1808	7078

While reliable high efficiency plant operating at base load is also required, some of this demand will be met from renewable and alternative forms of electricity production, such as wind, in line with Government strategy.

The production of electricity by conventional thermal power plants requires the use of fossil fuels and Ireland has a very high energy import dependency (85%).

Through the Public Service Obligation (PSO) levy, electricity consumers in Ireland support national policy objectives, including peat fired and renewable electricity generation.

16.3.2 Impact of the Development

The proposed Oweninny wind farm will contribute to ensuring that adequate electricity supplies are available to support economic activity and growth in a manner fully compatible with Government energy and environmental policies. It will ensure that national economic development is not constrained by shortfalls in the availability of electric power.

The wind is an intermittent energy resource, since it does not blow all the time. However, this does not reduce its environmental value as a source of power. While energy output

[167] SONI EirGrid, All Island Generation Capacity Statement, 2014 - 2023

from a wind farm is variable, electricity demand itself is constantly fluctuating and supply and demand must be matched on a minute to minute basis, 24 hours of the day, every day of the year.

At a typical capacity factor of 33% it is anticipated that the project will generate approximately 497,218MWh of electricity per annum and this is a very significant contribution to national availability of electricity supplies. The Sustainable Energy Authority of Ireland (SEAI) estimates that each additional MW of installed wind capacity generates in one year the equivalent electricity consumed by 525 average homes for the same period. The electricity generated at Oweninny will be the equivalent to the annual consumption of approximately 90,000 homes.

16.3.2.1 Cumulative impacts

The cumulative estimated energy benefits that would occur from other wind farm projects are as follows:

- Corvoderry wind farm at a rated output of 23MW, a capacity factor of 33% would generate 66,488 MWh of renewable electricity annually.
- Dooleeg wind turbine with a rated output of 2 MW a capacity factor of 33% would generate 5,781 MWh of renewable electricity annually.
- Tawnanasool wind farm at a rated output of 23MW a capacity factor of 33% would generate 46,252 MWh of renewable electricity annually.

However, as the existing Bellacorick wind farm, rated at 6.45MW will be decommissioned following Phase 1 and Phase 2. This would result in the loss of existing renewable energy generation of 18,790 MWh annually

The total cumulative renewable energy generation should all wind the above wind farms including phase 1 and Phase 2 of Oweninny be constructed and operated would be 596,950 MW annually.

The uprating of the Bellacorick to Castlebar 110kV OHL and the modifications to the existing Bellacorick substation would facilitate the export of renewable energy from Phase 1 and 2 of the Oweninny development.

The production of electricity by the proposed development will not involve fuel consumption. Each additional MW of installed wind capacity removes the need to import fossil fuels.

A common assertion by opponents of wind power is that as much energy is consumed in the manufacturing and installing wind turbines as they subsequently produce. Energy balance is the comparison of energy used in manufacture with the energy produced by a wind turbine or power station. This can be expressed in terms of energy 'pay back' time, i.e. the time needed to generate the equivalent amount of energy used in manufacturing the wind turbine or power station. The average wind farm will pay back the energy used in its manufacture within 3-5 months of commencement of operation[168]. This is dependent on turbine size and wind speeds. Larger turbines such as those proposed at Oweninny will have longer pay back times. For example a life cycle analyses of the Vestas V112 3.0 MW wind plant indicates that the breakeven time is approximately 8 months[169].

This means that over its operating life an onshore turbine is expected to recover multiples of the input energy required. This takes account of energy associated with maintenance of the wind farm, as well as the losses that are inherently part of electricity transmission and distribution systems.

The SEAI and EirGrid conducted a joint modelling exercise to investigate the impact of increased wind generation on electricity generation costs in 2011[170] for Ireland. In general, while capital costs of wind energy plants are higher than conventional generation, wind energy can act as a hedge against high fuel costs by depressing the wholesale cost of electricity. This exercise attempted to identify how much the wholesale cost was depressed and compared this to the additional costs faced by consumers, namely the PSO and the additional constraint costs. A scenario with the expected 2011 installed wind capacity was compared to a scenario that did not have any wind capacity. The Single Electricity Market (SEM)[171] operates on an all-island basis and both Ireland's and Northern Ireland's electricity systems were modelled.

The modelling exercise specifically quantified the impact of wind generation on the SEM wholesale price of electricity. The differing operational constraint costs were included for both scenarios. For the 2011 expected wind capacity scenario the cost of Ireland's PSO for wind generation was added. Key findings were as follows:

168 Milborrow, Dispelling the Myths of Energy Payback Time, as published in Windstats, Vol 11, No 2 (Spring 1998).

169 D'Souza et al, PE North West Europe ApS, Life cycle assessment of electricity production from a V112 Turbine wind plant

170 Impact of Wind Generation on Wholesale Electricity Costs in 2011, SEAI & Eirgrid, February 2011

171 The Single Electricity Market (SEM) is the wholesale electricity market operating in the Republic of Ireland and Northern Ireland. The SEM provides for a competitive, sustainable and reliable wholesale market in electricity, a joint venture between Eirgrid plc and SONI Limited.

- The wind generation expected in 2011 reduced Ireland's wholesale market cost of electricity by around €74 million.
- The reduction in the wholesale market cost of electricity was approximately equivalent to the sum of PSO costs, estimated as €50 million, and the increased constraint costs incurred, due to wind in 2011.

The study clearly demonstrated that wind energy is not contributing to higher wholesale electricity prices on the Irish electricity system.

In a separate analysis that looked at the cost impact of wind and other renewable technologies in the 2020 time frame, under the scenarios studied consumers were shown to pay less through the support mechanisms than the savings they make from lower wholesale power prices.

16.3.2.2 Potential future development of Oweninny Phase 3

The impact of the implementation of all three phases of Oweninny on energy supply if implemented has been described in the original EIS submitted as part of the planning application to An Bord Pleanála in 2013. Phase 3 would add considerably to the National renewable energy supply.

16.3.3 Mitigation

No mitigation of impacts is required.

16.3.4 Conclusions

The proposed development will have significant positive effects and will not result in significant adverse environmental impacts.

16.4 AIR NAVIGATION

16.4.1 Receiving Environment

The highest part of the site lies at an elevation of approximately 149.5 m OD. There are areas at higher elevation nearby, including Slieve Carr (721 m OD) to the south east, Nephin Beg (627 m OD) to the south, Slieve Fyagh (351 m OD) to the northwest, Shannetra (239 m OD) and Cluddaun (252 m OD) to the north and northeast. There are also communications masts at Shanetra.

16.4.2 Impact of the Development

The most elevated of the stationary turbine towers at Oweninny will be at an elevation of about 121 m OD. Taking into account the maximum tip height of 176 metres, then the maximum elevation of the top of any turbine on the site will be 297 m OD. This compares with an elevation of 721 m OD at the summit of Slieve Carr.

The site is not within any of the zones for which guidelines are laid down by the Irish Aviation Authority (IAA). The IAA operates a Monopulse secondary surveillance radar (MSSR) at Dooncarton on the northwest Mayo coast near Ross Port. This radar location is approximately 18.7 kilometres from the Oweninny wind farm proposed site. Slieve Fyagh at 331 metres sits directly between the radar installation and the proposed wind farm location. The current policy of the IAA is to consider each wind farm scheme on its merits ensuring that the safety and efficiency of air navigation is not compromised. The Authority was contacted in the course of the consultation process. The Oweninny development will comply with any aeronautical lighting and positional data requirement specified by the Authority.

The Mayo County Council Development Plan 2008 – 2014 specifically identifies the following objective to support the growth of Knock Airport

Objective O/TI-A 3 states that

> *"It is an objective of the council to create and enforce an exclusionary zone of a 13km radius of Ireland West Airport Knock. The 13km exclusionary zone shall define a volume of airspace, by means of Obstacle Limitation Surfaces, above which no new objects shall be permitted. The 13km exclusionary zone shall define an area within which no new conventional or residual landfills shall be constructed."*

This policy is further reinforced in the Knock Airport local area plan[172].

The proposed Oweninny development is approximately 47km from Knock Airport which is well outside the proposed exclusionary zone

16.4.3 Mitigation

All requirements of the Irish Aviation Authority and the Department of Defence will be implemented in full.

16.4.4 Conclusions

The proposed development will not result in significant adverse impacts.

16.5 TELEVISION and COMMUNICATIONS SIGNALS

16.5.1 Receiving Environment

Some evidence exists that in certain circumstances wind turbines, more particularly the rotation of the blades, can adversely affect communication systems that use electromagnetic waves as the transmission medium, e.g. television, radio and microwave links.

[172] Mayo County Council, 2012 Ireland West Airport Knock, Local Area Plan 2012-2018, (Adopted 8th October 2012)

16.5.2 Impact of the Development

Scattering effects have been associated with television reception in the vicinity of wind turbines, causing double imaging or ghosting on the television screen. The effect is more significant with analogue signals. With the switchover to digital broadcasting the effect can be reduced. In general digital television signals are much better at coping with signal reflections and do not suffer from ghosting. However if the signal is fairly weak then problems can still arise and viewers can experience interruptions to their reception.

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 most significant potential effect of a wind farm, in terms of numbers of households affected, is where the wind farm is directly in line with the transmitter radio path. In practice, the majority of these difficulties arise where structures such as wind turbines are located in a region where there is a relatively weak signal.

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 turbine 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.

These problems are predominantly associated with turbines having metal or carbon-fibre blades. Modern turbines, such as the type proposed, have blades manufactured from fibreglass composite materials and the problem of scattering is much less likely to arise.

RTÉ was contacted in the course of the consultation process for the currently approved Oweninny Wind Farm. However, it is not generally in a position to provide detailed predictions of the possible effects that a wind farm may have on broadcast reception conditions in its vicinity.

Consultations occurred with Eircom, O_2 Ireland, Vodafone, Tetra Ireland, Three, Meteor and ESB Telecoms in connection with the proposed wind farm development at Oweninny. As part of the project scoping the proposed wind turbine location coordinates for the scoping layout of 117 wind turbines prepared were provided to service providers and coordinates of signal masts obtained. Mapping of these signal masts and communication corridors including a 100 metres buffer zone, (50 metres each side of the signal) indicated a number of conflicts with the layout, see Figure 16-5. Turbine locations were subsequently adjusted to ensure they were located outside the communication corridors, see Figure 16-6.

16.5.3 Mitigation

With regard to TV signals the Oweninny EIS assessed the potential for impact on these and undertook to implement RTÉ's policy regarding wind energy developments which is for both parties to enter into a protocol agreement that outlines a remedial mechanism for any loss of broadcast amenity that might be suffered by residents as a result of the wind farm development. This will ensure that should interference occur commitment was given to the following mitigation

- TV interference prediction study will be undertaken in advance of construction
- Remediation measures will be carried out.
- Aerial System Replacement (pointing to existing TV Transmitter)
- Re-tuning to alternative TV Transmitters
- Subscription Satellite TV installation
- Terrestrial / Satellite Remediation

With implementation of these measures no loss of the material value of television to any effected household will occur and no cumulative impact will arise with other projects.

The Tawnanasool wind farm EIS (Chapter 6 Part 1) provided a detailed assessment of TV signal interference arising from the proposed development. This indicated that the main digital terrestrial transmitter serving RTE’s Achill transmitter. The transmitter is located on Achill Island 22kmsouthwestof the wind farm development. Hence no signal interference from the Oweninny wind farm is possible with this transmitter.

No cumulative interference with the overhead line uprate projects or power plant projects will occur.

In the unlikely event that the wind farm development leads to interference with television reception, in collaboration with the appropriate bodies, all necessary measures will be undertaken to fully eliminate the impact. RTÉ’s policy regarding wind energy developments is for both parties to enter into a protocol agreement that outlines a remedial mechanism for any loss of broadcast amenity that might be suffered by residents as a result of the wind farm development. Oweninny Power Ltd. will enter into a protocol agreement with RTE to this effect.

Communication Signals

With regard to communication signals across the site consultations occurred with Eircom, O2 Ireland, Vodafone, Tetra Ireland, Three, Meteor and ESB Telecoms in connection with the proposed wind farm development at Oweninny. During the project scoping exercise the locations of communications masts were identified and proposed wind turbine locations were issued to service providers. Based on the response mapping of signal masts and communication corridors including a 100 metres buffer zone, (50 metres each side of the signal) was undertaken which indicated a number of conflicts with the proposed layout.. Turbine locations were subsequently adjusted to ensure they were located outside the communication corridors, see Figure 16 6 of the original EIS.

No impact on communication corridors was predicted and hence no cumulative impact with other projects in the area will occur.

16.5.3.1 Cumulative impacts

Tawnanasool Wind Farm

With respect to the Tawnanasool wind farm a similar process to Oweninny was followed. There are two telecommunication sites within 5km of the Tawnanasool development, (see Section 6.2 of the Tawnanasool EIS). These sites are the telecommunications site at Bangor and Lagduffmore. The Bangor mast site consists of three separate telecommunication masts and the Lagduffmoresite consists of a single telecommunications mast. No impact on telecommunications corridors was identified following adjustment of location of and no cumulative impact with Oweninny will occur.

Corvoderry wind farm

With respect to Corvoderry, the EIS for that project indicated that no significant impacts were identified with respect to material assets and no cumulative impacts with respect to the Oweninny Phase 1 and Phase 2 development will occur.

Potential future development of Oweninny Phase 3

The impact of the implementation of all three phases of Oweninny on telecommunications and television has been assessed in Chapter 16 Material Assets of the EIS submitted originally to An Bord Pleanála in 2013 as part of the planning application for all three phases.

With implementation of appropriate mitigation no cumulative impact was identified.

Overhead Line uprate and power plant projects

No cumulative impact on telecommunication signals will arise from the proposed overhead line uprate projects or power plant projects in the area.

16.5.4 Conclusion

Consultation with telecommunication providers was undertaken as part of the wind farm design process to ensure that no impact on communication corridors would occur from the development. A TV interference prediction study will be undertaken in advance of any construction to determine whether signal interference would occur and all necessary measures will be undertaken to fully eliminate the impact if this is required in line with the protocol to be signed with RTE.

16.6 WIND FARMS AND PROPERTY PRICES

The issue of whether the presence of a wind farm will impact negatively on the price of property located near a wind farm has been the subject of a number of specific studies.

A major study was carried out in the USA by the Renewable Energy Policy Project (REPP 2003)[173] in response to public opposition following claims that wind farms were having a negative impact on the value of property within view of the turbines. The research to determine whether the presence of wind turbines had any impact on proximate property values examined 24,300 property transactions from 10 locations within the US, over a period of six years. The study concluded

> *"that there was no evidence to suggest that wind turbines sited within a 5 mile radius of property had a negative impact on value. In fact, to the contrary, property values appeared to rise above the regional average within the case study locations, suggesting that wind turbines actually had a positive effect on value"*

A similar but limited study was carried out in the UK (on behalf of the Royal Institution of Chartered Surveyors – RICS) in 2007[174] . This study, focused on property prices near wind farms in Cornwall. Despite initial evidence that there was an effect, when investigated more closely, there were generally other factors which were more significant than the presence of a wind farm. The general findings were supported by a number of interviews with estate agents from the area who had not encountered any negativity towards the wind farms when marketing proximate houses.

A US government-funded study 'The Impact of Wind Power Projects on Residential Property Values in the United States carried out in 2009[175], recorded the sale price of around 7500 homes in nine states within 10 miles (16km) of existing wind farms. It found that homes less than 1.5 kilometres from a wind farm sold for no less, on average, than homes 8 kilometres away. Similarly, home values tended to remain stable long after wind farms sprung up.

The Expert Witness Statement of Mr. Ray Hanley a Chartered Surveyor presented at the Oral Hearing for Oweninny concluded that there would be no significant impacts on

[173] Sterzinger G., Beck F., Kostiuck D., Renewable Energy Policy Project, The Effect of Wind Development on Local Property Values, 2003

[174] Peter Dent and Dr Sally Sims of the Department of Real Estate and Construction, Oxford Brookes University, UK. , What is the impact of wind farms on house prices, RICS Research 2007

[175] Ben Hoen, Ryan Wiser, Peter Cappers, Mark Thayer, and Gautam Sethi, Ernest Orlando Lawrence, Berkeley National Laboratory Environmental Energy, Technologies Division , The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis, 2009

property valuation in the vicinity of the proposed Oweninny development having regard to the existing 2003 planning permission.

There is currently no evidence in Ireland to show that wind farms are having a negative impact on the property market.

16.7 CONCLUSIONS

In general, research into tourist attitudes to wind farm developments indicated that they are not seen as having a detrimental effect on tourist visits. Wind farms are often seen as an added attraction to an area. The development of the proposed Visitor Centre at Oweninny will provide an added tourist attraction to the area, complementing existing centres such as the Céide Fields. There is no predicted impact on air navigation and measures have already been taken at the design stage to ensure that no impact on communication signals will occur. A mechanism will be put in place to address any issue with television signal loss should the need arise. There is currently no evidence in Ireland to show that wind farms have a negative impact on property prices.

The proposed development will not result in significant adverse environmental impacts.

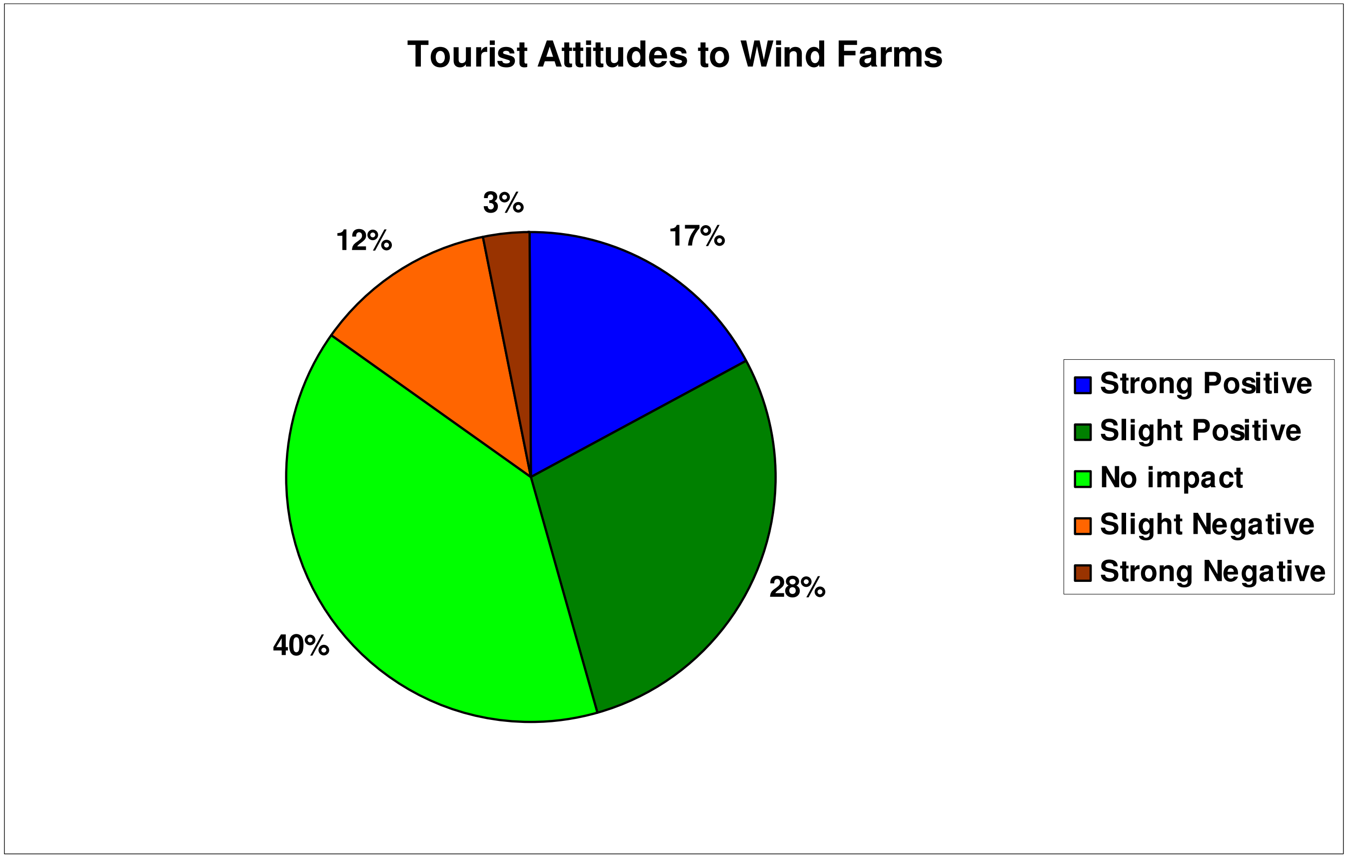


Figure 16-1: Failte Ireland Survey of tourist attitudes to wind farms

(Failte Ireland, 2008/No.3)

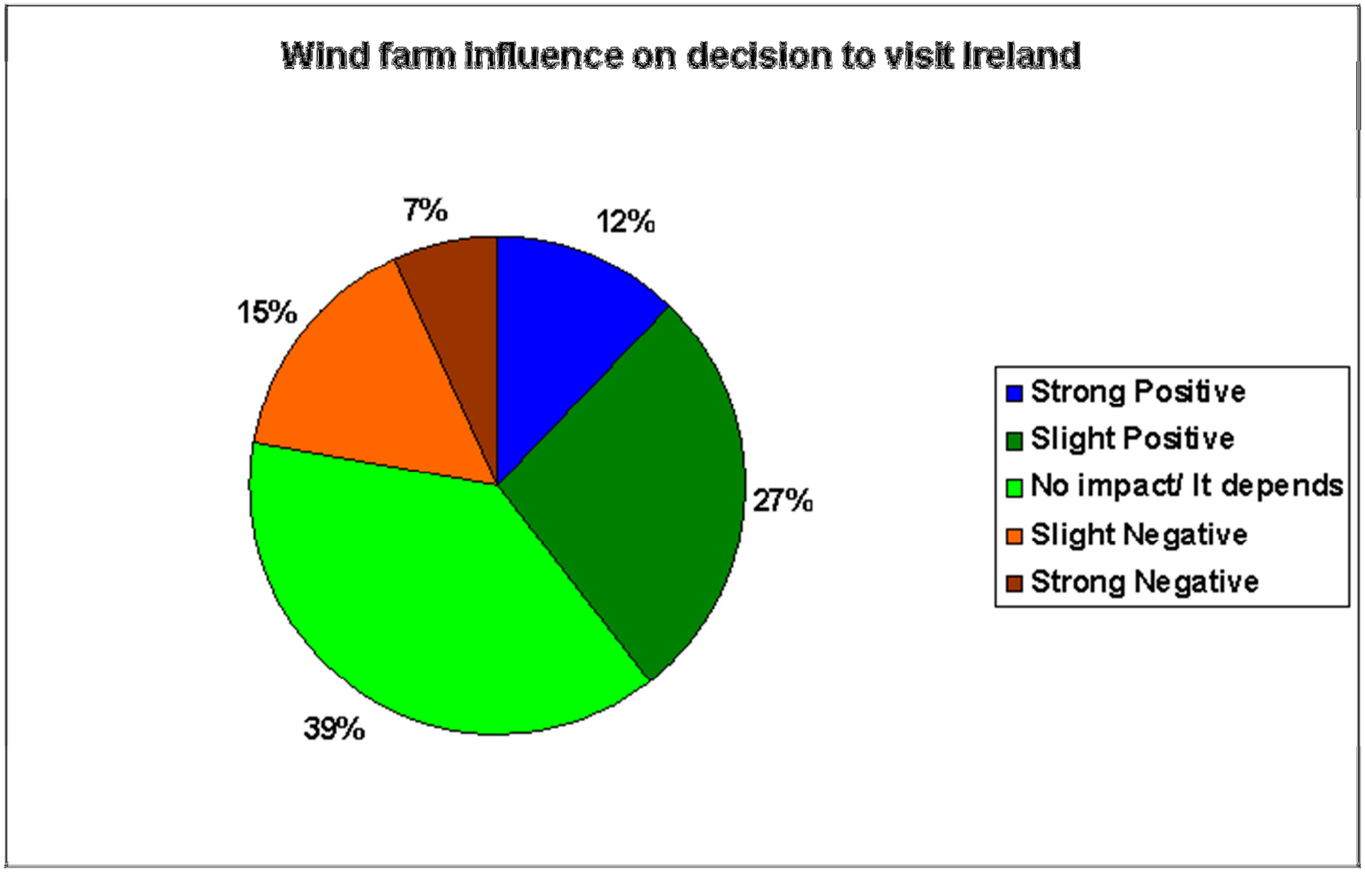
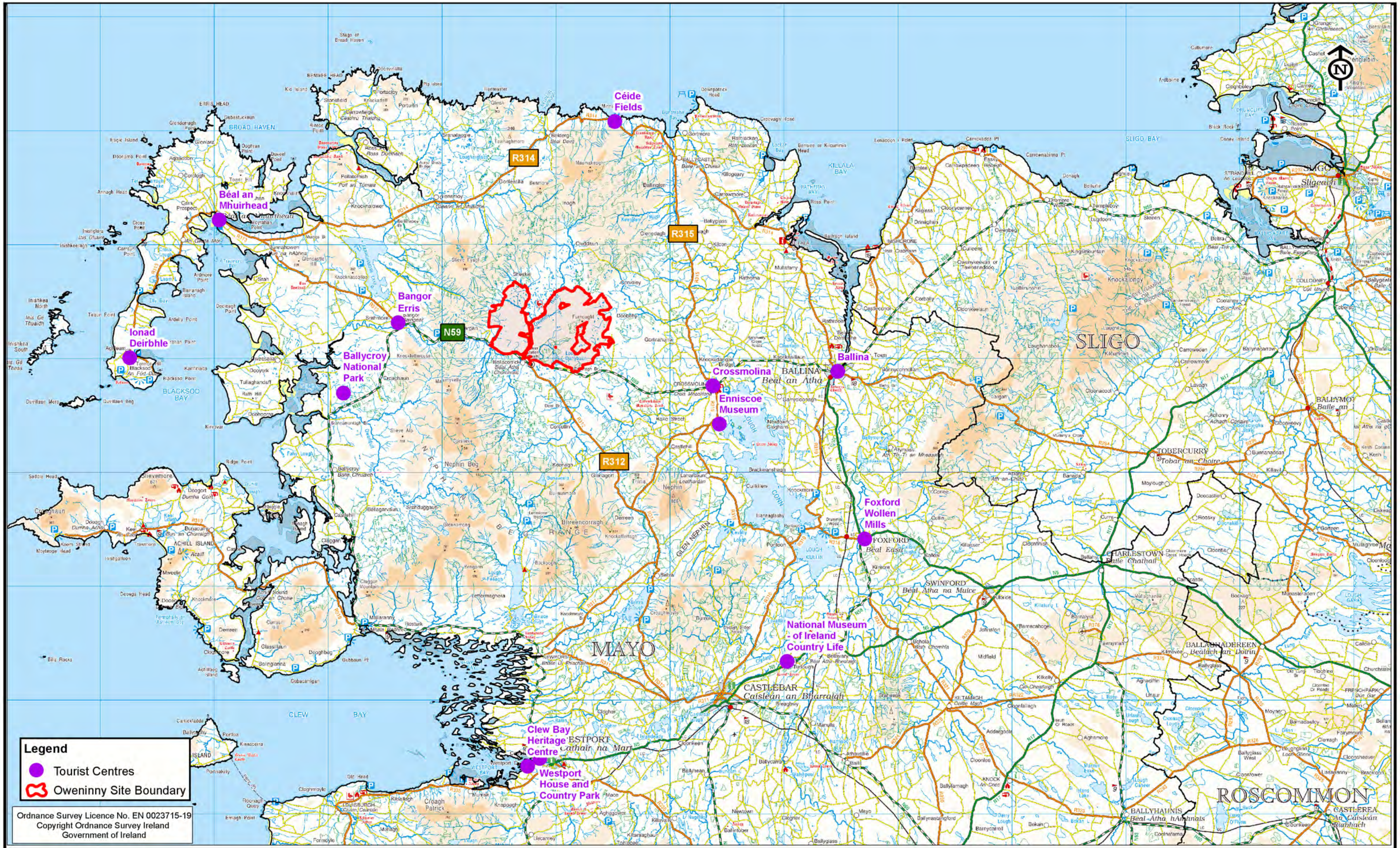


Figure 16-2: Fáilte Ireland Wind farm influence on decision to visit Ireland (Fáilte Ireland, Visitor Attitudes on the Environment - Wind Farms, 2008/ No 3)



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Tourist Centres

Project	Production Unit
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	10/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:300,000

MAP REFERENCE

FIGURE 16.3

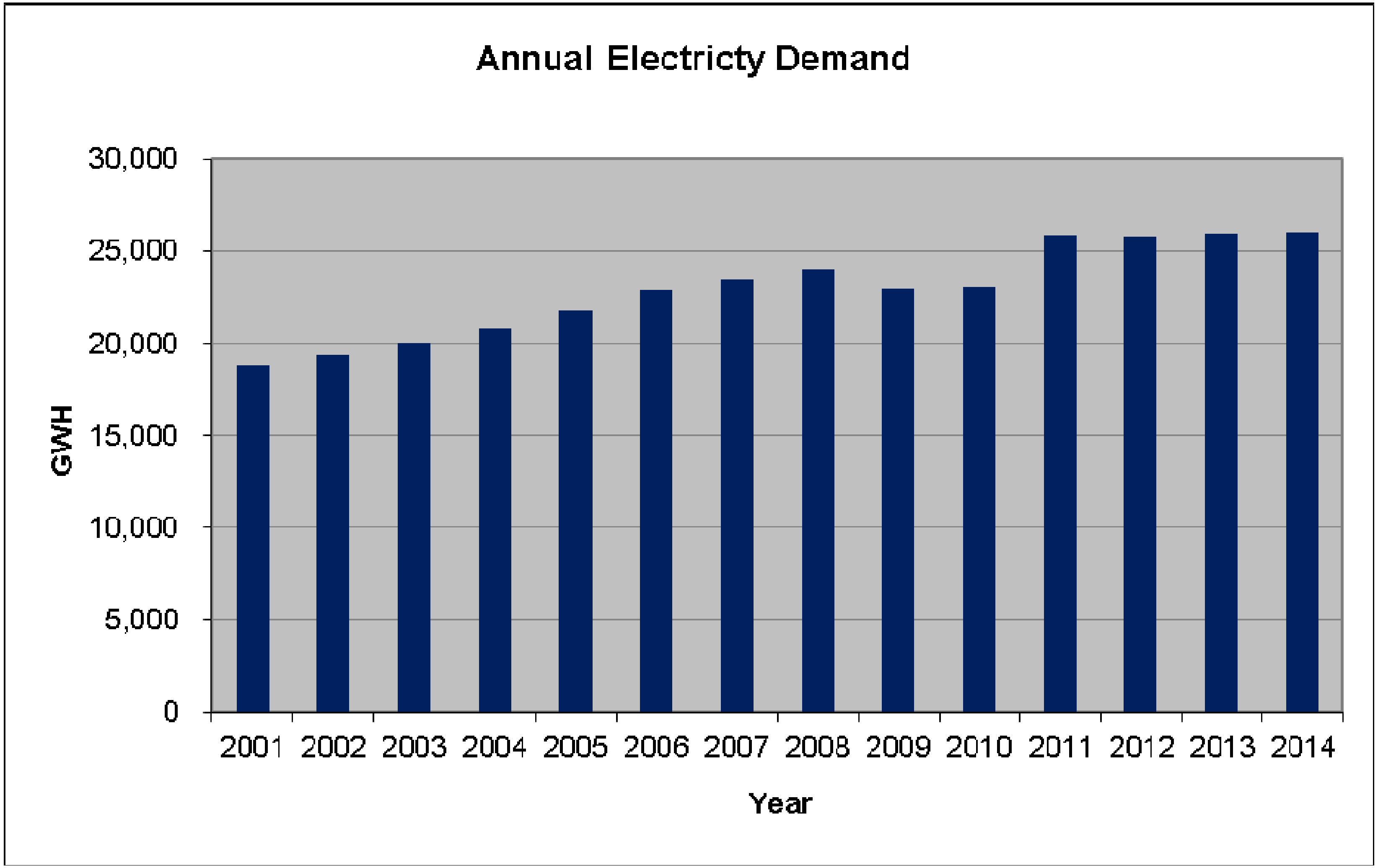
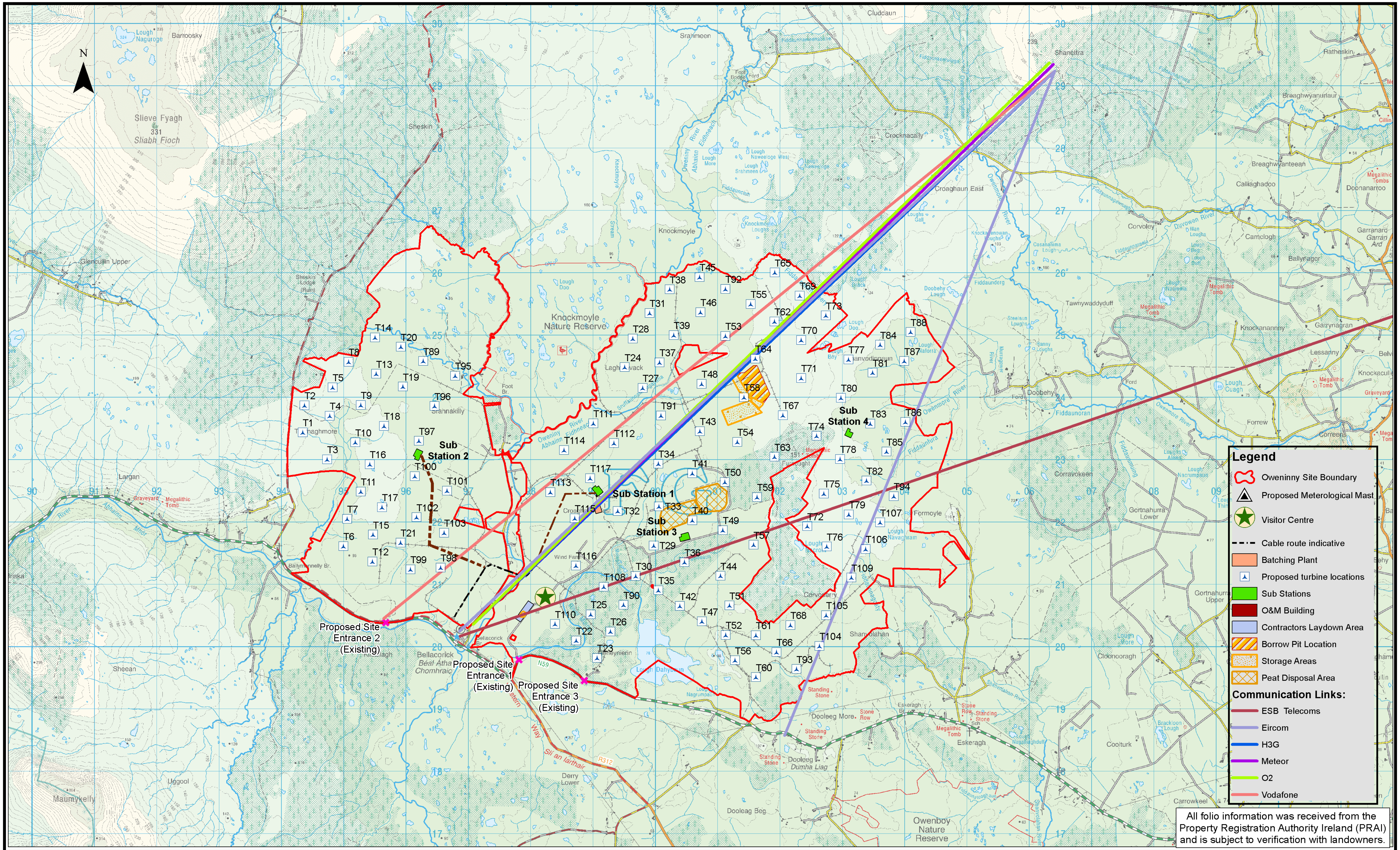


Figure 16-4: Annual Energy Demand

(Source: EirGrid Electricity Statistics)



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Oweninny Power Ltd.

Client	Title
Oweninny Power Ltd.	Communication signals crossing proposed layout

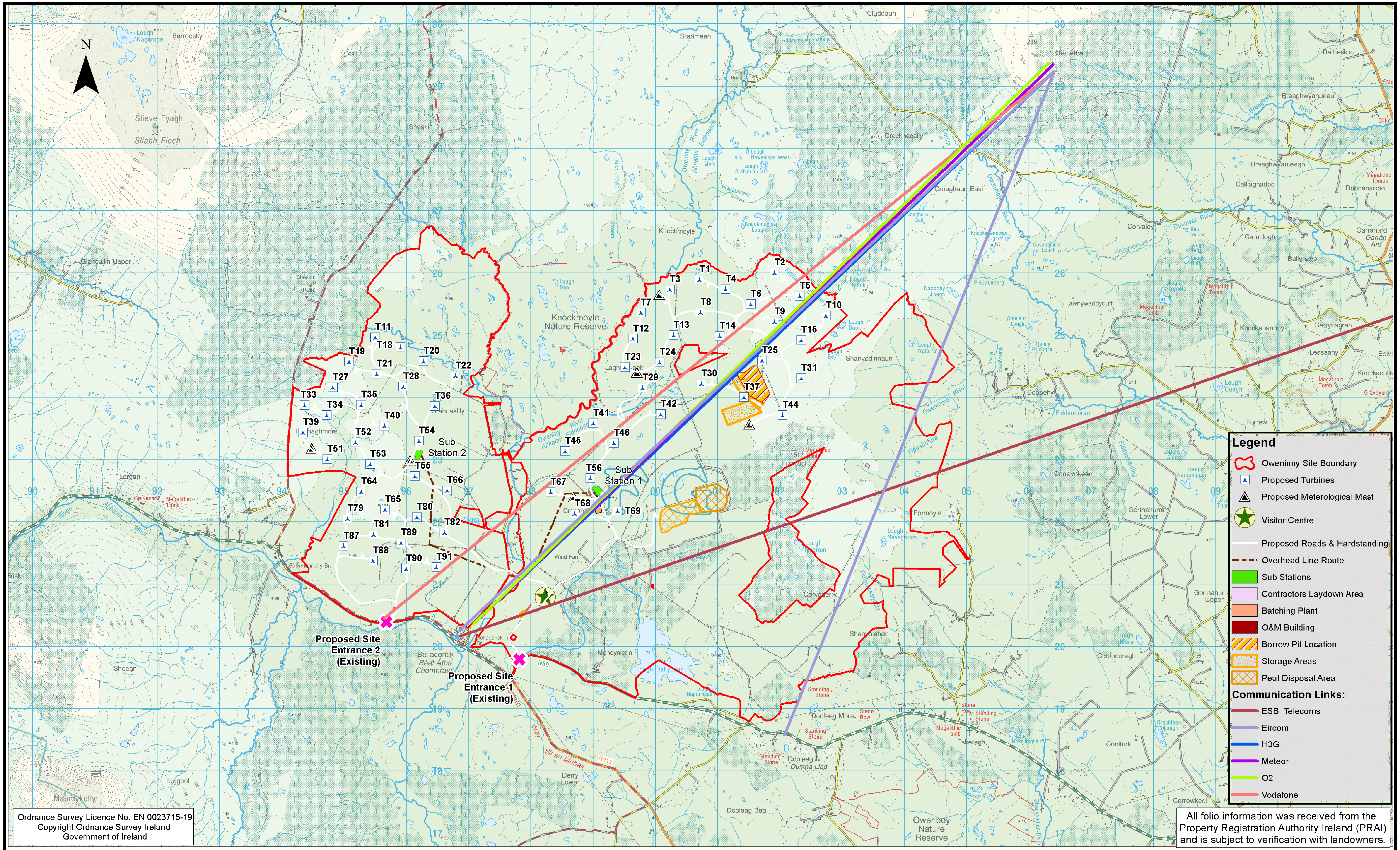
Project	Production Unit
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	J.C	30/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:55,000

MAP REFERENCE

Figure 16.5



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Communication signals crossing the site

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	N.Q	30/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:55,000

MAP REFERENCE

Figure 16.6

17 CULTURAL HERITAGE

17.1 INTRODUCTION

Cultural Heritage, in respect of a project, is assumed to include all humanly created features on the landscape, including portable artefacts which might reflect the prehistoric, historic, architectural, engineering and/or social history of the area. The Cultural Heritage of the area of the proposed development was examined through an Archaeological, Architectural and Historical study. The Archaeological and Architectural studies involved a documentary/cartographic search and field inspection of the area, while the Historical study involved a documentary search. Consultation was also held with the National Monument Service.

17.2 METHODOLOGY

The archaeological and architectural heritage assessment comprises the results of a survey and evaluation of selected sites of archaeological potential and architectural heritage interest within and in the immediate environs of the proposed wind farm. The work consists of the results of a Desk Study and Field Inspection following scoping and response from the Development Applications Unit (see Appendix 13A), Mayo County Council (See Appendix 13B) and consultation with the National Monument Service of the Department of Arts Heritage and the Gaeltacht (See Appendix 13C).

17.2.1 Desk Study

As part of a documentary/cartographic search, the following principal sources were examined from which a list of sites and areas of Cultural Heritage interest/potential was compiled:

- Record of Monuments and Places – Co, Mayo (RMP)
- Archives of the Archaeological Survey of Ireland - www.archaeology.ie
- Records of the National Museum of Ireland (NMI)
- Annual Archaeological Excavation Bulletin (up to 2010) – www.excavations.ie
- Stereoscopic photographic coverage carried out by the Geological Survey of Ireland (GSI)
- Historic and contemporary cartographic sources of Ordnance Survey Ireland (OSI)
- National Inventory of Architectural Heritage (NIAH0 – Co. Mayo – www.buildingsofireland.ie
- Documentary and cartographic sources in Mayo County Libraries (Appendix 13 D)
- Mayo County Development Plan 2008-2014 (MCDP).
- Mayo County Development Plan 2014 – 2020
- SEA of Draft Renewable Energy Strategy for County Mayo 2010.
- Mayo County Heritage Plan 2011-2016.

In addition, the following EIS and Planning & Environmental Consideration (PEC) Reports were consulted (see Section 17.3.3 below for discussion):

- Galway-Mayo Gas Pipeline – 2001 (Arup Consulting Engineers)
- Oweninny Wind Farm – October 2001 (Environmental Impact Services Ltd.)
- Corvoderry Wind Farm – April 2012 (Jennings O'Donovan & Partners)
- 200 MW Power Plant, Owenmore, Co. Mayo – 2012 (Mott MacDonald Ltd)
- Tawnanasool Wind Farm – 2014 (Ecopower Developments Ltd)
- Bellacorick – Castlebar 110kV Overhead Line Uprate Project – 2014 (ESBI)
- Bellacorick – Moy 110V Line Uprate Project (2015) – Tobin Consulting Engineers/EirGrid
- Furthermore, the following Codes of Practice were also consulted:
- Code of Practice between the Department of Arts, Heritage and the Gaeltacht, the National Museum of Ireland and Bord na Móna (February 2012).
- Code of Practice between the Department of the Environment, Heritage and Local Government and ESB Networks (April 2009).

17.2.2 Field Inspection

From the preceding desk study, a list of cultural heritage sites/sites of cultural heritage potential was compiled for inspection. The overall proposed wind farm landholding, together with a c. 1km area surrounding the boundaries of such lands, were assessed for the presence of archaeological monuments by reference to map and aerial photographic sources. Detailed surface reconnaissance surveys of the landholding and surrounding environs, where possible, was undertaken on a phased basis from October to December 2012.

An attempt was also made to identify previously unrecorded sites of cultural heritage potential within, and in the immediate environs of, the proposed development area.

17.2.3 Assessment Methodology

The baseline criteria used to describe the impacts on Cultural Heritage Sites (based on NRA, 2003, 21) are presented in Table 17-1.

Table 17-1: Description of Potential impacts

Type	Direct	Indirect
Severe	Cultural Heritage site is within a development area. Construction work will entail the removal of part or the entire cultural heritage site.	Cultural Heritage site is within a development area. Construction works will entail the destruction of the visual context of the site or isolate it from associated groups or features.
Potentially Severe	Cultural Heritage site is adjacent to a development area. There is potential for related remains being affected by development works.	Cultural Heritage site is adjacent to a development area. Construction works will greatly injure the visual context of the site or isolate it from associated groups or

		features.
Moderate	Existing access to a cultural heritage site will be severed. Development works will affect the context of a cultural heritage site.	N/A
No Predicted	The development will have no predicted impact.	N/A

17.3 RECEIVING ENVIRONMENT

17.3.1 Local History

North Mayo is rich in cultural history and background on the history of the general area and the site location is provided in Chapter 1. A brief summary is presented here.

There is a local tradition that in the early historic period the northern area of Mayo was part of Iorrus - Domann inhabited by the fir-bolg, and that the earliest known settlers of Moyleog (or Moylaw) were the Calry sept of the Fir-Domann. When Fiachra Folt-Snatnach assumed rule this territory had vastly diminished and came to be known as Hy-Fiachrach. The Kings of Hy-Fiachrach kept a fortress at Inniscoe, and another on Annagh Island in Lough Conn. One of the Fiachra sons Daithí reigned as Ard-Rí for 405 A.D. to 483 A.D. According to tradition Daithi died on Sliabh Alp in Ballycroy and a lake in Dooleeg is called Loch Dhaithí Bháin in his memory. His brother Amhalghaidh or Awley became ruler of Hy-Fiachrach Moy and this territory became known as Tír-Awley. During Awley's reign St. Patrick brought the faith to Ireland. On completing his sojourn on the Reek he set out for Tirawley following a route known as Tochar Phádraig or Patrick's road. He celebrated mass at Tristia. When he got to the locality now known as Mullaghfarry he found the princes and people converged disputing who would succeed Awley who had died. He baptized 12,000 people. Enda Crom became the first Christian ruler of Tirawley. His descendants settled in Moylaw, as did those of his brothers Aengus, Fionn and Connell.

The political history of the county in the early medieval period is fragmented and remains somewhat obscure. As previously noted, the general region was under the influence of the Uí Fiachrach but this clan was replaced by the Uí Briuin in the eighth century. From this clan sprang the O'Connor's, taking their name from one of their most successful warrior-kings, a man named Conchobair, who died in 973 and by the tenth century establishing themselves as the principal provincial Kings of Connaught, acting as overlords in Mayo.

The Anglo-Norman expansion into the province took place in 1235 under the leadership of the de Burgos (from which the family names De Burgh, De Burca, Burke and Bourke emanated). Anglo-Norman control meant the eclipse of many Gaelic lords and chieftains, particularly the O'Connor's of Connacht. From the de Burgos principal military allies sprang the great Norman families of Mayo – Prendergast, Staunton, d'Exeter and d'Angulo. Many other settler families also gained lands in Mayo, including the Barretts, Gibbons, Lynnots, Walshes, Joyces and Merricks. Following the collapse of the lordship in the 1330s, all these Anglo-Norman families became estranged from the central administration based in Dublin and assimilated with the Gaelic-Irish, adopting their language, religion, dress laws, customs and culture, and marrying into Irish families.

The most powerful clan to emerge during this era were the Mac William Burkes, also known as Mac William Iochtar, descended from Sir William Liath de Burgh.

In the 1570s, during the reign of Elizabeth I, the Tudors exerted a real effect on the political life of Mayo, gaining control of the county by the end of the Queen's rule in 1603. In the 1580s some attempts were made to map the general region - see Plates 17.1 and 17.2. Gradually during this time, the lordship system of the Normans was replaced by an English provincial administration. The province of Connacht was established by the Earl of Sussex and Sir Henry Sidney, Lord Deputy of Ireland, constituted the county of Mayo under an act of 1569.

Plate 17-1: Extract from the 1585 Map – Northwest Mayo

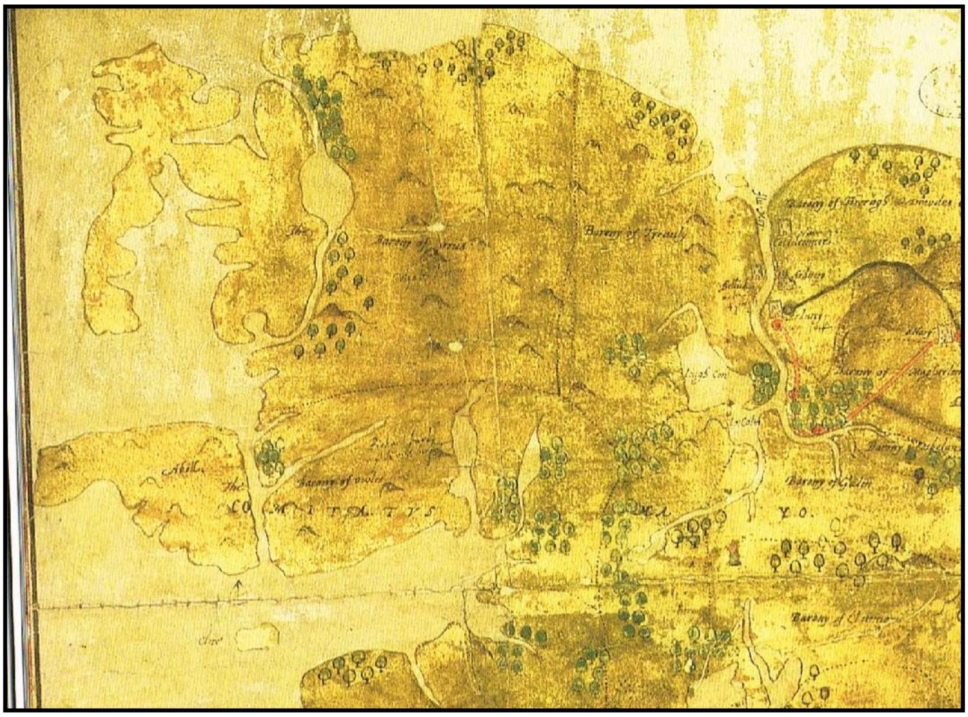


Plate 17-2: Extract from the 1587 Map – Northwest Mayo

Protestant settlers from Scotland, England and elsewhere in Ireland settled in the county in the early seventeenth century.

A third of the overall population was reported to have perished due to warfare, famine and plague between 1641 and 1653, with several areas remaining disturbed and frequented by Reparees into the 1670s.

In the 1640s, following the overthrowing of the English monarchy and establishment of a parliamentary government system the lands in the west, including Mayo, were divided and subdivided. During the seventeenth century, much of the barony of Tirawley was largely planted by former parliamentarian soldiers.

During the reign of Charles II (1660-1685) two thirds of the lands of Erris were acquired for £8000 by Sir James Shaen of Kilmore, Co. Roscommon. He was succeeded by his son, Sir Arthur Shaen, who took continuing interest in the Erris Estates bringing a colony of English settlers, with a vicar, to Erris and settling them on the best lands in the Mullet peninsula. Many native Irish were disposed of their lands in the Mullet and forced to settle in Kilcommon. Arthur was also a barrister and in 1708 was High Sheriff of the county. When he died in 1725, he was survived by two daughters, Frances and Susannah, who shared the estate equally. They married into the Bingham and Carter families, whose later family members were amongst the largest landlords in the barony.

For the vast majority of people in Mayo, the eighteenth century was a period of unrelieved misery suffering under the 'penal laws' and leading to the unsuccessful rebellion of 1798.

In the late eighteenth and early nineteenth centuries, sectarian tensions arose as evangelical Protestant missionaries sought to 'redeem the Irish poor from the errors of

Popery', with many 'missions' set up in Mayo. These too were the years for Catholic Emancipation and, later, for the abolition of the tithes.

During the early years of the nineteenth century, famine was a common occurrence, particularly where population pressure was a problem. This was accentuated by the Great Famine of 1845-8. This is reflected largely in the wider area by ruinous dwellings. This latter problem was not resolved until the early twentieth century when tenants became owners of their lands under the Land Commission set up by the Irish Government following the establishment of the Irish Free State. Despite modernised transport and communications systems, the county has remained an essentially rural community to the present day.

The subject development lands incorporate all, or portions of, the townlands of Corvoderry, Laghtanvack, Shanvodinnaun and Croaghaun West in the civil parish of Moygawnagh, Knockmoyle and Formoyle in the civil parish of Kilfian South and Dooleeg More, Moneynierin and Shanvolahan in the parish of Crossmolina, all in the barony of Tirawley, together with the townlands of Kilsallagh, Sheskin, Srahnakilly and Tawnaghmore in the civil parish of Kilcommon and the barony of Erris.

The name Moygawnagh derives from the Irish *Maigh Ghamhnach*, which, according to the *Ordnance Survey Name Books* of 1838 may mean the 'plain of the strippers'. However, the local tradition of how the parish got its name is told in the 7th century *Life of Corma* where Mag Gamhnach is described as the – 'plain of the Milch Cows'. Corvoderry derives from the Irish Corr Bhotha Doire – the 'odd hut of the oak wood' and formed part of the overall landholding of the Knox family. The Knox estate also included the townland of Croaghaun West at this time (An Cruachán – 'round hill'). Laghtanvack is believed to derive from the Irish Leacht an Bhaic – the 'monument of the bend'. Shanvodinnaun townland name derives from the Irish Sean Bhoth Doineáin - 'Dinan's Old Hut'. The parish of Kilfian is said to be derived from a 6th century local saint named Finan. The townland name Formoyle drives from the Irish For Maoil – a 'round hill' while that of Knockmoyle derives from An Cnoc Maol – a 'bald or flat hill'.

Crossmolina takes its name from the Irish Crois Uí Mhaoilíone – the 'Cross of Mullany. A church was founded in the sixth century in the area of the present town of Crossmolina and an abbey subsequently founded there in the late 13th century. The townland name Shanvolahan derives from the Irish Seanbhoth Leathan – 'broad old hut or booth'. The name Dooleeg More derives from the Irish An Dubh Ligh Mór – 'the large black flagstone'. The name Kilcommon takes its name from St. Coman, a sixth century saint who is believed to be buried in the ruined church in Kilcommon graveyard at Pollathomas. The townland of Srathnakilly derives from Srath na Cille – the 'holm of the church'. The townland of Sheskin derives from An Seisceann – a 'quagmire' or 'sedgy place'. Prior to 1838 the McDonnell family built a hunting lodge in the townland, and this was replaced in 1879. At the turn of the twentieth century, the Jameson family, whiskey distillers, owned the lodge and visited during the hunting season. The lodge was sold in 1920 and in more recent years was abandoned and become derelict, although some refurbishment works are presently being undertaken. The lodge is surrounded by dense forestry and is not accessible to the public. The townland of Tawnaghmore derives from An Tamhnach Mór – the 'great field'.

By the end of 1813, William Bald and his assistant had produced the first detailed topographical map of the area (see Plates 17.3 and 17.4). In 1817 he was persuaded by the Grand Jury of Co. Mayo, led by Major Bingham, to engineer a new road from Castlebar to Belmullet (via Bellacorick), which was completed in 1824. The contractor responsible for the construction of the road employed local labour, with specialist masons employed to build the bridges (see CH-19 and CH-22 below).

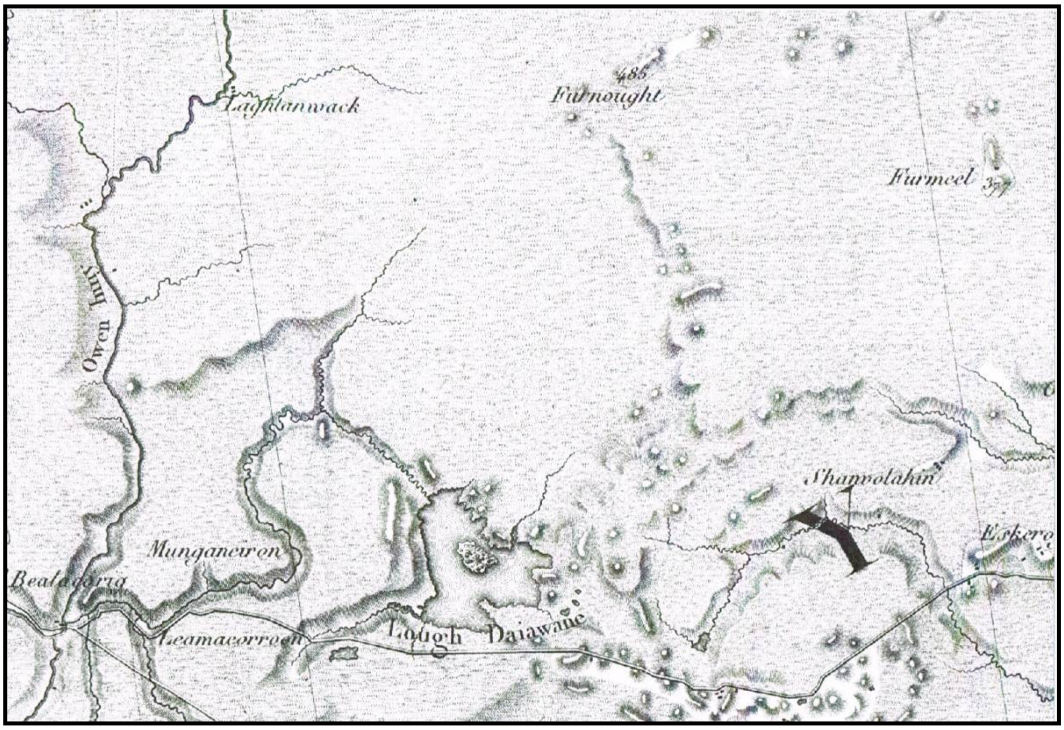


Plate 17-3: Extract from Bald's Map of 1813 (Bellacorick – Eskeragh and area north

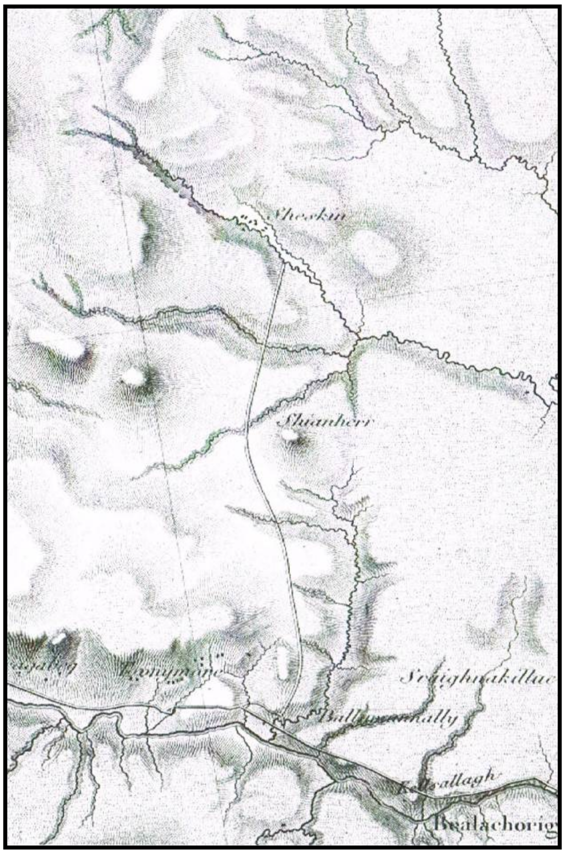


Plate 17-4: Extract from Bald's Map of 18 13 (Ballymonnelly - Bellacorick and area to north

Domestic commercial activity in the area during the 19th and early 20th centuries centred on the hamlet of Bellacorick, where in the early-mid 19th century, Arthur Rose, postmaster and merchant at Belmullet, owned seven acres of land there on which was a general store and changing station for mail-car horses. The horses were housed in stables on the opposite side of the road (see CH-20 below). In 1859 the property was leased to a Patrick Burke. Between the present pubic house (now closed) and the bridge was a shooting lodge, later to become a post-office. The building was demolished as part of road improvement works to provide access to the former ESB Generating Station. The hamlet also included a constabulary barracks which was demolished in the 1940s when a new Garda Station with attached residence was opened across the road. This station is now closed.

In June 1949, Michael Kilroy T.D. representing Erris, requested the government to build a "turf-fired station for the generation of electricity in Erris" (Western People, June 11th 1949).

In 1952, following a decision to locate a peat fired power station at Bellacorick, the Electricity Supply Board (ESB) acquired a 5.5 acre site at Bellacorick, immediately north of the main road and hamlet. Construction of the power station commenced in May 1958, with the first boiler/turbine unit introduced to service in November 1962 and a second in January 1963. The total cost of the power station and ancillary buildings was £400,000 and it burned 350,000 tons of peat per annum at the height of its use. The station had one cooling tower which was 290 feet high (Plate 17.5). Construction of this element of the works provided the most difficulty as "workmen found quicksand when installing a 30 feet deep pit (Western People, June 10th 1961). The ESB employed up to 111 persons at the power station.

Plate 17-5: Former ESB Bellacorick Power Station

At the same time, Bord na Móna (BnM) commenced acquiring a landholding of approximately 20,000 acres around Bellacorick and in the townlands southwest of Bangor to supply the required peat to the power station. These lands at Bellacorick, which form the subject development lands, were known as the Oweninny and/or Bellacorick Works. However, peat deliveries did not commence until 1962 and in the preceding ten years a number of associated developments were undertaken, including drainage, railway, road and bridge construction, workshop construction and general surface grading works. At the height of production, BnM employed up to 500 at the works. Bord na Móna ran a tourist train - the Bellacorick Bog Railway – around part of the system. This commenced in July 1994. It ran to the Wind Farm Control Centre and back again, a round trip of 3 miles 14 chains and the service ceased at the end of 1996 (Johnson, 1997,131).

Peat operations on the Oweninny bogs ceased in 2005 following which a rehabilitation plan was designed and implemented by Bord na Móna. The power station at Bellacorick was subsequently decommissioned and demolished.

The country's first commercial wind farm was established at Oweninny in 1992. It comprises 21 wind turbines with a total capacity of 6.45 MW.

17.3.2 Settlement History

A review of Bald's maps of 1813 (Plates 17.3 & 17.4) indicated very little evidence for houses within the overall landholding, with most residences concentrated along the existing road network. This is similar to that illustrated on the 1830 O.S. maps, which also show some field boundaries in surrounding lands, to the west, south and east of the subject lands, and along the strip of land between the Srahnakilly road, running north from Bellacorick, and the Oweninny River. There are little or no changes to the landscape illustrated on the 1896 O.S. maps, when compared to the previous edition, save for a slight increase in dwellings and field boundaries in the surrounding areas to the subject development lands. Likewise, the landscape illustrated in the 1915/16 editions of the O.S. maps show little change from previously, save for further subdivision of lands in those areas previously referred to, together with some additional residences in the general surrounding landscape. Surface reconnaissance surveys of the subject lands did not lead to the discovery of any 'historic' land/field boundaries within the overall lands, save for some peat-formed linear banks at Srahnakilly – see CH-11 below. A similar field boundary (CH-10; ITM: 497630 822802), formed by a peat-mounded linear bank with fosses on either side (Plate 17.22 below) was noted adjacent the eastern side of the Srahnakilly road close to CH-16.

No historical events associated with the subject lands were noted as a result of research undertaken with respect to the preparation of this report.

17.3.3 Archaeology

The area under assessment is part of a regional landscape which is generally rich in historical and archaeological material. The general region has attracted settlement from early times as evidenced by the presence of monuments dating back to the prehistoric period. Continuity of settlement is illustrated by artefacts dating to the Later Mesolithic and by identified monuments ranging from Neolithic to Medieval and Post-Medieval remains.

The siting preferences of particular monument types are well documented. Broadly speaking, the general landscape of the proposed development area offers a potential setting for the discovery of archaeological sites and remains, as follows:

- The subject lands and surrounding landscape offer many opportunities for the location of Fulachta Fiadh (prehistoric cooking sites). These sites are location specific, generally located close to rivers and streams or in wet marshy areas, and sometimes occur in groups.
- The localised upland areas of the site and environs are a favoured position for the location of prehistoric burial sites, ringforts and enclosure sites in the general region surrounding the subject development lands.

There is significant archaeological potential associated with Blanket Bog. Tomlinson (2011, 180) notes that "unlike raised bogs, which began their growth without appreciable human interference and in some cases before the arrival of man, blanket bogs developed over millennia of settlement and are essentially post-Neolithic. Although following a complex regional and local pattern, their initiation and spread in the first and second millennium BC were stimulated by deteriorating climate, combined by substantial woodland clearance by farmers. Human activities were especially influential in the growth of lowland blanket bog in western Ireland, where the acidic rocks provided favourable circumstances for peat formation. Many western bogs formed on soils previously used by Neolithic farmers, classically demonstrated at Céide Fields, county Mayo". In addition, as noted by Lynch (1991, 28) "exceptional powers of preservation make wetlands a unique archaeological resource. The oxygen-free conditions prevailing in the waterlogged peat mean poor microbial activity, which in turn allows for almost complete preservation of organic materials". Consequently, there is potential for features such as field walls and prehistoric burial and settlement sites to be sited under blanket bog and for well-preserved artefacts, especially organic materials – arrowheads and axe-heads with intact wooden handles, clothing such as woollen caps and cloaks, 'bog-butter' - to be recovered from close to the surfaces of intact bogs. In addition a growing number of human bodies – with skin, hair etc. relatively intact – have been recovered from blanket bogs in recent years. However, it should be noted that much of the overall site has little or no peat cover due to previous industrial harvesting. Indeed, where the peat layer has been removed, it is considered that that there is little or no potential for the discovery of, hitherto, previously unrecorded features or artefacts, although the potential for discovery is greater in those areas that still retain a significant covering of peat.

The density of known monuments on the Oweninny site is low when compared to the general region. There are a total of four sites of archaeological interest/potential, three listed as Recorded Monuments (see Appendix 13D), and one listed solely in the Sites and Monuments Record (SMR) of the Archaeological Survey of Ireland as being located within the overall proposed wind farm. These are designated CH-1 to CH-4. In addition, there are a total of ten additional monuments located outside, but within 1km of the overall development site boundary. These are designated CH-5 to CH-9, with the latter comprising six individual monuments. All of these monuments are listed as Recorded Monuments, except for MA028-003006 which is listed solely in the Sites and Monuments Record. The locations of these sites are illustrated in Figure 17-1 and they are listed below in Table 17-2, after which they are further described (Table 17-3 - Table 17-11)).

Table 17-2: List of archaeological monuments within overall study area

SITE No.	SMR No.	TOWNLAND(S)	CLASSIFICATION	ITM	
				Easting	Northing
CH-1	MA027-003	Tawnaghmore	Cist	494944	821729
CH-2	MA028-001	Shanvodinnaun	Megalithic Tomb – Court Tomb	502230	823130
CH-3	MA028-007	Corvoderry	Ringfort - unclassified	501336	819524
CH-4	MA027-005	Tawnaghmore	Roadway – trackway	NPL	
CH-5	MA028-002	Dooleeg More	Standing Stone	502832	819279
CH-6	MA028-006	Dooleeg More	Stone Row	503232	818809
CH-7	MA028-004	Dooleeg More	Standing Stone	502876	818650
CH-8	MA028-005	Dooleeg More	Standing Stone	502022	818139
CH-9	MA028-003001		Field Boundary	504932	818831
	MA028-		Standing Stone	504932	818831

SITE No.	SMR No.	TOWNLAND(S)	CLASSIFICATION	ITM	
				Easting	Northing
	003002	Eskeragh			
	MA028-003003		Megalithic Tomb – Court Tomb	504883	818832
	MA028-003004		Stone Row	504873	818923
	MA028-003005		Enclosure	504932	818831
	MA028-003006		Fulacht Fia	504892	818873

Table 17-3: Site CH-1

Site CH-1	Description
SMR No: **MA027-003** **TOWNLAND:** **Tawnaghmore** **CLASSIFICATION:** **Cist** **ITM (from ASI):** **494944 821729** **PROTECTION:** **RMP; MCDP**	There are no depictions of this monument on any O.S. maps. The NMI Topographical Files note the following: 'On 8th July 1971 when digging a hole for a gatepost, a cist was discovered. The grave was built in a pit dug into boulder clay which underlay 85cm of peat; pit was roughly circular and flat-bottomed – 100cm E/W x 95cm N/S and 100cm deep in boulder clay. Rectangular cist walled by 4 large slabs set on edge; long axis was N-S. Internal Cist measurements: 49.5cm N/S; 35cm E/W; 36 cm deep. N slab had a natural (?) irregular 'rebate' at its E end, into which the N end of the E slab had been set. Thin slabs resting on the tops of the N, W & S slabs averaged 2-3cm thick. Large packing stones the W, S & E slabs. N slab backed against the wall of the pit. Cist closed by a single large capstone, 86cm long, 49cm wide & 15cm thick. Top of capstone was 135cm below the surface; made of local sandstone. On floor of cist was found a large quantity of poorly preserved human bone without any associated funery deposits – now in MNI (Reg: 1971:1042). Situated in SSW-facing mountainside [Cist-Grave at Tawnaghmore, near Bellacorick, Co. Mayo. E Rynne, 13th July 1971]'. The ASI Files note that the 'co-ordinates given for this site may be incorrect'.

Table 17-4: Site CH-2

Site CH- 2	Description
SMR No: MA028-001	This monument is not depicted on any OS 'historic' maps. It is described by de Valera & Ó Nualláin (964, 40-1) as follows:

Site CH- 2	Description
TOWNLAND: Shanvodinnaun **CLASSIFICATION:** Megalithic Tomb – Court Tomb **ITM (from ASI):** 502342 823108 **PROTECTION:** RMP; MCDP	"The tomb stands on the side of a prominent ridge in rolling bogland about two miles south-west of the hamlet of Doobehy. Save for a few widely separated small areas of grassland and arable on isolated esker hills the whole district, including the ridge on which the site lies, is covered in healthy bog. The tomb is about sixty yards south-west of the top of the ridge and some twenty feet lower than the crest. The top of the ridge commands a very extensive view on all sides across the bog-lands and plains to the great arc of mountains from Benbulbin along the Ox, Nephin and Nephin Beg ranges to Slieve Fyagh and northwards to the mountains along the north coast of Mayo from Belderg to Killala Bay. However, from the site itself the rising ground of the ridge restricts the outlook on the south-west to less than 100 yards. The tomb is poorly preserved. A row of four orthostats evidently represent the more northern side of a gallery aligned roughly WSW-ENE. These four are the only orthostats certainly in situ. Two other firmly embedded stones are situated 2.00m to 2.50m north of the row. The remaining five large blocks are prostrate. The more easterly stone of the row is .50m high, the next 1.0m high and the third .80m high. These three stones are erect and placed with their straight surfaces facing southwards. Between the more easterly of them and the next is a fairly embedded stone, .45m high, acting as filler. A gap between the edges of the second and third orthostats is packed with a few small stones which may be original. The fourth stone of the row is 1.7m high. It leans very slightly southwards. It protrudes to a maximum of .40m southwards of the line formed by the southern surfaces of the three other stones and is obviously a jamb stone. Two heavy prostrate slabs immediately adjoin the western side of the jamb. The more southerly of these measures 1.30m by 1.00m and is .35m thick. The other is 1.60m by .70m and .60m thick. Close to these at the south and west are two loose prostrate stones measuring 1.00m by .40m by .25m and .60m by .50m by .10m respectively. The more westerly of the tow set stones about 2.00m north of the row stands erect and is 1.00m high. It appears to be set at a somewhat higher level than the stones in the row and, though a fine block, is not necessarily in situ. If it is a structural stone its function is not clear. The other stone, .75m to the north-east of it, is firmly embedded but protrudes only .30m above the surface and is quite probably not structural. West of these stones is a prostrate slab

Site CH- 2	Description
	1.50m long, .80m wide and .40m thick.
	Along the southern side of the row of orthostats a hollow about .20m deep probably represents the position of the gallery. Some remains of surrounding cairn are present but on the western side the rough surface and the rising ground make definition of the cairn impossible. Elsewhere the edge is not sharp and probably gives little indication of the original cairn design. The ASI Archive/SMR Files note that the site was visited by a survey team on 24th April 1996 but the monument was not located. The row of four stones can be accepted with a high degree of probability as belonging to the more northerly side of a Court Cain gallery. The placing of the flat surfaces of the side stones inwards and the outward slope of the top surfaces which would facilitate corbelling are both typical features of that class. The tall jamb could equally well belong to a segmentation or entry – hence the orientation remains in doubt". Likewise, field reconnaissance undertaken with respect to the subject development undertaken in December 2012 failed to locate the monument at the co-ordinates published by ASI (www.archaeology.ie – SMR MA028-007. However, the survey area was widened and a flat-faced boulder was noted lying on the ground surface at ITM 50223 823130. The boulder measures c. 1.2m E-W x 1m N-S x 0.32m in thickness (Plate 17.6). This was located in an area of forestry at the base of a steep-sloping hill, with the surface quite overgrown with a mixture of heather and grass. No other possible remains of archaeological interest were noted at, or in the general area of, the ASI co-ordinates of the monument.

Site CH- 2	Description

Plate 17-6: Boulder located adjacent published location for Site CH-1

Table 17-5: Site CH- 3

Site CH-3	Description
SMR No: MA028-007 **TOWNLAND:** Corvoderry **CLASSIFICATION:** Ringfort - unclassified **ITM (from ASI):** 501232 819999 **PROTECTION:** RMP; MCDP	There are no depictions for this monument on O.S. 'historic' maps and its existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. The monument was not located by an ASI survey team in April 1996. Likewise, it was not located at the co-ordinates published by the ASI (www.archaeology.ie – MA028-007) by a surface reconnaissance survey undertaken with respect to the preparation of this report. Consequently, consultation with Ms. Margaret Keane, who presently holds a position of Senior Archaeologist, National Monuments Service, Department of Arts, Heritage and Gaeltacht and who initially made the ASI aware of the monument, indicated that the monument was not located in an area of cut-away bog, as indicated by the ASI, but on a gravel ridge and that it comprised a cashel, consisting of a low, heather-covered bank made of stone and with an external ditch, with an overall internal diameter of *c.* 21m. Further consultation, together with aerial photographic research, indicated a possible feature, largely coinciding with the foregoing description at ITM 501336 819524 (Plate 17.7). The area was subsequently visited in December 2012 and a circular area, delimited by a growth of grass in a slightly hollowed trench (backfilled fosse?) in an area of dense heather growth, was noted on the northern side of a NW-SE ridge. Immediately inside the grassed area was a very slightly raised area, *c.* 1m wide, and this may be the remains of the enclosing wall/bank. The northern extent of the feature incorporated a heavily overgrown step in the slope of

Site CH-3	Description
	the ridge (Plate 17.8). This was up to 1.3m in height and appears to form a section of the enclosing wall/bank. The interior of the feature is extremely overgrown, as illustrated in Plate 17.9 and, consequently, the overall feature has a very low visibility in the landscape.

Plate 17-7: Site CH-3

Plate 17-8: North-facing enclosing bank/wall to SITE CH-3

Site CH-3	Description

Plate 17-9: View of Site CH-3 from the east

Table 17-6: Site CH-4

Site CH-4	Description
SMR No: MA027-005 **TOWNLAND:** Tawnaghmore **CLASSIFICATION:** Roadway - unclassified **ITM:** Not Precisely Located **PROTECTION:**	Within the NMI Topographical Files for MA027-003 (SITE CH-1 above) is a letter from Dr Lucas to the landowner, Mr. Martin Campbell, Tawnaghmore, Bellacorick, Ballina (on whose land the cist was discovered) about a trackway Mr Campbell had pointed out to him. Dr Lucas informs him that the 'trackway' is a roadway which may be 500 years old or may be more recent. As Dr Lucas travelled towards Bangor from the site he kept a look out for it and thought he was able to see the line of it in some places. There is no information about the possible location of this feature, other than the townland.

Table 17-7: Site CH-5

Site CH-5	Description
SMR No: MA028-002 **TOWNLAND:** Dooleeg More **CLASSIFICATION:** Standing Stone **ITM (from ASI):** 502832 819279 **PROTECTION:** RMP; MCDP	There are no depictions for this monument on O.S. 'historic' maps and its existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. It was visited by an ASI survey team in April 1996 and is described as being situated in a prominent NNE-SSW ridge in peatland. It is described as being an irregular-shaped stone (H: 1.33m; L: 1.22m; Max. W: 0.7m) aligned NNE-SSW, with a low boulder located immediately to the SE. No evidence for these features were noted at the co-ordinated published by the ASI (www.archaeology.ie) which position the feature on relatively level peatland downslope and to the west of a ridge. The ridge is covered with dense heather and a reconnaissance survey undertaken in November 2012 failed to determine the exact location of the monument.

Site CH-5	Description
	The published co-ordinated position this monument at a distance of c. 150m outside the nearest development site boundary.

Table 17-8: Site CH- 6

Site CH-6	Description
SMR No: MA028-006 **TOWNLAND:** Dooleeg More **CLASSIFICATION:** Stone Row **ITM (from ASI):** 503232 818809 **PROTECTION:** RMP; MCDP	There are no depictions for this monument on O.S. 'historic' maps and its existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. It was visited by an ASI survey team in April 1996. It is located on a low rise in peatland, which hinders its views to the north, and comprises three large boulders aligned NNE-SSW (L of row: 5.1m). The stone at the SSW end (H: 0.95m; L: 1.2m; W: 0.95m) is approximately dome-shaped, while the others are irregularly shaped – Plate 17.10 This monument is positioned at a distance of c. 600m outside the nearest development site boundary.

Plate 17-10: Site CH - 6

Table 17-9: CH - 7

Site CH-7	Description
SMR No: MA028- **TOWNLAND:** Dooleeg More **CLASSIFICATION:** Standing Stone **ITM (from ASI):**	There are no depictions for this monument on O.S. 'historic' maps and its existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. It was visited by an ASI survey team in April 1996 who determined that its position was incorrectly marked on the SMR, and was subsequently corrected. It is situated on a prominent height in an extensive area of peatland, affording it good views in all directions. It comprises a massive irregularly-shaped boulder (H: 1.85m; L: 1.74m; W: 1.22m) aligned

Site CH-7	Description
502876 818650 **PROTECTION:** RMO; MCDP	NNE-SSW – Plate 17.11 The monument is positioned at a distance of c. 750m outside the nearest development site boundary.

Plate 17-11:Site CH - 7

Table 17-10: Site CH - 8

Site CH-8	Description
SMR No: MA028-005 **TOWNLAND:** Dooleeg More **CLASSIFICATION:** Standing Stone **ITM (from ASI):** 502022 818139 **PROTECTION:** RMP; MCDP	There are no depictions for this monument on O.S. 'historic' maps and its existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. It was visited by an ASI survey team in 1996 It is positioned on the southern slope of a drumlin hill, slightly below the summit, affording extensive views in all directions except to the north. It comprises a large rectangular block (H: 1.52m; L: 1.22m; W: 0.45m) aligned NE-SW. There are a number of small-medium packing stones around the base area. The monument is positioned at a distance of c. 1km outside the nearest development site boundary.

Table 17-11: Site CH - 9

Site CH-9	Description
SMR No: MA028-003 **TOWNLAND:** Eskeragh **CLASSIFICATION:** Archaeological Complex **ITM:** 504932 818822 **PROTECTION:** RMP; MCDP (except F)	This complex comprises a number of individual monuments, as described below. In general there are no depictions for sites A, B, D or E on O.S. 'historic' maps and their existence was first brought to the attention by Ms. Margaret Keane whilst undertaking a field survey in the area as part of the preparation of an MA Thesis. Likewise, there are no 'historic' depictions for site F, which was discovered during a survey by Archaeological Development Services Ltd (Whitaker, 2004) – see Section 17.2.3.1below.
	A. MA028-003001 – Field Boundary – 504932 818831 It was visited by an ASI survey team in 1996 who failed to locate the feature, which is described as 'pre-bog walls' in the ASI Files. A line of stones resting on the surface of the bog were noted by a reconnaissance survey undertaken in November 2012 – Plate 17.12. These extend over a distance of 12m in an E-W direction and it is possible that these are the basal remains of a former field boundary.
	B. MA028-003002 – Standing Stone – 504932 818831 Visited by an ASI survey team in April 1996. It is situated on a prominent height in otherwise low-lying peatland and comprises a large irregular block (H: 1.75m; L: 1.1m; W: 0.55m) tapering to a point; aligned NE-SW. There are a number of packing stones at the base – Plate 17.13
	C. MA028-003003 – Megalithic Tomb-Court Tomb – 504883 818832 This monument is not depicted on any OS 'historic' maps. It is described by de Valera & Ó Nualláin (964, 41) as follows: "The monument lies about 150 yards west of Eskeragh School and some 300 yards north of the Crossmolina – Bangor road. It stands on a low gravel ridge surrounded by vast stretches of bog. The land on the ridge is mostly under pasture but a little tillage is undertaken. The site commands an extensive outlook southwards across flat boglands to Nephin and the Nephin Beg Mountains. The tomb is very ruined [Plate 17.14]. It consists of the remains of a gallery orientated roughly NW-SE. The gallery is 4.6m long and seems to have been about 1.75m wide. Low indefinite traces of a mound extend for a distance of about 5.00m north-west of the backstone. Some small stones in front of the gallery are probably

Site CH-9	Description
	exposed cairn stones. The entrance to the gallery is at the south-east and is marked by two fine jambs set .40m apart. The south-western jamb is .80m high, and the opposite jamb is 1.00m high. Adjoining the last is a stone, .50m high, which seems to be a courtstone. .50m north-east of this stone, .35m high, may also be a courtstone but this is not certain. The south-western side of the gallery is represented by two stones. That nearest the entrance is .60m high and the other is .50m high. Only one stone of the opposite side of the gallery survives. It stands immediately behind the entrance jamb and is .75m high. The top edges of the three surviving sidestones slope downwards on the outside. A much concealed stone, .50m high, at the north-west, marks that end of the gallery.”
	D. MA028-003004 – Stone Row – 504873 818923 Visited by an ASI survey team in 1996. It comprises five stones aligned NNE-SSW (total L: 4.9m); stones decrease in height from the largest at SSW end (H: 1.05m; L: 0.85m; W: 0.6m) to the NNE end. Second stone from SSW has fallen and is now on its side – Plate 17.15.
	E. MA028-003004 – Enclosure – 504932 818831 Visited by an ASI survey team in April 1996 who failed to locate the feature. Likewise, a survey reconnaissance survey in November 2012 failed to locate this possible monument. Subsequent consultation with Ms. Margaret Keane, who initially discovered this monument, indicates that the remains may be a possible robbed-out hut site comprising a u-shaped arrangement of set boulders. It measured 1.5m x 2m and was on the line of a robbed-out field wall (Site 9A above).
	F. MA028-003006 – Fulacht Fia – 504892 818873 This monument, which was first discovered in 2003 (Whitaker, 2004) comprises a slightly raised sub-circular area measuring 4m N/S x 3m E/W and with a height of up to c. 0.2m; there is evidence for some stone edging from S to W – Plate 17.16. This complex of monuments is located c. 1.2km outside the nearest development site boundary.

Site CH-9	Description

Plate 17-12:Site CH-9A

Plate 17-13:Site CH-9B

Plate 17-14: Site CH-9C

Plate 17-15:Site CH-9D

Plate 17-16:Site CH-9F

17.3.4 Results from previous documented relevant archaeological reports

A number of Environmental Impact Statements with respect to development applications within, and in the immediate environs of, the overall Bord na Móna landholding, and all containing Archaeological/Cultural Heritage Assessments, have been prepared over recent years. These are as follows:

- Galway-Mayo Gas Pipeline – 2001 (Arup Consulting Engineers)
- Oweninny Wind Farm – October 2001 (Environmental Impact Services Ltd.)

Likewise, two Planning and Environmental Considerations Reports (PECR) have been prepared with respect to the uprating of existing 110kV Overhead Lines (OHL) within, and in the immediate environs of, the overall landholding as follows:

- Bellacorick – Castlebar 110kV Overhead Line Uprate Project – 2014 (ESBI)
- Bellacorick – Moy 110V Line Uprate Project (2015) – Tobin Consulting Engineers/Eirgrid

In addition, the Cultural Heritage Impact Assessment Report prepared by Dermot Neilis Archaeology (2015) with respect to a Meteorological Mast at Sheskin Td by ABO Wind Ireland Ltd, was also inspected.

No additional monuments, other than those identified above in Table 17.2, were discovered by fieldwork associated with the preparation of the Archaeological/Cultural Heritage Assessment Reports contained in the above EIS/PECR.

In addition, a review of the Archaeological Monitoring Report with respect to the Galway-Mayo Gas Pipeline Project (Linnane, 2008) indicates that no features or artefacts of archaeological interest/potential were uncovered by excavation works associated with the pipeline through the overall Bord na Móna landholding.

A pilot archaeological survey by the Archaeological Wetlands Unit was undertaken in May 1998 at Oweninny (McDermott et al, 2000, pp226-7). The object of the survey was to investigate the archaeological potential of the lowland blanket bog. No sites of archaeological interest and/or potential were noted in the exposed peat-faces or on the surface of the bog by this survey.

A more detailed archaeological peatland survey of the Oweninny Bog was undertaken by Archaeological Development Services Ltd., on behalf of the Department of Environment, Heritage and Local Government (DEHLG) in 2003 (Whitaker, J. 2004). A number of areas were subjected to a surface and peat-face survey, carried out under Licence 03E1319 from the DEHLG. These were:

- Area 1 – Srahnakilly and Tawnaghmore;
- Area 2: Tawnaghmore;
- Area 3: Shanvolahan, Dooleeg More and Corvoderry;
- Area 4: Shanvodinnaun, Furnought and Formoyle;
- Area 5: Knockmoyle, Furnought and Shanvodinnaun;
- Area 6: Croaghaun West and
- Area 7: Sheskin.

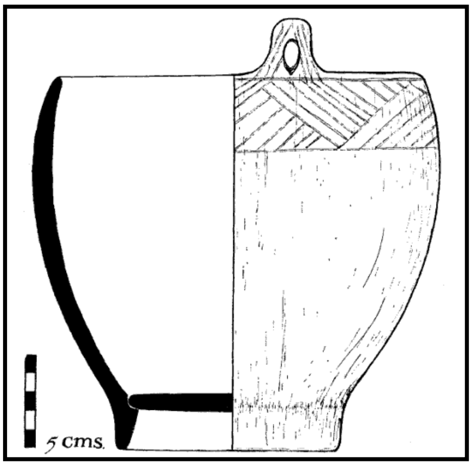
In general, field walking was undertaken at an interval of every fourth drain for each area, except for Area 1 where every second drain was walked. No features of archaeological interest/potential were noted by such survey.

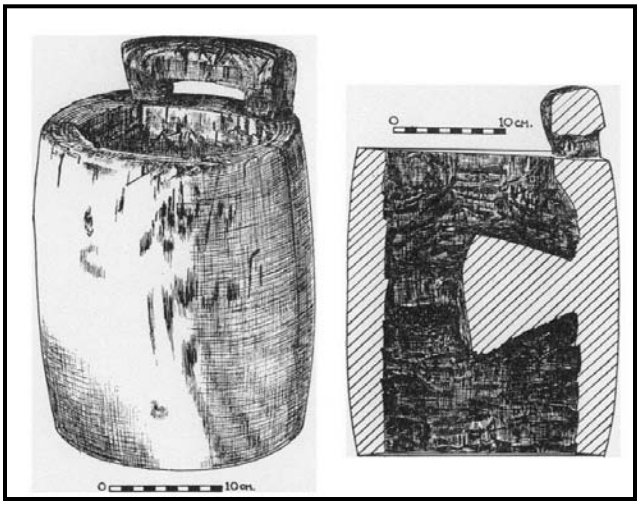
A search undertaken of the annual Archaeological Excavations Bulletin (www.excavations.ie), up to 2010, indicates that no licensed archaeological investigations have been undertaken within the overall landholding, except for those associated with monitoring of the Galway-Mayo Gas Pipeline (Ref: 05E0584) and the 2003 Peatland Survey (Ref: 03E1319) mentioned above.

17.3.5 Reported archaeological artefacts

A search of the Topographical Files of the National Museum of Ireland, together with published sources, was undertaken as part of the preparation of the report. A number of entries concerning the overall landholding were noted, as follows:

Table 17-12: Reported Archaeological Artefacts

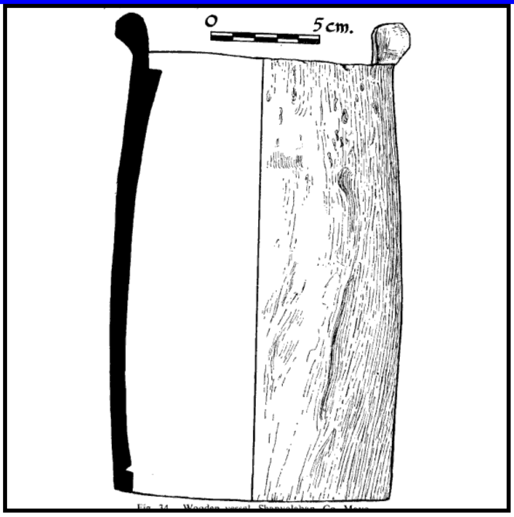
Location	Description
Townland: Corvoderry **Parish:** Moygawnagh **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 1960:609a; 609b;	**Decorated Wooden Vessel with Bog Butter – Plate 17.17** Found by J Moran while working for Bord na Móna and at a depth of about 2 feet from the surface of the bog. Portion missing and otherwise damaged during finding; now in fragments. Globular, carved from a single piece of wood except for the base which was inserted into a ledge-like rebate 2.5cm from the bottom. On the rim is a vertical lug, 2.8cm high and averaging 2.2cm in width, which has a central ovoid perforation; there was, probably, another similar projection on the opposite side but no trace of it remains. Around the upper part of the vessel, immediately below the rim, is a 3.7cm wide band of alternately inverted triangles filled with parallel oblique lines and executed in poker-work. There are also three oblique lines to either side of the perforation in the lug which are crudely joined to the main design. H (excluding lug): *c.* 20cm; D of rim: *c.* 18cm; Weight of butter: 6.5 lbs. Ref: Prendergast & Lucas, 1962, 165.  **Plate 17-17: Decorated Wooden Vessel – Corvoderry – NMI Reg: 1960:609 (From Prendergast & Lucas, 1962, p. 161)**

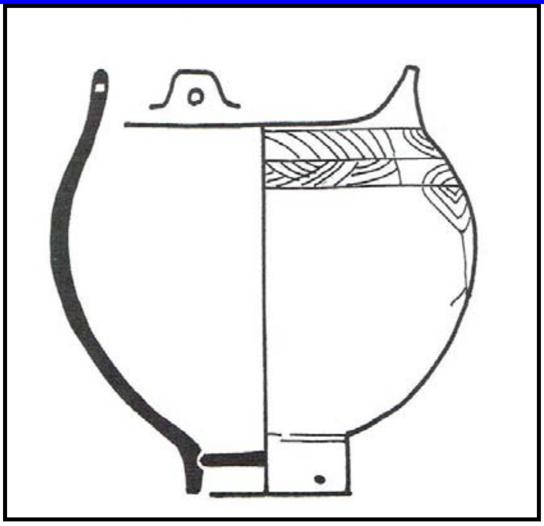
Location	Description
Townland: Croaghaun West **Parish:** Moygawnagh **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 1961:188	**Decorated Wooden Vessel** Vessel containing bog butter, large, made from a single piece of wood except for the base; base missing. Oval in shape, with two long lug-like handles. Decorated with a scored pendant triangle pattern on the outside, with zig-zag lines. Found at a depth of 3.5 feet below bog surface.
Townland: Croaghaun West **Parish:** Moygawnagh **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 1958:16	**Wooden Vessel – Plate 17.18** Found 2.5 feet below bog surface. Specimen is interesting in that it shows the manner by which such vessels are made. It is carved from a single log and has one strap-handle projecting from the rim. The walls of the vessel are slightly convex. The interior is hollowed out, by gouge or chisel, from both ends and an unexcavated portion remains at one side in the middle. The interior wall has been smoothed. H: 29cm; handle projects a further 6cm; Ext. Base D: 21.7cm. Ref: Lucas et al, 1960, 26.  **Plate 17-18: Wooden Vessel – Croaghaun West – MNI Reg: 1958:16, (Lucas et al, 1960, p. 25)**
Townland:	**Wooden Deer Trap**

Location	Description
Dooleeg More **Parish:** Crossmolina **Barony:** Tirawley **O.S. 6" Map:** Mayo – 28; 37 **Reg. No(s):** 1948:8	Complete with movable parts; it has a valve spring and three pegs. The frame is made of single piece of wood, the grain running lengthways; oblong with a slightly rounded outline. Pegs complete but the whole object is very brittle. Made from oak, alder and yew; 3 feet long and 10 inches wide; found at a depth of 3 feet below bog surface.
Townland: Dooleeg More **Parish:** Crossmolina **Barony:** Tirawley **O.S. 6" Map:** Mayo – 28; 37 **Reg. No(s):** 1950:8	**Wooden Vessel** Vessel in advanced state of decay deposited by BnM in peat moss. Body made from one piece; base made of two unequal pieces; three pegs passed through wall of vessel help keep it in place.
Townland: Dooleeg More **Parish:** Crossmolina **Barony:** Tirawley **O.S. 6" Map:** Mayo – 28; 37 **Reg. No(s):** 1950:16	**Wooden Vessel (fragments)** Badly broken, original shape and size difficult to determine; portion of base suggests cylindrical shape.
Townland: Kilsallagh **Parish:** Kilcommon	**Bog Butter in Wooden Vessel** Found 3 feet below surface of bog. Graceful-shape, resembling in outline an enlarged goblet with a short pedestal stem. It is carved from the solid but the bottom is a separate piece which is inserted into the croze about 2cm from the lower edge. Around the rim, beyond which

Location	Description
Barony: Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1958:154	the butter projects by 7cm, there is a band made of split withe. The pedestaled foot is damaged. H: 19cm (excl. pedestal); greatest W: 22.5cm; External D: 8cm. Ref: Lucas *et al,* 1960, p. 129
Townland: Knockmoyle **Parish:** Kilfian **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 1997:28 (IA/91/97)	**Rough out for wooden vessel** Single piece unfinished wooden vessel. Survives as a cylindrical block with a sub-rectangular area cut at both ends; axe and tool marks present.
Townland: Shanvodinnaun **Parish:** Moygawnagh **Barony:** Tirawley **O.S. 6" Map:** Mayo – 20; 28 **Reg. No(s):** 1958:15	**Wooden Keg** Presented by BnM. Keg in two parts and unfinished; discovered by hand drainers. Carved from the solid and consists of a cylindrical body with two solid handles projecting upwards from the rim of the vessel. Bottom is missing, the croze for it has not been completed. Inside the rim there is a rebated ledge for a lid. The croze is found on one portion of the vessel only and this suggests that the vessel may have been split when it was carved and thus discarded. Outer and inner surfaces bear the marks of the tool used for fashioning and no attempt has been made to smooth them. H: 22cm with handles projecting a further 1.8cm; Ext, Base D: 15.5cm Ref: Lucas *et al,* 1960, 26
Townland: Shanvodinnaun **Parish:** Moygawnagh **Barony:** Tirawley	**Wooden Vessel containing Bog Butter** Made from a single piece of wood; separate base; incised decoration below rim – line and double chevron pattern. Length: 390mm; Width: 280mm. Found on bog surface.

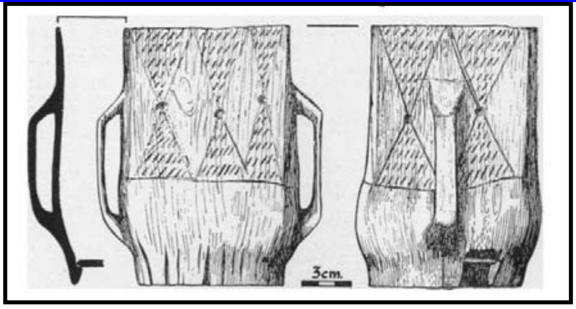
Location	Description
O.S. 6" Map: Mayo - 28 **Reg. No(s):** 1986:57	
Townland: Shanvodinnaun **Parish:** Moygawnagh **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 2000:68 (IA/144/2000)	**Three Horseshoes** Three iron horseshoes; broad with three rectangular holes on either side which sit in a groove around the outer edge of the shoe; heels are slightly tapered; no calkins.
Townland: Shanvolahan **Parish:** Crossmolina **Barony:** Tirawley **O.S. 6" Map:** Mayo - 28 **Reg. No(s):** 1959:57	**Wooden Vessel – incomplete Plate 17.19** Found at depth of 3 feet below bog surface. Vessel is carved out of solid; roughly barrel-shaped, sides swelling in a convex curve from base to rim, which is flat; there are two solid handles, each carved with a projecting roll. Below the rim, on inner surface of the vessel there is a ledge for the lid. A croze is provided for the bottom. Lid and bottom are missing. H (incl. handles): 55.8cm (to rim only: 51.2cm); external D (at base); 32cm; (at rim): 21.3cm; Average thickness of walls: 2.2cm; L of handles: 12.75cm & 13cm respectively; T of handles: 2.8 cm & 3.2cm. Ref: Lucas *et al,* 1961, 106-7.

Location	Description
	 **Plate 17-19: Wooden Vessel – Shanvolahan – NMI Reg: 1959-57 (From Lucas et al, 1961, p. 105)**
Townland: Sheskin **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo – 12; 13; 19; 20 **Reg. No(s):** 1958:11	**Bark Vessel and Bog Butter** Presented by BnM; bog butter container of bark and bladder; part of butter may have been removed by machine. At bottom is an encircling withy with bonding marks from 'stitched-in' piece of wood.
Townland: Sheskin **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo – 12; 13; 19; 20 **Reg. No(s):** 1958:13	**Wooden bog-butter container – Plate 17.20** Handed to NMI by T. Lee. Lightly scored ornamentation around rim; small holes, some plugged with pegs; looked like a large egg cup when found. Length: 200mm; Diameter: 220mm.

Location	Description
	 **Plate 17-20: Wooden Bog Butter Container – Sheskin – NMI Reg: 1958:13, (From Earwood, 1997, p. 30)**
Townland: Srahnakilly **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1999:88 (IA/188/1999)	**Bog Butter** Lump of bog butter; no container. Roughly conical and cut at an oblique angle.
Townland: Srahnakilly **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1979:4	**Wooden Yoke** Y-Shaped yoke made from a single piece of wood. The arms are roughly equal in length; rectangular in cross-section with squared-off ends; lateral perforation towards the end of each arm. Traces of wear can be seen around the edges and there are fresh tool marks on the surfaces. Found at a depth of 1.5m below bog surface.
Townland:	**Wooden Vessel**

Location	Description
Srahnakilly **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1957:326	Found at a depth of 2 feet below bog surface. Carved out of the solid but the bottom is a separate piece inserted into a croze. The vessel, which was full of butter, is rectangular in plan, 15cm x 14cm at the base and 21.5cm H. Provided by a single lug-handle carved into one piece with itself and pierced by a rectangular opening. Presented by BnM. Ref: Lucas, *et al.* 1958, p. 119.
Townland: Tawnaghmore **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1971:1042	**Human Bones** A large quantity of poorly cremated human bones, described by Dr. Stephen Shea as 'those of an adult'. Found at SITE CH-1 above.
Townland: Tawnaghmore **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1930:131	**Deer Traps** Wooden deer trap, the frame made of a single timber; none of the movable parts are present, and the artefact is damaged and warped. It is irregular in cross-section and narrow towards the ends, which are squared-off; rectangular opening in the centre.
Townland: Tawnaghmore **Parish:** Kilcommon	**Wooden Vessel** An upper portion of a churn with lid intact; considerably damaged. It is carved from a single piece of wood and there are lugs present with two perforations. It may contain part of the original contents.

Location	Description
Barony: Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1997:25 (IA/86/1997)	
Townland: Tawnaghmore **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1960:610	**Wooden Vessel Lid** Wooden lid of a vessel found near 1960:620 (below) in Sheskin Bog. Circular in plan; in the centre of its upper surface is a rectangular projection, 6cm high and shaped like a truncated pyramid. Through this projection is a vertical perforation, the upper part of which is oval (3cm x 3.6cm) and the lower part square (4cm x 4cm). Average D of lid: 16.3cm; Projection: 8cm x 6.5cm at base & 5.2cm x 4.5cm at top. Ref: Prendergast & Lucas, 1962, 165.
Townland: Tawnaghmore **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1960:620	**Wooden Vessel – Mether – Plate 17.21** Two handled decorated Mether found at the same spot (Sheskin Bog) as a lid (1960:610 above) previously presented to NMI. Carved from a single piece of wood except for the base which was inserted into a ledge-like rebate near its bottom. Rectangular in plan, the upper 10cm of the body is vertical, below which it bulges slightly outwards before narrowing towards the bottom. On opposite sides are two D-shaped handles extending from 2.7cm above the bottom to 10cm below the rim and projecting 1.5cm outwards. The upper portions of all four walls are decorated externally with poker-work ornament, consisting of crossing lines which make a design of lozenges between pendent and erect triangles. The triangles are filled with short oblique lines and at the crossing points of the border lines are a circular mark made, apparently, by a hot metal object. H: 16.2cm; Mouth (ext.): 10.8cm x 10cm. Ref: Prendergast & Lucas, 1962, 165.

Location	Description
	 **Plate 17-21: Wooden Mether – Tawnaghmore – NMI Reg: 1960:620, (From Prendergast & Lucas, 1962, 166)**
Townland: Tawnaghmore **Parish:** Kilcommon **Barony:** Erris **O.S. 6" Map:** Mayo - 27 **Reg. No(s):** 1965:68	**Axe Head** Found 3-4 feet deep in bed of stream. Broad in relation to its length. Long edges straight; convex cutting-edge slightly wider than the thin, rounded butt. The material is green medium-grained sandstone with interstitial limonite. L: 12.1; max. W: 6.9cm; max. H: 3.5cm Ref: Lucas, 1968, p. 95.

17.3.6 Summary of Archaeological Heritage

There are a total of four sites of archaeological interest/potential, three listed as Recorded Monuments (see Appendix 13D), and one listed solely in the Sites and Monuments Record (SMR) of the Archaeological Survey of Ireland as being located within the overall proposed wind farm. These are designated CH-1 to CH-4. In addition, there are a total of ten additional monuments located outside, but within 1km of the overall development site boundary. These are designated CH-5 to CH-9, with the latter comprising six individual monuments. All of these monuments are listed as Recorded Monuments, except for MA028-003006 which is listed solely in the Sites and Monuments Record. In addition, a total of twenty-three artefacts have been reported to the National Museum of Ireland as having been discovered within the overall proposed development landholding and immediate environs. The main concentration of monuments is around the south-eastern perimeter of the landholding, near Dooleeg More and Eskeragh, while the artifactual material has been found dispersed across the site. The nature of the archaeological landscape around the bog is decidedly prehistoric, with megalithic tombs and, particularly, standing stones occupying prominent positions in the surrounding landscape. The concentration of sites to the southeast of the bog suggests that this area may have had a particular importance during the prehistoric period, particularly the Bronze Age, given the preponderance of Standing Stones.

One of the artefacts discovered was a Stone Axe Head (1965:68; Tawnaghmore) and may be of Neolithic or Bronze Age date. It is difficult to assign a date to the Iron Horse Shoes recovered from Shanvodinnaun. Of the remaining twenty one artefacts, twenty are made of wood. While it is difficult to assign dates for much of these vessels, it is likely that, based on typology, three of the vessels may date to the early/mid 1st millennium AD – 1959:57 (Shanvolahan), 1958:15 (Shanvodinnaun) and 1997-25 (Tawnaghmore). Five of the vessels are decorated – 1960:609 (Corvoderry), 1961:188 (Croaghaun West), 1986:57 (Shanvodinnaun), 1960:610 and 1960:620 (both from Tawnaghmore), which based on the form of decoration may date to the later 1st millennium AD. The vessel from Sheskin – 1958:13 – has been ascribed a dated by Earwood (1997, 30) to the Medieval Period. The remaining artefacts are likely to generally date from the early first to the mid second millennium AD, based on their typologies and the depths of the bog from which they were discovered.

17.3.7 Architectural Heritage

There are no protected structures within the meaning of the Planning and Development Act, 2000 situated within the defined study area. There are two structures of Architectural Heritage listed by the National Inventory of Architectural Heritage (NIAH) situated within the defined study area. These are Sites CH-19 and CH-21 below

A total of twenty-four structures/features of architectural heritage interest are listed below. These are largely included due to the location of some of the structures within the overall landholding (Sites CH-10, CH-11, CH-12 and CH-13), their association with the former peat operations on the lands (Sites CH-15, CH-16, CH-17, CH-18 and CH-23), or reflective of the architectural, engineering and social history of the area historical associations with the area (CH-14, CH-19, CH-20, CH-21, CH-22 and CH-24).

Table 17-13: Site CH - 11

Site CH-10	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Peat formed peat boundary **ITM:** 497630 822802	A field boundary formed by a peat-mounded linear bank with fosses on either side (Plate 17.22 below) was noted adjacent the eastern side of the Srahnakilly road close to CH-16.

Plate 17-22: CH-10 Srahnakilly – Peat-formed Field Boundary

Table 17-14: Site CH - 11

Site CH-11	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Cottage, Outbuilding & Field Boundary **ITM:** 496839 824539	A. A dwelling is shown at this location on the 1838 O.S. map but the present structure is a replacement dating to the latter half of the 19th century. It comprises a gable-ended cottage with off-centre chimney and additional chimney to southern gable; replacement corrugated iron roof material to former thatch; no rainwater goods. Four square-headed window opes with stone sills to front façade; rough plaster render to stone walls. Later concrete lean-to porch structure to front incorporating entrance door to southern side. Partial remains of stone outbuilding to north incorporation northern gable and side walls to full height – Plate 17.23. This house was inhabited until the 1950s.

	B. Peat-formed field boundary c. 120m to east of cottage and running south to river. Up to 1.2m high with rounded top and covered with grass and heather – Plate 17.24. Of late 19th century date.

Plate 17-23: SITE CH-11A - Srahnakilly – Cottage & Outbuilding

Plate 17-24: CH-11B Srahnakilly – Field Boundary

Table 17-15: Site CH - 12

Site CH-12	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:**	Cottage dating to second half of 19th century. It comprises a gable-ended structure with replacement corrugated roof; off-centre chimney and additional chimney to west gable; rough plaster render to stone walls; no rainwater goods. Northern end of cottage incorporates a

Cottage **ITM:** 497181 824366	square-headed door opening to a store room. Later lean-to concrete extension to front façade incorporating two square-headed window opes with entrance door to east side and roofed with corrugated iron sheeting. One original square-headed window ope with stone sill on front façade – Plate 17.25. The house was inhabited until the 1950s and serves as a store for agricultural activity

Plate 17-25: Site CH-12 - Cottage

Table 17-16: Site CH - 13

Site CH-13	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Cottage – in ruins **ITM:** 496879 824315	Ruined remains of cottage dating to second half of 19th century. Gable-ended; side walls largely standing to full height but tops of gables have collapsed; four partial window opes to front façade with slightly off-centre doorway. No roof or render. Partial remains of internal wall incorporating remains of fire place and chimney – Plate 17.26

Plate 17-26: Site CH-13 – Srahnakilly – Cottage Ruins

Table 17-17: Site CH - 14

Site CH-14	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Bridge **ITM:** 497499 824010	Bridge over tributary of Oweninny River, constructed in 1950s. Central concrete support in river to concrete carriageway; incorporated metal fencing along edges to carriageway – Plate 17.27

Plate 17-27: Site CH-14 - Srahnakilly - Bridge

Table 17-18: Site CH - 15

SITE CH-15	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Bridge **ITM:** 497663 822820	Concrete bridge constructed by BnM in the 1950s providing vehicular/pedestrian access across Oweninny River. Two concrete supports in river to concrete carriageway with concrete parapets – Plate 17.28.

Plate 17-28: Site CH-15 - Srahnakilly – Bord na Móna Bridge

Table 17-19: Site CH - 16

SITE CH-16	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Bridge **ITM:** 497616 821644	Concrete bridge over Oweninny River providing access from Srahnakilly road to farm complex on eastern side of river. Incorporates 8 concrete supports, in land and river, to concrete carriageway with slightly raised parapet holding supports for metal fencing. Service pipe attached to outside of structure on southern side – Plate 17.29.

Plate 17-29: Site CH-16 – Srahnakilly - Bridge

Table 17-20:Site CH - 17

SITE CH-17	Description
TOWNLAND: Srahnakilly **CLASSIFICATION:** Road Bridge **ITM:** 497798 821127	Road bridge to public road over former BnM railway line. Constructed 1952. Single central concrete support to carriageway with concrete parapets – Plate 17.30. Road raised to accommodate bridge.

Plate 17-30: Site CH-17 - Srahnakilly - Road Bridge

Table 17-21: Site CH - 18

Site CH-18	Description
TOWNLAND: **Srahnakilly** **CLASSIFICATION:** **Railway Bridge** **ITM:** **47798 821127**	Disused railway bridge over Oweninny River, constructed by BnM in the 1950s. Concrete central support in river to steel superstructure (Plate 17.31) onto which timber sleepers were bolted (Plate 17.32).

Plate 17-31: Site CH-18 – Srahnakilly – Railway Bridge

Plate 17-32: Site CH-19 – Detail to surface of railway bridge

Table 17-22: Site CH -19

Site CH-19	Bellacorick Bridge
TOWNLAND:	A plaque on the bridge reads “By order of the Grand Jury, Right Hon.

Site CH-19	Bellacorick Bridge
Bellacorick **CLASSIFICATION:** Road Bridge **ITM:** 496927 819972. **NIAH Reg. No.:** 31302702	Denis Browne, Foreman. This bridge was designed and built by William Bald, Civil Engineer, 1820" The structure, which spans the Oweninny River, is construed with cut stone, and comprises four elliptical arches, with parapet walls incorporating flat coping – Plate 17.33. Also known as the 'Musical Bridge' which has now become an object of curiosity. 'Music' is produced in two ways. First by rolling a rounded stone along the parapet on either side. As the stone drops along, musical notes are produced in rapid succession. The second method is to hold a stone and strike the coping slabs as you go along, rapidly drawing back the stone immediately after striking. Each slab gives forth its own peculiar note and a wonderful musical scale is produced (Noone, 1991, 282).

Plate 17-33: Site CH-19 – Bellacorick Bridge

Table 17-23: Site CH - 20

Site CH-20	Description
TOWNLAND: Bellacorick **CLASSIFICATION:** Stables **ITM:** 496828 820015	Detached former stable block on side of road. Two storey rough stone gable-ended structure with rough squared quoins and roofed with slate. Two square-headed door opes on ground floor façade incorporating remains of timber frames but no door; blocked up small square-headed window with shallow stone sill on west end of facade – now blocked with timber board painted to resemble a window frame. Central square-headed ope to first (attic) floor incorporating replacement timber frame and door and protruding step to base. This was probably used to access the first floor storage space. Small square-headed window opes to bales, no windows or sills – Plate 17.34

Plate 17-34: Site CH-20 – Bellacorick – Former Stable Block

Table 17-24: Site C - 21

SITE CH-21	Description
TOWNLAND: Tawnaghmore **CLASSIFICATION:** Church **ITM:** 493933 821529 **NIAH Reg. No.:** 31302701	**Ballymonelly Catholic Church:** Foundation stone dated 22nd May 1952 and dedicated to Blessed Virgin Mary. Detached three bay nave with bellcote to west gable; pitched roof of slate with replacement water goods; Chamfered lancet east window and narrow chamfered windows to side walls; chamfered lancet window over west doorway of rounded chamfered lancet opening with solid timber panel doors. Painted plaster render with mock panted quoins – Plate 17.35. Set back from road on own grounds with low concrete boundary wall to road frontage and simple wrought iron hates with concrete painted piers.

Plate 17-35: Site CH-21 – Tawnaghmore – Ballymonelly Church

Table 17-25: Site 22

Site CH-22	Description
TOWNLAND: Moneynierin **CLASSIFICATION:** Road Bridge **ITM:** 497664 819473	Grand Jury bridge constructed 1820. Comprises cur-stone structure with single rounded arch and stone parapet walls incorporating flat coping Plate 17.36.

Plate 17-36: Site CH-22 – Moneynierin – Road Bridge

Table 17-26: Site 23

Site CH-23	Description
TOWNLAND: Moneynierin **CLASSIFICATION:** Workshops **ITM:** 499051 819608	Warehouse, workshops, offices and storage works buildings to Oweninny Work, mostly dating to 1950s. Site is dominated by workshop building with rising zig-zag gables from west to east and iron clad roofs; front façade incorporates square-headed windows, pedestrian and vehicular door openings, all with timber doors – Plate 17.37. Buildings are set back from road.

Site CH-23	Description

Plate 17-37: Site Ch-23 – Moneynierin – Industrial Complex

Table 17-27: Site 24

Site CH-24	Description
TOWNLAND: Moeynierin **CLASSIFICATION:** Cottages – in ruins **ITM:** 500574 819096	Two ruined cottages at right angles to each other. One is of stone; gable-ended, with east gable collapsed by west is standing to full height; front and rear walls partially collapsed; internal wall, off-centre, standing almost to full height; no render of roof; evidence for three window opes and single door ope to front façade. This is of late 19th century date. Second cottage is of 20th century date and is concrete built; walls, including an internal wall, standing largely to full height; no roof; plaster render; two square-headed window opes with concrete sills and door ope to east-facing façade. Set in own grounds to south of former public road – Plate 17-38. Remains of low concrete wall with gate piers along road frontage.

Plate 17-38: Site Ch-24 – Moneynierin – Ruined Cottages

17.4 IMPACTS OF THE DEVELOPMENT

17.4.1 Construction Phase

Local History

The general historical background to the subject development area was introduced above in Section 17.2.2. In summary, there are no significant historical events associated with the proposed development lands which have the ability to be impacted upon by the proposed development. A peat-formed field boundary at Srahnakilly (CH-10) is located outside the overall site boundaries and, consequently, it is not envisaged that it has the ability to be directly impacted by the development, as proposed.

Archaeology

Only four sites, designated CH-1 to CH-4, of archaeological interest/potential are listed as being located within the overall proposed wind farm development area. Three of these are listed as Recorded Monuments (see Appendix 13D), and one listed solely in the Sites and Monuments Record (SMR) of the Archaeological Survey of Ireland. Additionally, there are a total of ten monuments located outside the site boundary, largely to the southeast, but within 1km of it. These are designated CH-5 to CH-9, with the latter comprising six individual monuments. No additional monuments or surface features of archaeological interest/potential were noted by cartographic or aerial photographic research or by subsequent surface reconnaissance surveys. Likewise, no previously unrecorded monuments were noted by survey work undertaken by previous archaeological studies prepared with respect to EIS for developments within, and in the immediate environs of, the subject development lands.

In addition, nothing of archaeological interest was noted by a detailed survey of the Oweninny Bog System by a study undertaken in 2002 (Whitaker 2004). During the surface reconnaissance surveys undertaken with respect to this report, a particular emphasis was placed on the edges of exposed peat lying on exposed sterile geological subsoils, in order to determine if any evidence existed for any pre-bog walls (Plates 17.39, 17.40 and 17.41). No such evidence was noted. In addition, for large areas of the landholding, the subsoil surface is devoid of peat (Plate 17.42). This is due to the removal of peat almost onto the underlying subsoils, following which the remaining shallow depths of basal peat were washed off by weathering, exposing the sterile geological subsoils. Such areas were also subjected to detailed surface reconnaissance survey.

Plate 17-39: Exposed Edge to Internal Access Road showing peat overlying gravelly sandy subsoils

Plate 17-40: Exposed edge showing peat overlying gravelly subsoil

Plate 17-41: Exposed peat overlying sandy subsoil

Plate 17-42: Exposed Gravelly Subsoil

Groundworks associated with developments such as that under discussion have the general ability to uncover and disturb hitherto unrecorded subsurface features, deposits, structures and artefacts of archaeological interest and potential, particularly within, though not confined to, existing peat-bog areas. However, in terms of the present site, much of the bog has been removed and the surface of the underlying archaeologically sterile subsoil has been exposed and subjected to detailed survey inspections. It is not considered likely that any subsurface archaeological features might exist in such exposed areas. However, without specific mitigation strategies, such subsurface archaeological features that might exist within areas of existing peat cover would be disturbed and destroyed and not identified and recorded.

It is further noted that, for the most part, the reported archaeological discoveries associated with the subject lands were associated with initial peat excavations, which were undertaken on a phased basis. None of the artefacts appear to have been recovered from depths in excess of 1 – 1.5m from the original bog surface.

Given the above, it is considered that there is low-medium potential for the discovery of previously unrecorded subsurface archaeological features and artefacts within the subject development areas that comprise peat cover, while such potential is considered to be very low with regard to those areas where the subsoils are presently exposed.

It is noted that only one monument – CH-3 (Enclosure) – located within the landholding is anyway extant. However, this is virtually hidden by extensive heather growth. Furthermore, only minimal extant evidence survives for CH-2 (Megalithic Tomb). There is a possibility that some subsurface remains might exist for CH-1 (Cist) although no surface traces were noted by a surface reconnaissance survey in the area of the monument. No traces for CH-4 (Trackway) were noted as a result of aerial photographic research or during the surface reconnaissance survey. The remaining monuments are located at distances of 150m to greater than 1km from the boundaries to the site. As a result of inputs from the Cultural Heritage Consultant, the proposed layout has been designed to ensure that no impacts occur to all known archaeological remains. In general, the distances from the proposed turbine locations and associated roads can be measured in 100s of meters from any of the archaeological remains within the landholding. Equally so, the proposed turbine locations and associated roads can be measured in 100s of meters from the site boundaries. It is considered that such distances are such that while the turbines will be visible from some of the archaeological sites, the settings to such will preserved and that any impacted views from the monuments is considered minimal.

Given the above, it is considered that there are No Predicted Impacts by the proposed development on archaeological monuments identified as being located within, or in the general environs of, the overall subject development landholding.

Architectural Heritage

There are no Protected Structures located within, or in the general environs of, the subject development lands. Although a total of twenty four structures are included above (Section 17.2.4) it should be noted that these are included to represent the architectural, engineering and social history of the general area, or because of their locations within the overall landholding or associated with the former peat development works.

It is considered that the potential for significant impact on these structures by the development, as proposed, is very low, although it is likely that some of the bridges over the Oweninny River constructed by BnM (CH-15 and CH-18) will be utilised during construction works associated with the development. In addition, it is noted that CH-13 is sited c. 10m from an existing access road which will be utilised during construction works. Consequently, there is a possibility that, without an appropriate mitigation strategy, this might be accidently damaged by construction works associated with the proposed development.

It is not considered that any direct impacts will occurs to any of the identified sites/structures of architectural interest described above in Section 17.2.4 Consequently it is considered that no predicted direct impacts will occur during the construction phase of the development.

17.4.2 Operational Phase

It is considered that no impacts to features of historical interest will occur during the operational phase of the development.

It is noted that only one monument – CH-3 (Enclosure) – located within the landholding is anyway extant. However, this is virtually hidden by extensive heather growth. Furthermore, only minimal extant evidence survives for CH-2 (Megalithic Tomb). There is a possibility that some subsurface remains might exist for CH-1 (Cist) although no surface traces were noted by a surface reconnaissance survey of in the area of the monument, while there are no traces for CH-4 (Trackway). The remaining monuments are located at distances of 150m to greater than 1km from the boundaries of the site. The proposed layout has been designed to ensure that no impacts occur to all known archaeological remains. The distances from the proposed turbine locations and associated roads can be measured in 100s of metres from any of the archaeological remains within the landholding. Equally so, the proposed turbine locations and associated roads can be measured in 100s of metres from the site boundaries. Consequently, while the turbines will be visible from some of the archaeological sites, the settings to such will be preserved with minimal impacted views. Given the above, it is considered that there are no predicted Impacts by the proposed development on archaeological monuments identified as being located within, or in the general environs of, the overall subject development landholding.

Likewise, given the siting of the proposed turbines with respect to the structures of architectural interest listed above in Section 17.2.4, it is considered that there are No Predicted Impacts by the proposed development on such structures identified as being located within, or in the general environs of, the overall subject development landholding.

17.4.3 ‘Do-Nothing’ Scenario

In terms of Cultural Heritage, no impacts will occur.

17.5 MITIGATION MEASURES

17.5.1 Construction Phase

Local History

There are no potential impacts on any onsite features or areas of historical interest. Consequently, no mitigation measures are considered.

Archaeology

As noted above in Section 17.3.1, it is not considered likely that the development, as proposed, will cause any direct or indirect impacts to previously identified archaeological monuments. It is noted that large areas of the overall development lands consist of exposed subsoils, with the remaining area covered by varying depths of peat. Consequently, with respect to the latter, there is a possibility that previously undocumented subsurface archaeological features/artefacts might exist with such areas. No specific areas of significant archaeological potential have been identified as a result of the archaeological research and fieldwork undertaken with respect to the preparation of this report. Consequently, it is not considered necessary to undertake any targeted pre-development archaeological investigations – geophysical or intrusive testing – with respect to the development lands. However, in light of the general requirements of the National Monuments Service, Department of the Arts, Heritage and the Gaeltacht and Mayo County Council with regard to similar developments, together with the Code of Practice between the Department of Arts, Heritage and the Gaeltacht, the National Museum of Ireland and Bord na Móna, the following mitigation measures are suggested:

- Prior to the commencement of each phase of construction works, an archaeologist shall be appointed to oversee all required archaeological mitigation strategies, in consultation with the Bord na Móna Project Archaeologist
- The archaeologist shall undertake a further field survey, walking the routes of all proposed roads, the locations of turbines and substations and any other associated construction activities (construction compound, locations of overhead line structures, drainage, etc.) and agree with the Planning Authority and National Monuments Service the degree of archaeological monitoring of works that might be required, Such agreement will form part of the method statement to be submitted to the National Monuments Service with respect to the application for an archaeological licence.
- Prior to the commencement of works, a temporary buffer area of 30m shall be created around CH-2 and CH-2 (e.g. post-and-rope fence with appropriate signage).
- In general, all works requiring removal of, or disturbance to, the remaining in situ peat deposits onto the surface of the underlying geological subsoils should be monitored, on a full-time basis by the appointed archaeologist.
- No spoil or fill material should be stored on, or within 50m of any identified Archaeological Heritage features. In addition, the locations of works compounds, offices, material storage areas, etc. should be sited well away from the identified archaeological monuments.
- In the event of archaeological material being uncovered during the course of such monitoring, the archaeologist shall be empowered to have works stopped in the vicinity of such material pending receipt of advice from the National Monuments Service. Likewise should archaeological/historical artifactual material be recovered during such works, then the requirements of the National Museum of Ireland with regard to such items should be implemented.

- Following completion of all monitoring and any other possible archaeological investigations associated with each phase of works, the archaeologist shall prepare a report for submission to the Planning Authority and the Department of Arts, Heritage and the Gaeltacht.

Architectural Heritage

Although it is not envisaged that any impacts will occur to identified structures of architectural interest, it is noted that there is a possibility for accidental damage to be caused to CH-13 (cottage in ruins). Consequently, the following mitigation strategy is suggested:

- A buffer area of 10m be established around the CH-13 (post-and-rope fence with appropriate signage).
- No spoil or fill material should be stored on, or within 50m of any identified Architectural Heritage features. In addition, the locations of works compounds, offices, material storage areas, etc. should be sited well away from the identified architectural heritage structures.

17.5.2 Operational Phase

It is not envisaged that any visual impacts will occur to any previously identified sites or features of Cultural Heritage Interest as a result of the operation of the subject development. Consequently, it is not considered that a mitigation strategy is required.

17.6 PREDICTED IMPACTS

17.6.1 Construction Phase

The requirement for an archaeologist to be present on a full-time basis for all removal of peat deposits required of the development will ensure that in the event of archaeological features being uncovered, appropriate measures can be implemented in consultation with the Department of Arts, Heritage and Gaeltacht. Likewise, should artifactual material be recovered, then the requirement of the National Museum of Ireland, with regard to such items, can be implemented.

The requirement that no spoil or construction fill/materials is stored adjacent to the immediate environs of any Cultural Heritage monument or structure will likewise ensure that no accidental damage is caused to such features.

17.6.2 Operational Phase

There are no predicted impacts.

17.6.3 ‘Worst Case’ scenario

A ‘worst case’ scenario with respect to archaeological heritage would arise where the development was permitted to commence without any archaeological mitigation requirements being included in a Grant of Planning, without the appointment of an archaeologist to undertake mitigation requirements or without the attendance of the archaeologist. In such scenarios, features or artefacts which might be uncovered during the course of the works would, most likely, be destroyed and not recorded.

17.7 CUMULATIVE IMPACTS

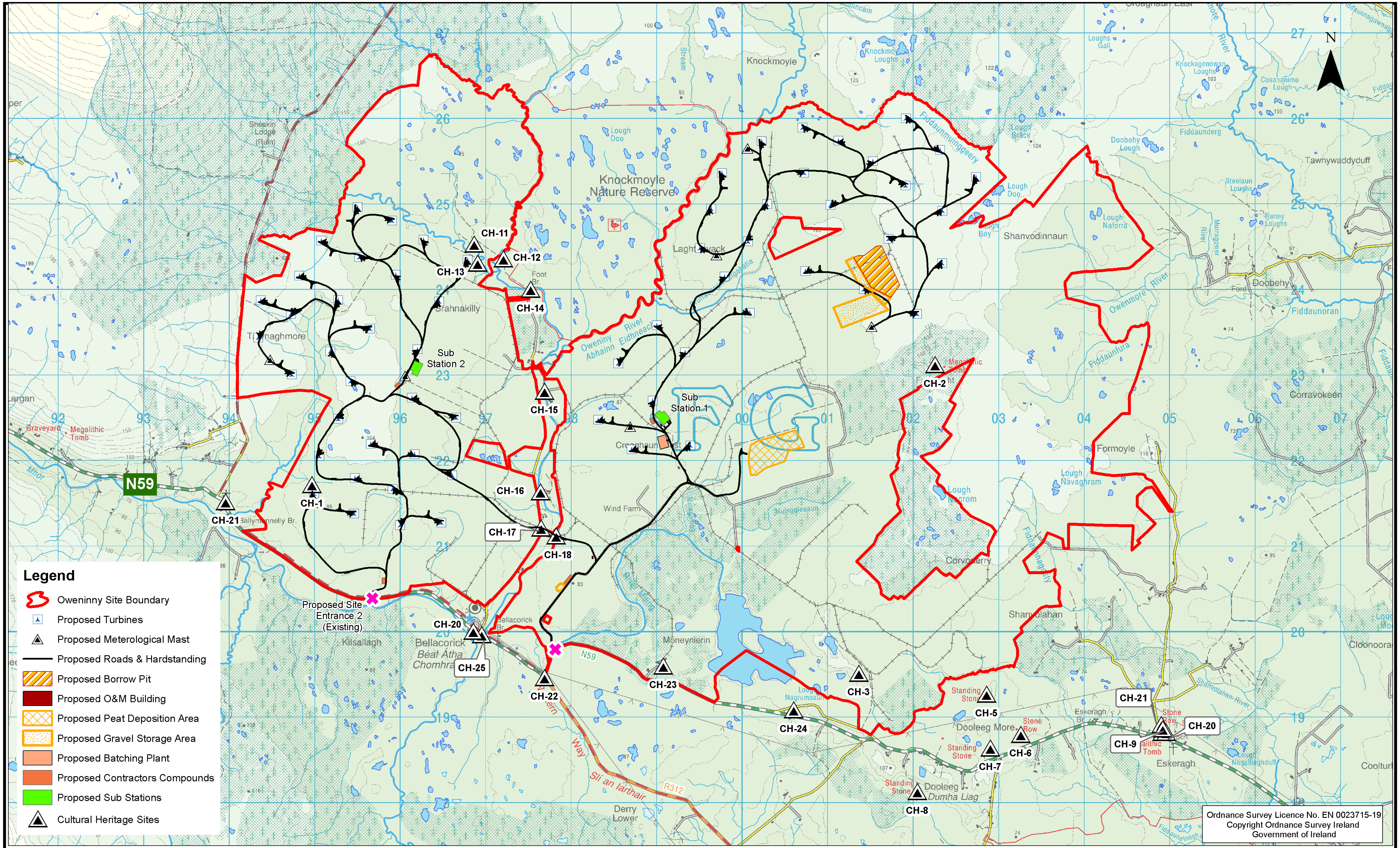
A review of the Cultural Heritage Assessment reports contained in the EIS' with respect to Tawnanasool Wind Farm, together with the Planning & Environmental Consideration Reports (PECR) of the Bellacorick – Castlebar and Bellacorick – Moy 110kV Overhead Lines Projects, the Cultural Heritage Assessment Report prepared with respect to a Meteorological Mast at Sheskin Td, and the Archaeological, Architectural and Cultural Heritage Impact Assessment for the Bellacorick – Bangor Erris 38kV Line Uprate/Refurbishment Project indicate that no Cultural Heritage impacts will occur with respect to any of these projects. Likewise, the Cultural Heritage Chapter of the EIS prepared with respect to the Wind Farm element of the project determined that no impacts would occur with respect to any identified Cultural Heritage site/feature. In addition, reports prepared with respect to the Oweninny Wind Farm Phase 3 Grid Connection (i.e. connection to Gridwest Project) would have 'neutral' impacts. Consequently, it is not considered that the cumulative effect of the construction of the proposed development, and associated grid connections, together with other projects such as the Tawnanasool Wind Farm, Meteorological Mast at Sheskin, the Bellacorick – Castlebar and Bellacorick – Moy 110kV Overhead Lines Projects or the Bellacorick – Bangor Erris 38kV Line Uprate/Refurbishment Project will cause any increased negative impacts to sites of Cultural Heritage interest.

Potential future development of Oweninny Phase 3

With respect to the potential future development of Oweninny Phase 3, a full assessment of all three phases has been provided in Chapter 17 of the original EIS submitted as part of the planning application for the wind farm to An Bord Pleanála in 2013. No significant impacts were identified.

17.8 CONCLUSION

It is not envisaged that any residual effects will occur with respect to Cultural Heritage as a result of the project proceeding.



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Oweninny Power Ltd.

Client
Oweninny Power Ltd.

Project
Wind Farm Project at Oweninny, Bellacorick, Co. Mayo

Title
Cultural Heritage Sites

Production Unit
Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
CF	CF	P.K	N.Q	30/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:40,000

MAP REFERENCE

FIGURE 17.1

19 HYDROLOGY & SEDIMENT

19.1 INTRODUCTION

Sediment loss and water management within the site are critical to protecting the water environment. Historically peat harvesting on the site gave rise to peat sediment loss from bare peat areas leading to downstream increases in suspended matter and sediment deposition. The rate of surface runoff at high flows was reduced by provision of additional storage within the drained areas of the peat bog. With the introduction of a sediment control system, comprising settlement lagoons and subsequent implementation of a bog rehabilitation plan by Bord na Mona, peat sediment loss has reduced significantly and water clarity is now good as reported by Inland Fisheries Ireland, see Section 10. It is important that activities associated with Oweninny wind farm do not result in any significant loss of sediment to the receiving rivers and that they complement the rehabilitation measures undertaken on the site, particularly during construction.

This section considers the potential impacts relating to surface water hydrology and sediment loss from the construction areas.

The assessment is based primarily on:

- Contoured Light Detection and Ranging (LiDAR) Mapping and OSi Aerial Photography[181,]
- Bord na Mona Oweninny Bog Rehabilitation Plan[182,]
- CIRIA, The SuDS Manual – C697, Planning for SuDS – C687, SUDS Best Practice Manual – C523, Site handbook for the construction of SUDS – C698, Control of water pollution from linear construction projects – C648 and Designing for exceedance in urban drainage – C635183,

[181] Osi Aerial Photography, Osi Mapviewer.

[182] Bord na Móna, Oweninny Bog Rehabilitation Plan, 2003.

[183] CIRIA: The SuDS Manual – C697, Planning for SuDS – C687, SUDS Best Practice Manual – C523, Site handbook for the construction of SUDS – C698, Control of water pollution from linear construction projects – C648, Designing for exceedance in urban drainage – C635, . CIRIA C532 – Control of Water Pollution from Construction Sites – C532 and Design of Flood Storage Reservoirs – B14.

- EPA river maps and catchments (EPA ENVision environmental mapping system and EPA "Hydrotool"[184,185]
- OPW and Mayo Co. Co. Flood hazard mapping and preliminary flood risk assessment[186,187,188],.

19.2 RECEIVING ENVIRONMENT

19.2.1 Site Characterization

The site is located on a catchment boundary between three catchments, the Oweninny/Owenmore (A), the northeastern Owenmore (B) and the Moy (C), see Figure 19-1. The Oweninny River drains the central part of the site. The Oweninny River is fed by the Srahmeen River and Knockmoyle Stream from the west and by numerous small tributary streams from the east (Fiddaungal, Fiddaunnaglogh, Fiddaunnameenabane, Fiddauncam and the Fiddaunnamuingeery) before entering the Oweninny wind farm site. The Oweninny is joined by the Sheskin Steam which drains the forested south-eastern slopes of Slieve Fyagh and also forms the site's internal boundary with the O'Boyles Bog area. The Oweninny and the Fiddaunnamuingeery form part of the site boundary. The Sruffaunnamuingabatia, which drains the Bellacorick Iron Flush SAC area within the site, flows westwards and joins the Oweninny River. The Oweninny is also joined by the Muing River which drains Lough Dahybaun within the site. The Owenmore drains a catchment of approximately 332 km^2 before entering the sea at Tullaghan Bay. The Oweninny flows southwards, externally to the site and effectively dividing the site in two before joining the Owenmore turning westwards after Bellacorick Bridge and paralleling the N59. The Owenmore is joined at this location by the Altanabrocky River flowing

[184] EPA ENVision environmental mapping system, http://maps.epa.ie/InternetMapViewer/MapViewer.aspx.

[185] EPA "Hydrotool", http://watermaps.wfdireland.ie/HydroTool/Authentication/Login.aspx?ReturnUrl=%2fHydroTool%2fDefault.aspx

[186] Mayo Co Co, Strategic Flood Risk Assessment for the Draft Mayo County Development Plan 2014 – 2020

[187] OPW Flood Hazard Mapping, www.floodmaps.ie

[188] OPW National Preliminary Flood Risk Assessment, www.cframs.ie

northwards from the Nephin Mountains.

The north-eastern part of the site is drained by small tributaries (Fiddaunfura) which rise in Shanvodinnaun and flow eastwards to the main easterly flowing river, also named the Owenmore. This river rises in the townlands of Cluddaun and Shanetra to the north of the site before flowing eastwards becoming the Cloonaghmore River before entering the sea at Rathfran Bay which is within Killala Bay. It is also referred to as the Palmerstown River. The Cloonaghmore River drains a catchment of approximately 132 km^2 before entering the sea at Rathfran Bay.

The south-eastern part of the site drains to tributaries of the Shanvolahan River (Fiddaunagosty, Shanvolahan and Fiddauntooghaun) before entering the Deel River which drains to Lough Conn and eventually joins the River Moy at Ballina before entering the sea at Killala Bay. The River Moy drains a catchment of approximately 1,966 km^2 before entering the sea at Killala Bay. The area of the Shavolahan catchment before it enters the Deel River is approximately 23.7 km^2.

Table 19-1 summarises the three main river catchments and the extent of proposed turbines and access tracks in each.

Table 19-1: Catchments and Turbines

Catchment	Draining to	Area sq km	No of Turbines
Owenmore (Oweninny)	Tullaghan Bay	332	61
Cloonaghmore (Owenmore)	Rathfran Bay	132	0
Deel (Shanvolahan)	River Moy	1,966	0

There are no elements of the Oweninny Phase 1 and 2 development within the Clonaghmore or Deel/Moy catchments.

The area is an Atlantic blanket peatland, comprising largely drained cutaway bog but with significant areas of rehabilitated cutaway and also remnant bog. The peat deposits generally vary in depth from 0.5m to 3.5m but 80% of the construction area has a depth less than one metre. Glacial till occurs in places and this generally underlies the peat. Small areas of glacial sand and gravel deposits are also present, particularly in the south and east of the site. Finally, alluvial deposits are shown to be present along the course of the Oweninny/Owenmore River.

There are natural rivers within the site as shown in Figure 19.2 and the area is drained by a network of manmade drainage ditches.

19.2.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The long-term (30-year) annual average rainfall (AAR) for the Oweninny/Owenmore Catchment of 187 sq km, to immediately downstream of the site is 1,554mm.

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Belmullet, Co. Mayo, located approximately 32km west of the site. The long term average annual PE for this station is 518mm/year. The effective annual average rainfall (ER) represents the water available for runoff or groundwater recharge and is the rainfall less the actual evapotranspiration. To determine Actual Evaporation (AE), a standard crop factor of 1.3 has been regularly applied to blanket bog settings in Ireland were the surface of the bog is dominated by sphagnum. However, at the Bellacorick site there is little or no sphagnum and a value of 1.3 would overestimate AE here. A conservative estimate of 1.1 is used for the Bellacorick site which equates to an AE of 570mm/year. The ER for the site is estimated at 984mm. During the months April to October, there is very little runoff or recharge. Most of the effective rainfall at field scale occurs in the winter months.

There are no long-term recording surface water flow gauging stations in or near the site. In the 1950s and 1960s however, three water level gauging stations associated with the original Power Station recorded levels in the rivers for a short period and flows were measured at one of these, in the Owenmore River downstream of the site. These provide an indication of the surface water response at the time. Anecdotal observations at Oweninny during harvesting agree with field measurements of blanket peatland drainage made in a neighbouring bog at Glenamoy[189], which concluded that flood runoff was reduced in frequency and amount, and summer flow of streams was increased. The bog rehabilitation programme would have reversed this process to some extent. A water level recession curve measured in 1962, prior to peat harvesting, is shown in Figure 19-3 for the channel downstream of the site. This plot indicates some storage in and around the peat and possibly in the underlying groundwater.

More recently, an investigation of groundwater at the Bellacorick Iron Flush SAC area within the site recorded water tables, phreatic pressures and flows where links between surface and groundwater were identified, see Chapter 18.

Flows estimated using the EPA Hydrometric System (Hydrotool), also suggest a relatively fast runoff, which is a characteristic of blanket peatlands. This estimation method does not account for the cutaway nature of the site, with rewetting and revegetation, explicitly. This rehabilitation has stabilised the sediment.

The objective is to minimise any potential impact on this water balance of the site.

19.2.3 Flooding

The Office of Public Works (OPW) compiles Flood Hazard Maps which record known historic flood locations for the entire country[187]. They are also in the process of preparing

[189] Burke, W. 1967: Principles of drainage with special reference to peat. Irish Forestry 24,1–7.

flood hazard maps based on a risk assessment. Flood Hazard Maps are tools used to assist with the management of development in floodplains and other areas at risk from tidal, fluvial or surface water flooding. OPW has prepared a national “Preliminary Flood Risk Assessment” Report[188]. Mayo County Council has prepared a flood risk assessment of its county development plan[186] in line with requirements of the Regional Planning Guidelines 2010 to 2022.

Although there are no recorded incidences of flooding at or near the site, this would relate to local roads and houses. The area is a peatland where surface flooding is of course commonplace.

Flood Risk Assessment reports have been prepared of each substation, for the operation and maintenance building and for the visitor centre, see Appendix 15. They conclude that the developments comply with the principles of “The Planning System and Flood Risk Management - Guidelines for Planning Authorities, November 2009".

19.2.4 Cutaway Bog Rehabilitation

A Cutaway Bog Rehabilitation Plan has been implemented on the site. This involved detailed consultations with relevant agencies, authorities and affected parties to arrive at an implementation procedure to ensure minimum impact to the environment.

There are a significant number of features of the rehabilitation within the site that will benefit a Sustainable Drainage System (SuDS) approach to surface water management for the development.

These are:

- Vegetated Filter Strips
- Existing Wetland
- Existing Surface Ponds
- Vegetated Drainage Channels
- Existing Settlement Ponds.

Typical land use and surface hydrology is illustrated in Plate 19-1 and Plate 19-2 below, where the impact of the bog rehabilitation plan can be seen.

Plate 19-1: Area prior to rewetting

Plate 19-2: The same general area as Plate 19-1, in 2010.[190]

A comprehensive assessment of the impact on fisheries arising from peat silt discharges from Bord na Móna bogs in North Mayo prepared by Inland Fisheries Ireland indicated that significant peat loss to waters occurred from bare peat areas within the site in the past but these have reduced significantly due to the bog rehabilitation works undertaken by Bord na Móna since 2003. The current water status is considered acceptable.

19.2.5 Sensitive Receptors

Flow disruption or sediment loss to any of the receiving rivers would pose a significant risk. In addition to fisheries risk throughout the river system, five areas in particular are considered for special attention.

Shanvolahan-Deel River

An area in the southeast of the site is particularly important as it drains to the Deel (Shanvolahan) River, which supports freshwater pearl mussel populations in downstream reaches. There are no elements of the Phase 1 and Phase 2 only development within the catchment of this area.

Lough Dahybaun

The catchment area of Lough Dahybaun, located within the site, has been delineated from detailed LIDAR Figure 19-6. There are no elements of the Phase 1 and Phase 2 only development within the catchment of this area.

[190] Ref. Wilson D, Farrell C, Mueller C, Hepp S, and Renou-Wilson F Rewetted industrial cutaway peatlands in western Ireland: a prime location for climate change mitigation? *Mires and Peat*, Volume 11 (2013), Article 01, 1–22.

Geoheritage of Oweninny River

The only geoheritage feature within the environs of the site is the geomorphology of the banks of the Oweninny River itself, as it traverses through the central part of the site.

Iron Flush

The Surface Water – Groundwater interaction at the Iron Flush SAC within the site was investigated in 2012 and is reported in Chapter 18.

Bog Remnants

There are small areas of relatively undisturbed bog within the site.

19.3 POTENTIAL IMPACT OF THE DEVELOPMENT

19.3.1 Working in Cutaway Peatland

Water and sediment management in and around the site has been the subject of international research over many years, from the 1960s[189] to 2013[190]. The experience gained in the area will be employed throughout the project, allowing a SUDS design which is site-specific and suited to the well-humified peat. Initially, water tables were lowered at the site by constructing shallow drainage ditches of 0.75m depth – there was no benefit at greater depths. The ditches needed to be at a very close interval of 4.5m as the well-humified peat is impermeable except in the pores near the surface. In the cutaway bog, peat banks remain vertical and the water table can be about 100mm below the surface.

Drainage work in a windfarm would normally pro-actively drain working areas and direct all flow and sediment within a designed drainage network. There is usually sufficient depth of outfall nearby all construction areas. However, in the undulating cutaway peat area of Oweninny, slopes are generally very low, some areas are flat and the likely outfall is a considerable distance from many construction areas. Although a drainage system was installed during peat extraction in most areas, this drainage system was largely revoked by the bog rehabilitation programme.

19.3.2 Windfarm Activities

Potential impacts that are typically associated with wind farm developments may include the following:

- Unmanaged erosion and sediment deposition generated from ground disturbance could cause modification to stream channel morphology, potentially smothering habitats and impacting on aquatic flora and fauna, especially fish. Water abstracted for drinking can also be affected by sediment.
- Any alteration of natural flows or subsurface hydrogeological patterns could disturb the water regime, particularly floods and droughts, unless properly managed.
- The development of new access tracks across existing rivers has the potential to obstruct water flow.

- Poorly designed drainage on unstable areas may increase the risk of landslide.

The potential impacts apply primarily during construction if the flow paths are interrupted or redirected. General disturbance of the vegetation cover during construction has the potential for short-term generation of high suspended sediment loads in rivers draining the area. This potential for an increased sediment loading will be short-term and will reduce as vegetation in disturbed areas re-establishes. Potential impacts may also arise in respect of increased sediment loading resulting from any dewatering of excavated areas.

The potential impacts can be mitigated by careful drainage design.

The historic planting of commercial coniferous forests in parts of the site at Oweninny has modified the hydrology of these planted areas of the site. Further potential alteration could arise from clearfelling in these areas. While the permanent removal of mature forests from large areas of the site could result in increased runoff directly into local rivers, the felling plan to facilitate the wind farm project proposal are not considered significant in relation to what is envisaged in the overall forest management plan.

As part of the wind farm development, a number of existing river crossings (e.g. across the Muing and Sruffaunnamuinggabatia Rivers) and culverted crossings across smaller streams will require upgrading. Potential impacts could result from disturbance of the river bed and flow constriction.

Foul effluent from kitchens and washrooms will be treated and discharged to ground through appropriately designed proprietary treatment and percolation areas. Rainwater harvesting will be provided at offices and excess surface runoff from roofs will be lead to soakaways.

19.4 MITIGATION

19.4.1 Approach

The approach to surface water management for Oweninny Wind Farm Project integrates with the methods already agreed with the environmental authorities for bog rehabilitation at Oweninny. These methods are tailored to the characteristics of the site and to the specific properties of the peat, and they form part of a suite of techniques used in the Oweninny Bog Rehabilitation Plan and in Sustainable Drainage Systems (SuDS).

The bog rehabilitation programme at Oweninny is based on three measures aimed at encouraging re-vegetation of the site and stabilising it to minimise suspended solids loading to receiving rivers: undisturbed buffer areas alongside rivers; rewetting of areas by blocking drains; and ploughing of a small number of areas with little or no peat to promote revegetation.

The objective of the wind farm hydrology and sediment control design is to replicate these natural drainage patterns within the project. The following design philosophy has therefore been adopted:

- Limit the impermeable fraction of the development, with particular attention to sensitive locations.
- Re-direct upslope clean surface water around structures and providing first stage treatment to construction/operation water locally at structures to remove and isolate contamination at source.
- Thereafter, spread surface runoff across the surface to maximise the benefits of the existing site characteristics through use of buffer zones and rehabilitation areas.

Surface water generated on the development area will predominantly continue to drain as it would under pre-development conditions. Access tracks and structures are generally located on relatively high areas and on local watershed boundaries, away from rivers. The system is a diffuse system. First-stage local treatment is provided throughout the site in settlement ponds and lagoons, with the type of pond and lagoon designed on the basis of the bog rehabilitation and SuDS features available and on the risk to the nearest river. In very sensitive areas, the number of turbines is minimised and additional settlement SuDS measures are proposed.

19.4.2 Water Quantity

The development has been minimised to the extent possible:

- The footprint of the development (areas of tracks, cranepads, borrow pits, substations, visitor interpretive centre and batching plant) will occupy approximately 0.45% of the upper Oweninny/Owenmore catchment after it passes through the site.

This figure reduces significantly as the catchment extends further downstream.

The localised footprint areas associated with the tributaries' sub catchment areas, see Figure 19-4 and the highest percentage occurs in the Muing river catchment.

Although runoff from constructed areas will form a relatively high percentage runoff, this can be compared to the high percentage runoff of the existing peat bog, as compared say to mineral soils. Hence, there is no significant increase in runoff and local first-stage treatment at each structure will deal with the same local runoff as occurs at present. At isolated areas of bare earth, where peat was completely removed, the link between surface runoff and groundwater is highly disturbed, leading to springs and local surface pathways. Again, the local water balance will be preserved by local first-stage treatment and second-stage treatment on the bog surface.

This approach does not require special measures to deal with extreme rainfall events. It facilitates access to and operation of the electrical substations, wind turbines meteorological masts and other buildings within the development during very extreme events.

Hence the potential impact for the footprint area is related to sediment rather than flow.

19.4.3 Sediment Control

Sediment control structures and associated local drainage will be constructed prior to the main construction at each site. An Erosion and Sediment Control Plan has been prepared for the site and will be fully implemented, see Appendix 16 of the original EIS application.

Sediment loss from the site is particularly important to all rivers draining the site given their important salmonid nature. Sediment loss to the receiving rivers would pose a significant risk to salmonid spawning areas and juvenile fish. The control of flow and sediment within the existing regime will ensure that the present buffer to runoff and sediment loss within the site is preserved.

The only geoheritage feature within the environs of the site is the geomorphology of the banks of the Oweninny River. No works are proposed on the river banks, with the exception of the replacement or upgrading of the existing river crossing within the site. It is not anticipated that this upgrade will affect the river bank substantially beyond the extent of the existing crossing and is unlikely to present a significant risk.

The layout design for the development has minimised the area to be disturbed by construction through rationalising the access track network serving turbine locations and locating turbine hardstandings and access tracks in areas of shallow peat depths. Proposals to manage the potential for erosion of sediment and the control of activated sediment are set out herein and will be incorporated into the Construction Environmental Management Plan which will be a requirement for site construction.

19.4.3.1 Settlement Lagoons and Ponds

Settlement ponds and/or lagoons are the main features proposed for first-stage treatment at each structure, followed by second-stage SuDS measures between the structure and the nearest river. The second stage will also control sediment and they include spreading flow across the peat surface and/or into large artificial ponds and wetlands.

First-stage treatment has been designed to provide initial detention for the settlement of solids activated during local earthworks, based on their contributing area and rainfall for the particular risk assessed for the specific structure location. A peat particle settlement velocity of 0.0025m/s[191] and a standard pond width of 8m were chosen, allowing ease of maintenance. Rainfall return periods of 10, 30 and 100 years have been applied to different areas of the site in accordance with identified risk to rivers, that is, depending on:

- the number and quality of subsequent measures of surface water treatment available following discharge from the pond, and on

[191] Mulqueen, J, Rodgers, M, Marren N and Healy, M.G. Erodibility of Hill Peat. *Irish Journal of Agricultural and Food Research* 45: 103–114, 2006

- the proximity of the pond to a local river.

The required pond length was calculated from this. The rainfall for these return periods were obtained from Met Eireann[192], and runoff flow rates for these return periods were derived using the Rational Formula with a runoff coefficient (C_v) of 0.70 which is consistent with the upper limit of the range recommended for stripped ground. A ten-minute design duration is appropriate for all structures, apart from the large peat repository where thirty minute duration was applied to a pond that will serve half of the site. A conservative instantaneous time of entry is assumed.

Ponds comply with CIRIA Guidance C648. Six types of ponds have been designed and, depending on their location within the site, they have been sized for different return periods, in accordance with Table 19-2.

Table 19-2. River Risk and Design Rainfall Return Periods

Location relative to River and Number of Subsequent Treatment Measures	Rainfall Return Period years	Peak Rainfall intensity mm/10min
River in close proximity and 1 subsequent SuDS treatment measure	100	23.2
River nearby and 1 to 2 subsequent SuDS treatment measures	30	16.7
Large distance to nearest river and 2 or more subsequent SuDS treatment measures	10	12.3

About 50% of eroded peat particles are finer than 0.2mm in diameter with 10% finer than 0.035mm

The pond hydraulic and sediment design criteria are:

- Standard dimensions of base width 5m, top width 8m, depth 2m (water depth 1.5m) and side slopes 1:0.75 were chosen to suit a standard 12 tonne excavator with a 1.5m jib extension. Lengths are then varied to suit risk and load. This excavator can clean the pond from both sides with minimum disturbance.
- Discharge will be via a 450mm diameter twin-wall pipe with a flap valve installed, to provide isolation during cleaning.

[192] Met Eireann, 2007. Estimation of Extreme Rainfall Depths.

- In the five very sensitive areas near the Shanvolahan River, Lough Dahybaun, Oweninny channel, Iron Flush and Bog Remnants, a piped inlet with a manually operated flap valve will be installed on the settlement pond. This valve can be closed preventing incoming flow in the event of an environmental incident, thus protecting the pond.
- At structures that are a long way from rivers and with extensive subsequent surface treatment, the first-stage treatment settlement pond may be replaced altogether by an artificial SUDS lagoon. Such a lagoon would be larger than a designed settlement pond, it would be fitted to the local topography allowing for continuous wetting to suit the bog rehabilitation plan. It will allow inlet and outlet flows across a wider area.

19.4.3.2 Swales

A swale is an open gently sloping grassed drainage channel. A swale may be used to collect and convey drainage water to the lagoons and special ponds, trapping sediment and enhancing filtration.

19.4.3.3 Check Dams

Check dams are small temporary barriers that will be constructed across larger areas of concentrated flow at structures. Their purpose is to reduce the velocity and to slow the rate of runoff. In steeper parts of site, check dams will be placed in the drainage channels, effectively creating ponding which will assist in sediment removal, see Plate 19-3.

Plate 19-3: Typical stone check dam in a drainage ditch

19.4.4 Access Tracks

The process of rewetting through drain blocking on the site has detained surface water on site thereby creating wetted areas and the conditions required for native peatland vegetation to establish. This is also very effective at trapping peat silt particles. Early stage rehabilitation areas are characterised by many small deep ponds, many larger shallow ponds and exposed peat surface areas. Access track drainage will be directed onto the peat surface and to these pond areas where feasible, providing for treatment and attenuation of surface water generated on access tracks. Some mature wetland areas offer substantial benefits to surface water drainage. Significant detention and attenuation of runoff can be achieved.

Drainage from the locations of turbines and associated development areas has been carefully selected to avoid the ecologically significant bog remnant areas. Consequently the surface water drainage proposals associated with these areas will have no hydrological impact on these ecologically important areas of the site.

Access tracks will be above the existing ground level where peat is shallow, that is, across 80% of the site. They will have a camber in both directions. Where peat excavated for the access track construction is sidecast there will be gaps left in this side cast peat to allow surface water flow paths through to the surrounding area. Where possible, the access tracks have been strategically positioned on watersheds so as to allow runoff in both directions. However, in the limited areas where the natural overland flow paths are interrupted by the line of the access track, regular culverts/ drainage paths will be provided so that the access tracks do not interfere with the natural hydrology of the site. These drainage paths will have check dams at regular intervals on any access trackside drains where the longitudinal access track gradient exceeds 10%. This will further promote treatment and detention of surface water runoff from the access track.

Surface cross drains will be installed on tracks that are particularly steep and have long gradients.

Where Access tracks will be below existing ground level, where peat depths in excess of one metre cannot be avoided, temporary local drainage will be installed to allow construction of the track sub-base. The final track will camber to both sides and be provided with a v-notch drain at both sides. This drain will follow the longitudinal fall in the track until the access track level is again above the surrounding ground level. At this point, ‘finger drains’ perpendicular to the access track will discharge runoff from the access track over surrounding lower lying ground. Should a low point of the access track and consequently the drains coincide with the access track level below existing ground, the access trackside drain will diverge from the access track in the direction of nearest lower ground.

Check dams will be provided at regular intervals on any access trackside drains where the longitudinal access track gradient exceeds 10%. This will further promote treatment and detention of surface water runoff from the access track.

19.4.5 Turbines, Substations and Buildings Hardstanding

An open drainage ditch will be located on the down slope side(s) of each of the turbine hardstanding development areas. Where possible this drainage ditch will be profiled as a swale with side slopes of 1:3. This drainage ditch/ swale will be easily maintainable from the edges of the hardstanding and will discharge to first-stage treatment in a dedicated settlement pond/lagoon, an example is shown in Figure 19-5. The type of settlement pond/lagoon at each location has been selected on the basis of the sensitivity of the area. Finally, discharge from the first-stage treatment system will be overland for further treatment on the surface.

Peat excavated for the construction of the hardstanding will be placed in an adjoining area of the hardstanding so that runoff from this area will also be routed through the specific water first-stage treatment measures at the hardstanding.

The particular sensitive areas are considered next.

Geoheritage of Oweninny River

No works are proposed on the river banks, with the exception of the replacement or upgrading of the existing river crossing within the site. It is not anticipated that this upgrade will affect the river bank substantially beyond the extent of the existing crossing and is unlikely to present a significant risk.

Bellacorick Iron Flush

The layout surrounding the Iron Flush is discussed in Chapter 18 where construction is considered in detail. There will be no significant impact.

Bog Remnants

Particular attention was given to keeping turbines away from significant bog remnants, to the extent possible and away from replacement siltation areas and riparian zones. Nearly all bog remnants have been avoided except in a small number of cases where minor incursions occur due to the necessity of the wind resource design and where existing Bord na Móna roads and paths were already established.

19.4.6 Borrow pit

Investigation of the site has indicated that materials suitable to support construction are available on site. These materials will be won through the excavation of a shallow borrow pit which may be inundated by groundwater. It is intended that the working of the pit will take place through the water table in a water filled excavation, i.e. no pumping of groundwater will take place to facilitate excavation. Excavated material will be dredged and left to dry on the storage area adjacent to the site before being loaded onto trucks. The gravel storage area will be drained to a settlement pond/lagoon and then to overland flow for approximately 450m to a small tributary of the Sruffaunnamuingabatia River. Further detail as to the operation of the borrow pit was set out in the Oral Hearing for the Oweninny wind farm in the witness statement of Michael Gill of Hydroenvironmental Services. This was reference din Section 18 above.

19.4.7 Peat Repository

The peat deposition area is enclosed on three sides by the existing Bellacorick wind farm access tracks. Internal access tracks within the repository area will be constructed to facilitate peat deposition. The peat repository area will be drained through the access tracks to a settlement pond system with subsequent overland flow to a large existing Bord na Móna artificial pond, see Figure 19-8.

19.4.8 Batching plant

The concrete batching plant location will be drained north-westwards through a settlement pond/lagoon and then through overland flow to a flat area comprising cutover bog with some exposed gravels and an extensive area of cutover bog with high cover of rushes, see Figure 19-9. The settlement pond/lagoon is located approximately 900m from a tributary of the Oweninny River flowing through the central section of the site. A water body formerly known as Lough Nagappal is located about 117m south of the batching plant site but the topography is such that natural gradients will not allow any discharge to the lake. The direction of overland flow from the batching plant is westerly and not southerly and no impact on this water body will occur.

19.4.9 Tree Felling

The impact of commercial timber harvesting on stream flow regimes has been studied in the past. Robinson et al presents a study of flow changes in four nested catchments in mid-Wales with increase of total annual flows[193]. Similar flow increases up to 30% were observed on 100% clearfell sites[194]. The results indicated that partial felling produced little increase in peak flows. In a similar study in the Burrishoole catchment in County Mayo[195], slight peak flow increase was observed in two sub-catchments after harvesting. However, statistical analysis indicated that the increase was not significant. The study further confirmed that the impact of harvesting on the peak flow was small. Similar studies across Europe[196], found that the impact of forest harvesting on extreme flows was relatively small and difficult to detect in the North West European conifers.

In some areas of felling, it may be possible to block existing forestry drainage networks at intervals in order to slow the rate of runoff to the drains. The forest plantation areas at Oweninny will not be felled until post 2020, as stated in the Forest Management Plan for the area. This is likely to coincide with the main felling plan. If it does not, approximately 1.05% of the present forest plantation will be clearfelled to accommodate the development; otherwise the area will be felled as part of the felling plan.

[193] Robinson, M. and Dupeyrat, A. (2005). Effects of commercial forest felling on streamflow regimes at Plynlimon. Hydrological Processes 19:1213-1226.

[194] Johnson R. 1998. The forest cycle and low river flows: a review of UK and international studies. Forest Ecol. Manag. 109: 1-7

[195] Xiao, L, Robinson, M, Rodgers, M, O'Connor, M, O'Driscoll, C, Asam, Z. UNESCO IHP Irish National Hydrology Conference 2011. Impact Of Blanket Peat Forest Harvesting On Stream Flow Regime – A Case Study In The Burrishoole Catchment, Co Mayo.

[196] Robinson M., et al. 2003. Studies of the impact of forests on peak flows and baseflows: a European perspective. Forest Ecol. Manag. 186: 85-97.

The forest plantation in these areas was planted in the late 1980's and early 1990's and is drained directly to the rivers with no intervening buffer zone as occurs with more recent forest plantation areas. Modern forest practice undertaken in accordance with the Forest Service Guidelines will be implemented. In practice this will result in the restructuring of the drainage to prevent direct flow to the river systems through development of riparian buffer zones. Runoff should also decline naturally as re-vegetation of the felled areas and buffer zones occurs.

While the permanent removal of mature forests from large areas of the site could result in increased runoff directly into local rivers, the known and possible changes to the current felling plan to facilitate the wind farm project proposal are not considered significant in relation to what is envisaged in the overall forest management plan.

19.4.10 Other Construction Settlement Control Measures

Additional temporary lagoons and if necessary settlement ponds will be constructed around the site should the need for these be identified. Portable propriety settlement systems will be used in conjunction with at risk activities in particular locations as required.

Temporary wheel wash facilities will be provided and utilised for heavy goods vehicles leaving the site. Runoff from this area will enter a dedicated lagoon.

In areas of significant crossfall, clean water runoff drains up to 0.5m deep will direct flow to peat surface areas away from the works. This will provide a significant reduction of the volumes of potentially discoloured run-off that would otherwise require treatment.

19.5 MONITORING AND MAINTENANCE DURING CONSTRUCTION

19.5.1 Monitoring

There will be no new point discharges to rivers from the development site.

Monitoring points will be set up at the outlet of those sediment control points located closest to rivers. The predominant test will be for suspended solids. Turbidity will also be tested for and recorded. Other tests can be added should there be any indication of other types of pollutants arising from construction activities on the site.

Peat extractions in sensitive locations will be secured in advance of predicted rainfall. In the unlikely event of works being unavoidably close to rivers, vehicular and equipment access will be restricted to working surfaces / pads as appropriate and bogmats or other surface protection used as required.

Procedures for maintenance of windfarm hydrology will include the following measures:

- A programme of regular cleaning, maintenance and inspection of the site runoff treatment system will be adopted to ensure it functions correctly. Sediment protection measures will be regularly inspected, and any collected sediment will be cleared out in dry weather to ensure maximum capacity can be maintained.

- Lagoons will be checked for leakage, particularly following periods of heavy rainfall. Travel paths of surface water run-off to downstream receptors will be examined.
- Growing vegetation will be left in place at ditches as this will aid in the filtering of some of the sediments.
- The key lagoons and designed settlement ponds will be assessed and restored at the end of construction.
- A drainage management protocol will be incorporated into the management procedures for the operation of the wind farm.

The development will form part of a Windfarm Environmental Management System certified to ISO14001. This includes a draft Construction Environmental Management Plan (CEMP), incorporating the Erosion and Sediment Control Plan which describes water management measures to control water runoff and drain hardstandings and other structures during the construction phase. It integrates local water management with the existing bog restoration plan and it is designed to minimise the potential for effects on surface water, groundwater, soils and subsurface water quality. Also included is an Incident Plan to be followed should a pollution event occur. This draft plan will be updated following receipt of planning approval with the planning conditions, if any, which relate to environmental management of flows and sediment. Appropriate construction and operation personnel working on the site will be trained in its use.

19.5.2 Operational Phase

For the operational phases of the wind farm:

- The programme of regular cleaning, maintenance and inspection of the site runoff treatment system will continue to be adopted to ensure it functions correctly. This will include inspection of the sediment protection measures, and removal and disposal of any collected sediment as described for the construction phase
- Lagoons will continue to be checked for leakage, particularly following periods of heavy rainfall and routes to surface waters reviewed.
- The revegetation of bare earth areas associated with ditches and swales will be monitored to determine if additional action is required.
- The key lagoons and designed settlement ponds will continue to be assessed.
- A drainage management protocol will be incorporated into the management procedures for the operation of the wind farm.

19.5.3 Decommissioning Phase

The decommissioning will be undertaken in accordance with a detailed decommissioning plan for the site agreed with the planning authority.

Decommissioning of the Oweninny wind farm will give rise to some limited ground disturbance and no requirement for any additional drainage. The wind farm is expected to be operational for a minimum period of twenty five years during which time the impact of the bog rehabilitation programme will be almost fully realised with large areas of bare peat revegetated. It is expected that any drainage channel and settlement ponds created as part of the sediment control measures will also have become revegetated. Decommissioning will involve covering over with peat material all foundations, crane hardstands and access tracks unless any of this infrastructure is required on site. As this has the potential to generate sediment through surface flow, an assessment of the effectiveness of the existing drainage system to control sediment in runoff will be made at that time and if warranted, an updated drainage control system will be designed and agreed with the planning authority.

Decommissioning can also take place over an extended time period, minimising the extent of areas at any one time which could generate sediment-laden runoff.

Impacts during the decommissioning period are expected to be insignificant.

19.6 CUMULATIVE IMPACTS

The nature of the diffuse drainage system designed and integrated with the bog rehabilitation programme, will mitigate the potential for accumulation of surface runoff and sediment in the site.

In terms of hydrology cumulative impacts could potentially arise from changes in drainage and runoff to receiving waters and the creation of conduits whereby suspended solids could gain access to water courses incrementally impacting on water quality. These cumulative impacts could arise during the construction activities of other wind farms located near the site, with the construction of the proposed gas peaking plant near the Oweninny River on lands running through the centre of the site. Cumulative impacts could also occur due to the upgrade works associated with the Bellacorick to Castlebar 110kV OHL, the Bellacorick to Moy 110kV line uprate, the proposed modification of the existing Bellacorick substation, the Grid West project and the proposed meteorological mast at Sheskin. These are discussed below.

19.6.1 Wind Farms

19.6.1.1 Corvoderry Wind Farm Development

Construction of the planning approved Corvoderry wind farm would likely coincide with the development of Phase 3 of Oweninny should this go ahead. The Corvoderry site is drained westwards by the Muing River and eastwards by the Fiddaunagosty Stream. There is potential for cumulative impacts to arise from increased runoff from modification of land use at the Corvoderry site to the Muing river catchment, this would be cumulative with any increased run off from the development of Oweninny Phase 1 and 2. Increased runoff would also increase the potential for sediment loss and this is dealt with in the water section above.

Phase 3 of Oweninny drains to thee Cloonamore and Moy catchment and there would be some potential for cumulative impact in terms of increased run off to these systems.

With the implementation of the sediment and Hydrology and Sediment Control Plan developed for the Oweninny project (Appendix 16 of the original EIS) and the hydrology and sediment control measures set out in the Corvoderry wind farm no significant cumulative impacts are predicted to occur.

19.6.1.2 Dooleeg, Bellacorick Wind Farm

This wind farm has permission to construct a single one 2 MW turbine at Dooleeg, Bellacorick. The location is a few hundred metres south of the Oweninny site in the upper drainage of a tributary of the Deel system and there is limited potential for cumulative impact on hydrology to occur.

19.6.1.3 Tawnanasool Wind Farm

Tawnanasool is located about 10km to the west southwest of the Oweninny site in the Croaghaun river catchment, a coastal catchment which drains directly to Tullaghan Bay. The Owenmore River into which the Oweninny flows also drains to Tullaghan Bay. Hence, there is very limited potential for cumulative impact on the hydrology of Tullaghan Bay to occur given both the distance and the extensive mitigation measures set out in the Tawnanasool proposal and the Oweninny wind farm proposal if implemented properly.

19.6.1.4 Potential future development of Oweninny Phase 3

The potential impact on hydrology and sediment control associated with the development of Phase 3 of the Oweninny site would occur in the eastwardly flowing Clonaghmore catchment and the south easterly flowing tributaries of the Deel catchment and subsequently the Moy catchment. The potential impacts of all three phases were addressed in Chapter 19 of the EIS which accompanied the planning application to An Bord Pleanála in 2013. No significant impact was identified as part of that assessment.

19.6.2 Meteorological Mast

This site is located within the catchment of the Oweninny River but the nature of construction and size of the development would not result in any significant cumulative impact on the hydrology of the river system

19.6.3 Overhead Power Lines

Planning permission has been granted for the following overhead power line projects in the Bellacorick area:

- Uprate of (planning reference P14/410) – granted to EirGrid plc by An Bord Pleanála on 11th August 2015.
  The uprate of the existing Bellacorick to Castlebar 110 kV Overhead Line will have only very limited potential to impact on the hydrology of the Owenmore system from the works associated with structures 1 – 18, are located within its catchment. No significant cumulative impact is predicted as it is likely that these works would be completed well in advance of the development of Oweninny wind farm
- Similarly with the uprate of the Existing Bellacorick to Moy 110 kV Overhead Line Given the nature of the works associated with the uprate there is limited potential for hydrological impacts of a cumulative nature with Oweninny.

No significant cumulative impact is predicted to occur between the Oweninny project and the planning approved line uprates

19.6.4 Substation Project

The modification works are all internal the existing substation. As the substation site and no significant cumulative impacts with Oweninny will occur.

19.6.5 Power Plants

As the planning documentation for the above projects did not identify significant adverse impacts on hydrology, it can be assumed that there would be no cumulative effects with the Oweninny development.

19.7 CONCLUSIONS

The hydrology and sediment control system on the windfarm development is designed to be sustainable using SuDS techniques and integrating with the bog rehabilitation plan. Drainage from the structures is compatible with rewetting of the bog.

The percentage runoff in the river catchments draining the site will not be significantly changed.

Clearfelling of mature forest can result in a local higher water table, which is aligned with the rewetting programme of bog rehabilitation.

The potential increase in sediment, particularly during construction, has been factored into the design of the SuDS system, based primarily on designed first-stage treatment at structures using local settlement lagoons and ponds, followed by spreading flow across the peat surface, wetlands and existing ponds.

It is worth noting that the drainage regime at the site is already a modified one, with its natural hydrology having been amended by peat extraction and by commercial forests.

LIST OF REFERENCES

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Ref. 6 OPW Flood Hazard Mapping, www.floodmaps.ie

Ref. 7 OPW National Preliminary Flood Risk Assessment, www.cframs.ie

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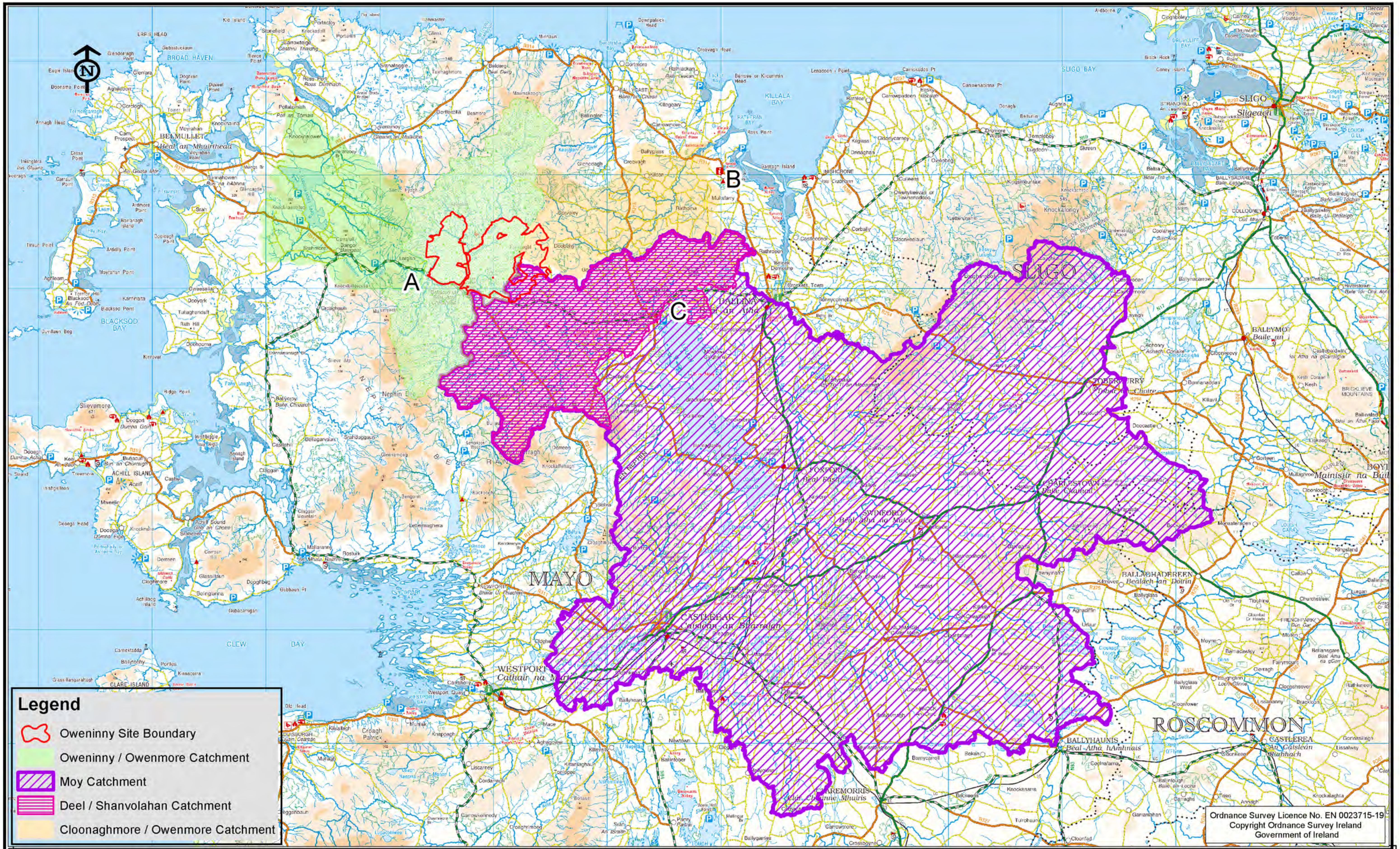

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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Title	Oweninny Site & Main River Catchments
Project	Wind Farm at Oweninny, Co. Mayo
Production Unit	Civil, Building & Environment Group

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E.O'S	E.O'S	A.D	P.K	09/09/2015

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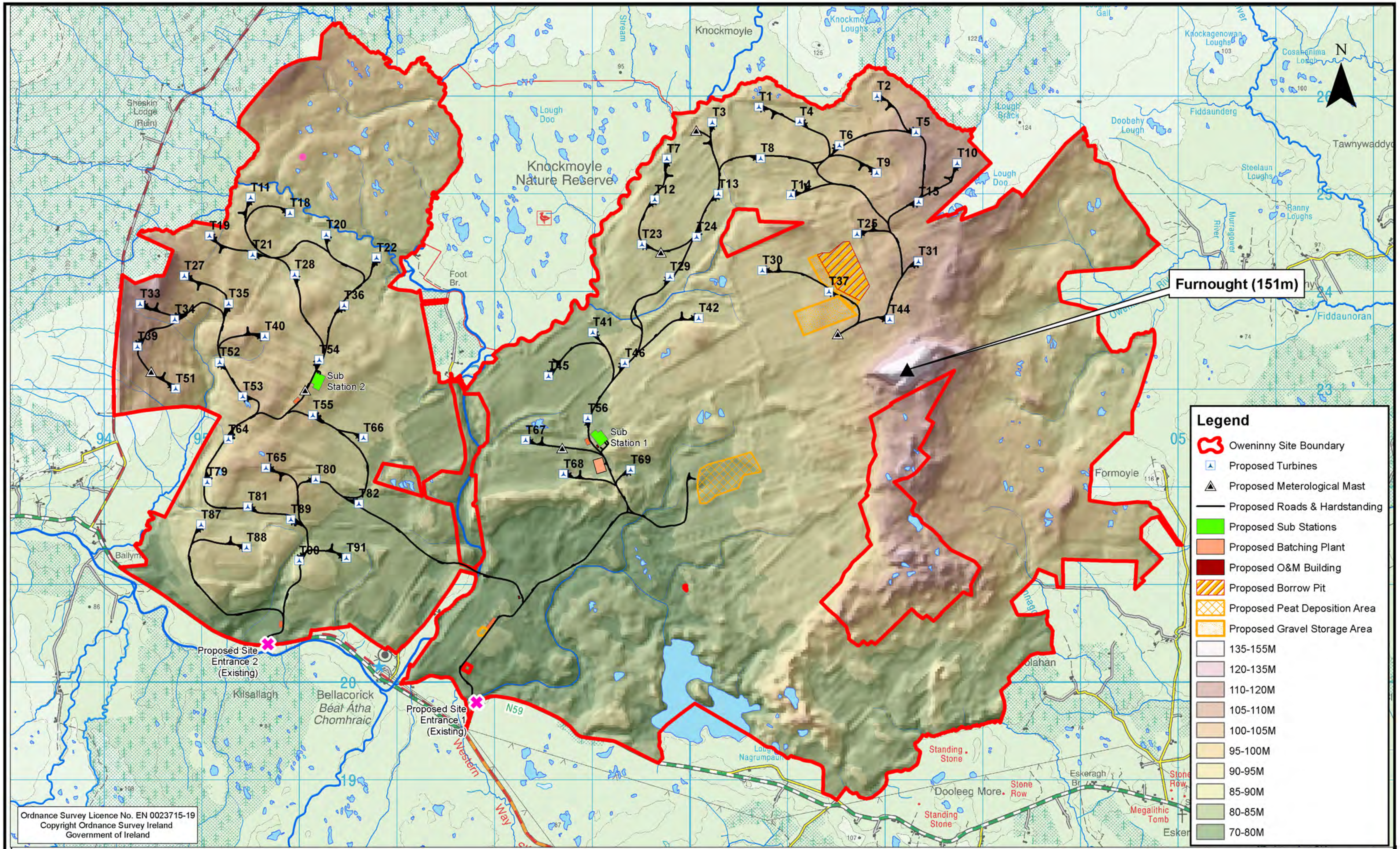
MAP REFERENCE

Figure 19.1



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Oweninny Power Ltd.

Client	Oweninny Power Ltd.
Project	Wind Farm at Oweninny, Co. Mayo
Title	Shaded Relief Topography Oweninny Wind Farm
Production Unit	Civil, Building & Environment Group

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CF	CF	PK	NQ	01/10/2015

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00-00	1/1	A3	1:35,000

MAP REFERENCE

Figure 19.2

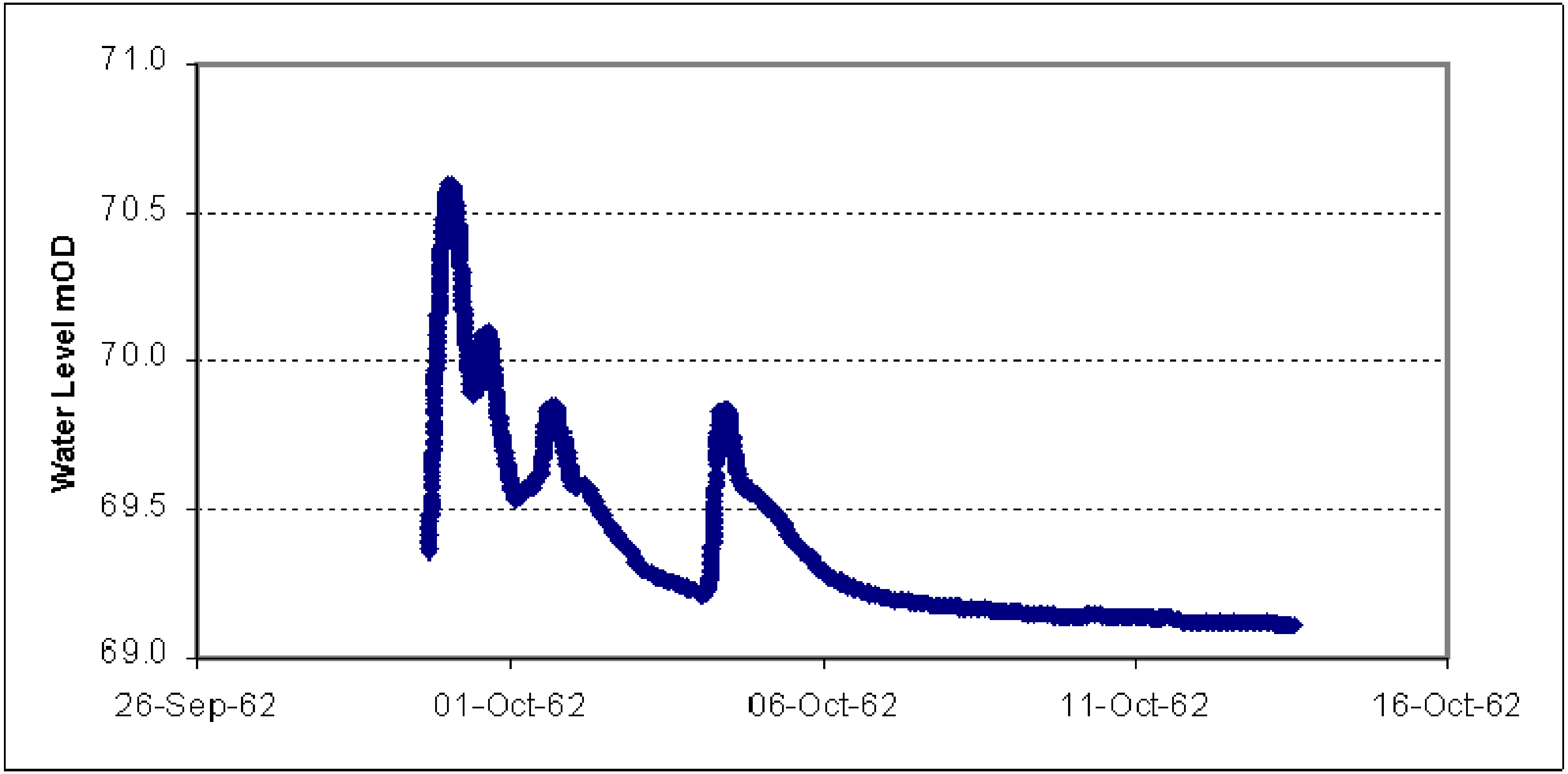
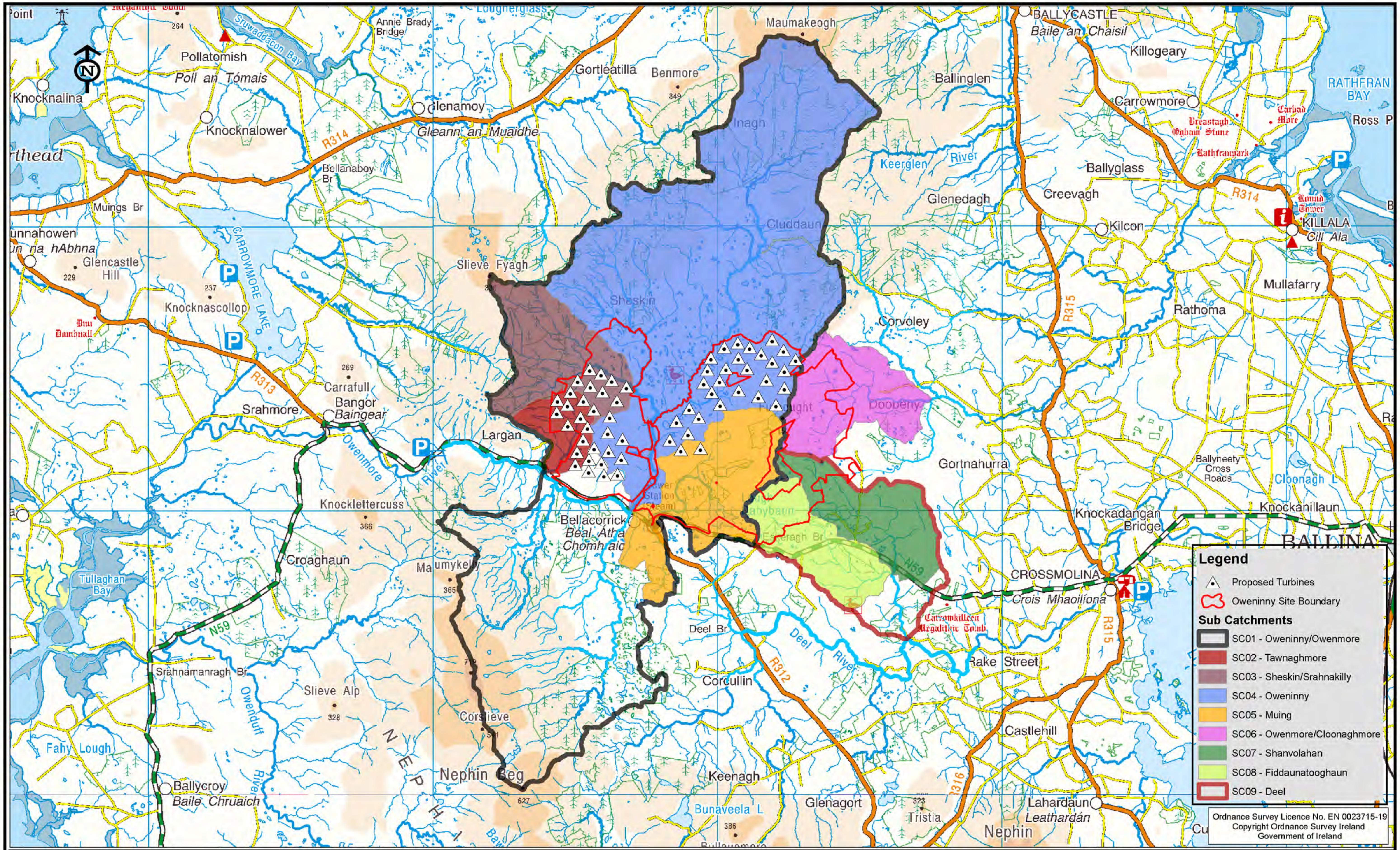


Figure 19-3: Water level recession curve



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Oweninny Power Ltd.

Client	Title				
Oweninny Power Ltd.	River Sub-catchments associated with the Oweninny Wind Farm-Phasing 1 & 2				

Project	Production Unit
Wind Farm at Oweninny, Co. Mayo	Civil, Building & Environment Group

DRAWN BY	PRODUCED BY	VERIFIED BY	APPROVED BY	APPROVED DATE
E.O'S	E.O'S	P.K	J.C	09/09/2015

CLIENT REF.	NO. OF SHEETS	SHEET SIZE	SCALE
00-00	1/1	A3	1:120,000

MAP REFERENCE

Figure 19.4

Legend:

- Site Boundary
- Proposed Turbines & Hardstandings (See drawing QR320201-P-000-042 for details)
- Proposed Access Tracks, Passing Bays, Turning Areas & Probable Track Type. (See drawings QR320201-P-000-056, QR320201-P-000-057 & QR320201-P-000-072 for details)
- Proposed Sub Stations (See drawings QR320201-P-000-043 to QR320201-P-000-050 for details)
- Proposed Meterological Mast & Hardstanding Area (See drawing QR320201-P-000-079 for details)
- Proposed Borrow Pit
- Proposed Peat Deposition Area
- Proposed Overhead Line & Structures
- Contours
- Rivers, Lakes & Pools
- Proposed Settlement Pond Types (See Drawings QR320201-P-000-063 & QR320201-P-000-064 for details)
- Existing Underground Electrical Lines
- Existing Overhead Electrical Lines
- Existing Gas Line
- Dwellings
- Former Peat Operations Settling Pond
- Forestry or Felled Areas
- Existing Bellacorick Wind Farm Turbines

Notes:
- For site layout sheet locations see Sheet Index Plan
- Drawing prepared using Irish Transverse Mercator (ITM) Map Grid
- For drainage details see drawings QR320201-P-000-059 to QR320201-P-000-072
- Industrial railway shown on maps has been decommissioned
- For clarity field drans formerly used for peat operations which still exist on site are not shown

Maps shown on site layout drawings: Mayo 5000 sheets 1174, 1175, 1176, 1177, 1240, 1241, 1242, 1243, 1309, 1310, 1311, 1312, 1378, 1379, 1380 & 1381

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PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, Co. MAYO

Contract:

Drawing Title: TYPICAL LOCAL DRAINAGE ARRANGEMENT

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

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Email: oweninnypower@esbi.ie Web: www.oweninnywindfarm.ie
Registered Office: as above Registered in Ireland No. 503730

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E.O'S	P.K	N.Q	09.09.2015

CLIENT REF	No. of Shts	SIZE	REV	SCALE
	1	A1	0	1:2500

DRAWING NUMBER: FIGURE 19.5

100 0 Meters 100 200
1:2500

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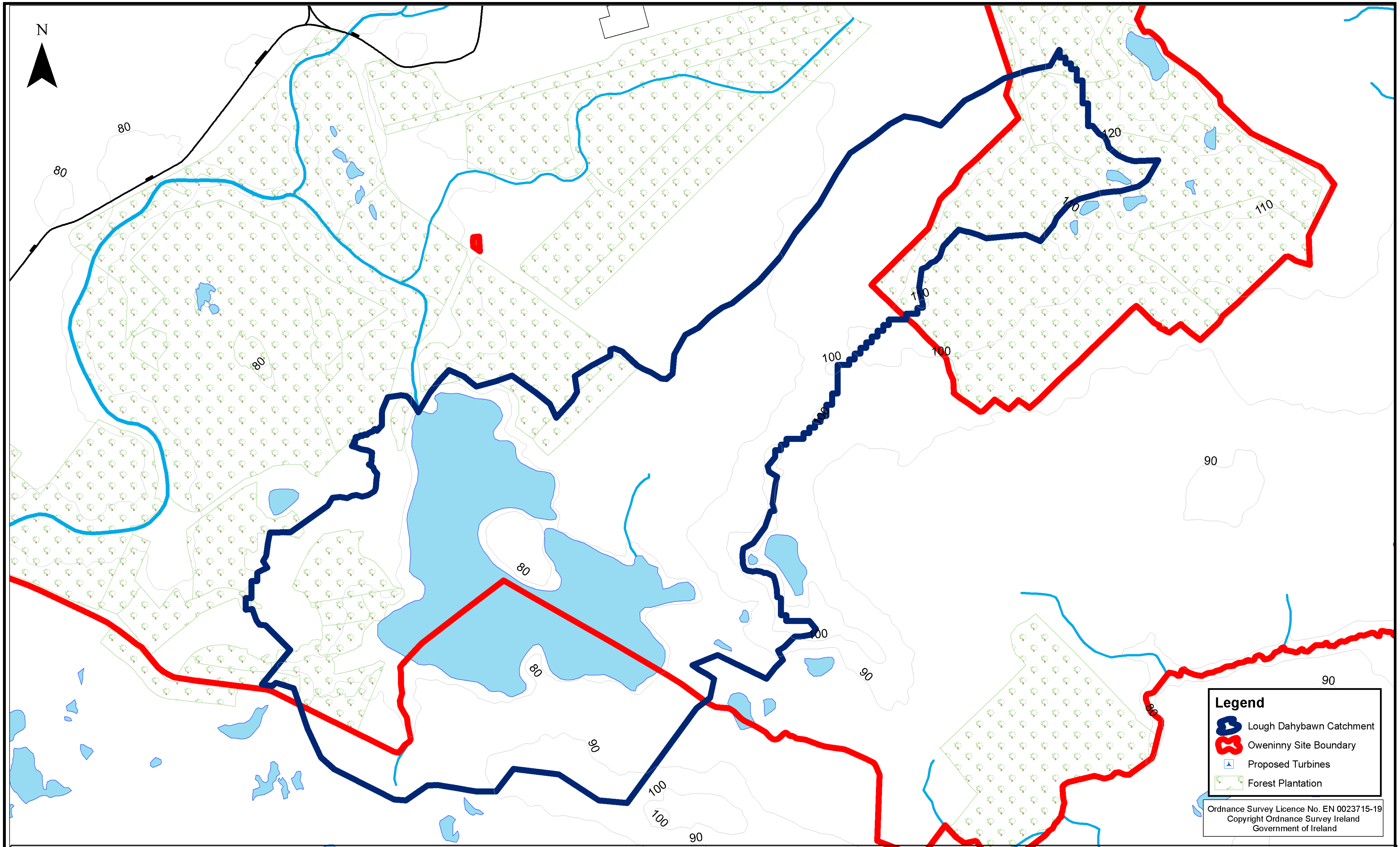

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Oweninny Power Ltd.

Client: Oweninny Power Ltd.

Project: Wind Farm at Oweninny, Co. Mayo

Title: Lough Dahybaun Catchment

Production Unit: Civil, Building & Environment Group

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EO'S	E.O'S	PK	JC	09/09/2015

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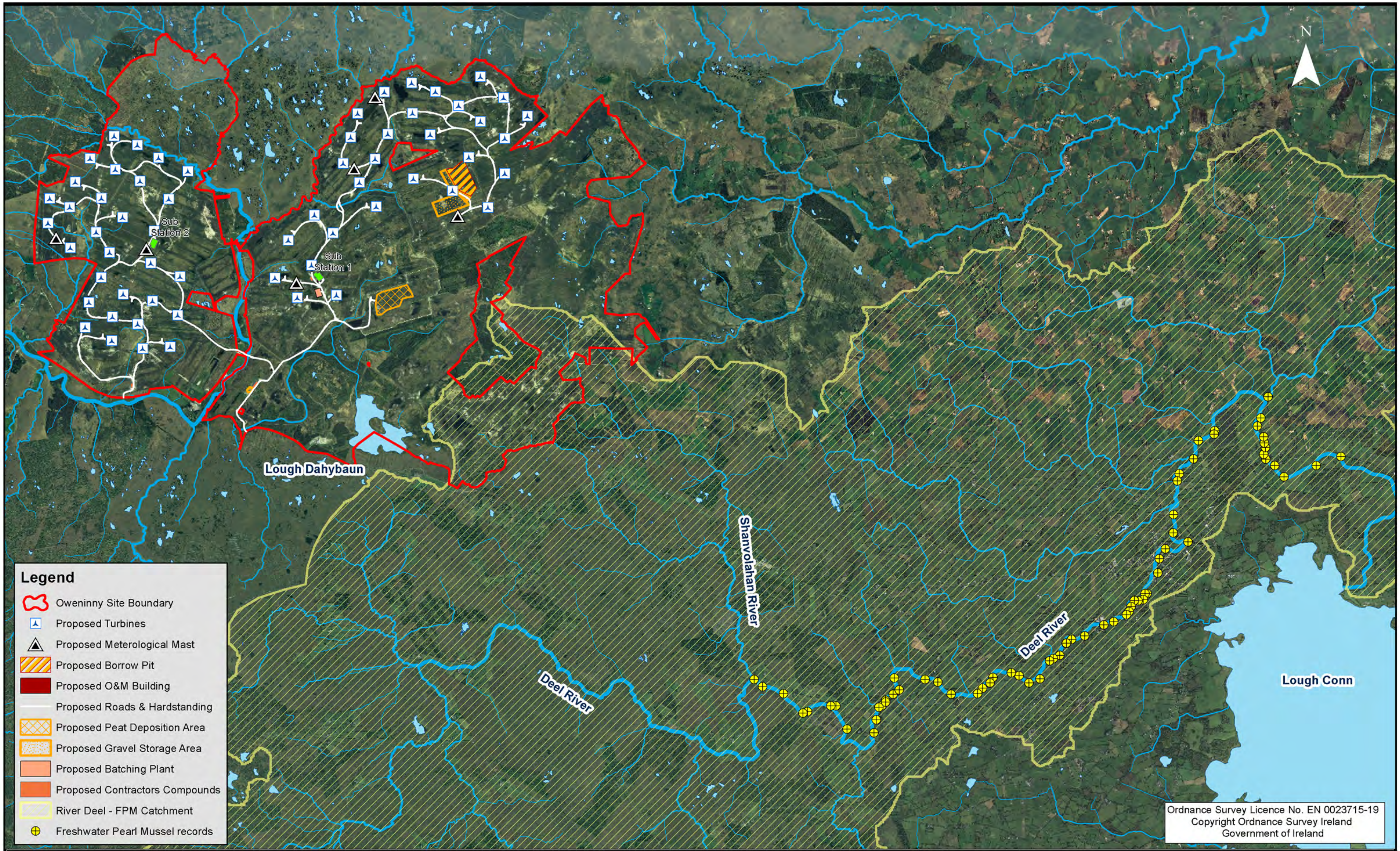
MAP REFERENCE

Figure 19.6



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Oweninny Power Ltd.

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Client: Oweninny Power Ltd.

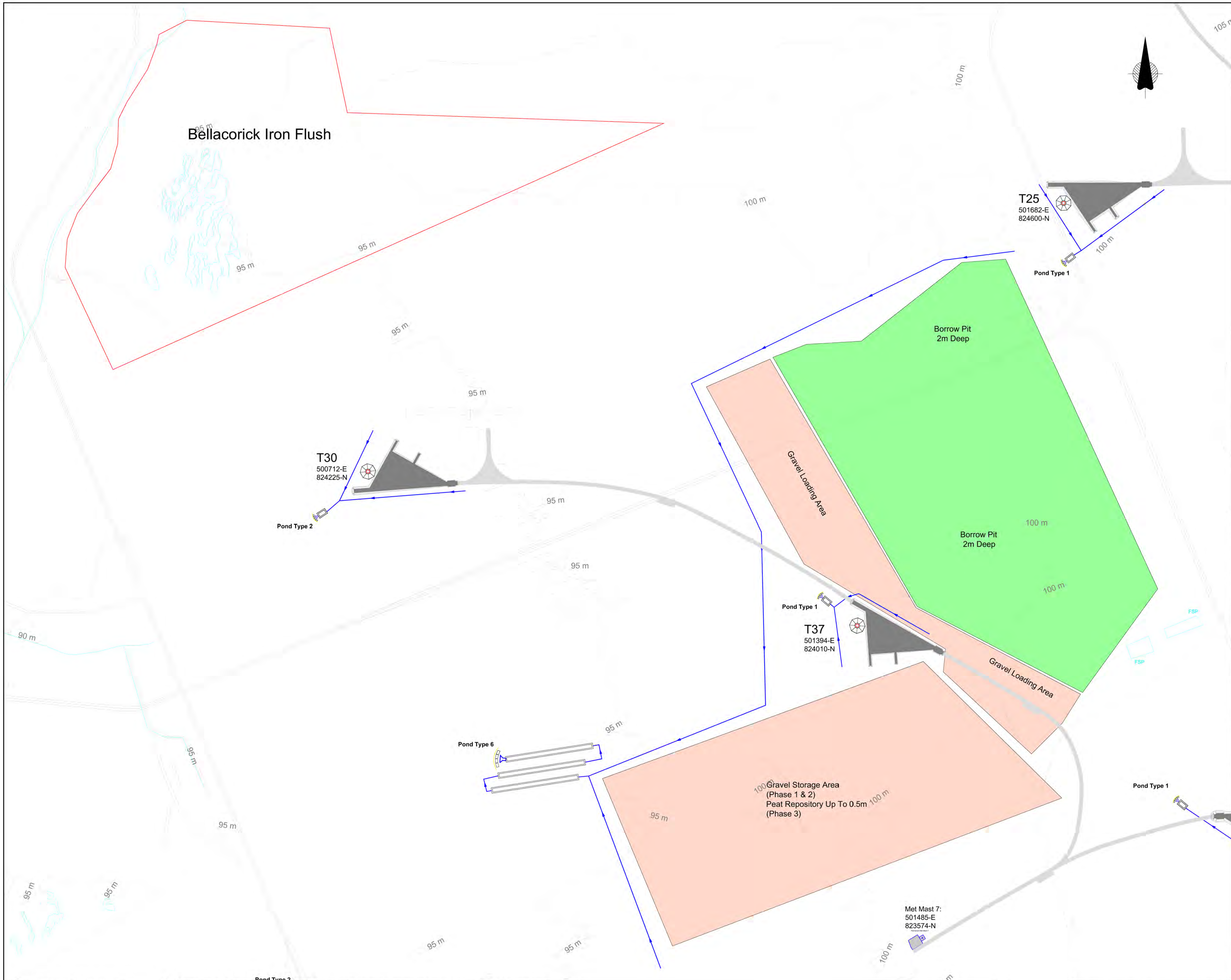
Project: Wind Farm at Oweninny, Co. Mayo

Title: Relationship of Oweninny wind farm site to Freshwater Pearl Mussel Records on the Deel River

Production Unit: Civil, Building & Environment Group

MAP REFERENCE

FIGURE 19.7



Legend:

- Site Boundary
- Proposed Turbines & Hardstandings (See drawing QR320201-P-000-042 for details)
- Proposed Access Tracks, Passing Bays, Turning Areas & Probable Track Type. (See drawings QR320201-P-000-056, QR320201-P-000-057 & QR320201-P-000-072 for details)
- Proposed Sub Stations (See drawings QR320201-P-000-043 to QR320201-P-000-050 for details)
- Proposed Meterological Mast & Hardstanding Area (See drawing QR320201-P-000-079 for details)
- Proposed Borrow Pit
- Proposed Peat Deposition Area
- Proposed Overhead Line & Structures
- Contours
- Rivers, Lakes & Pools
- Proposed Settlement Pond Types (See Drawings QR320201-P-000-063 & QR320201-P-000-064 for details)
- Existing Underground Electrical Lines
- Existing Overhead Electrical Lines
- Existing Gas Line
- Dwellings
- Former Peat Operations Settling Pond
- Forestry or Felled Areas
- Existing Bellacorick Wind Farm Turbines

Notes:
- For site layout sheet locations see Sheet Index Plan
- Drawing prepared using Irish Transverse Mercator (ITM) Map Grid
- For drainage details see drawings QR320201-P-000-059 to QR320201-P-000-072
- Industrial railway shown on maps has been decommissioned
- For clarity field drains formerly used for peat operations which still exist on site are not shown

Maps shown on site layout drawings: Mayo 5000 sheets 1174, 1175, 1176, 1177, 1240, 1241, 1242, 1243, 1309, 1310, 1311,1312, 1378,1379, 1380 & 1381

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PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED
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Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, Co. MAYO

Contract:

Drawing Title: BORROW PIT AND DRAINAGE

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

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Email: oweninnypower@esbi.ie Web: www.oweninnywindfarm.ie
Registered Office: as above Registered in Ireland No. 503730

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E.O'S	P.K	N.O	10.04.2013

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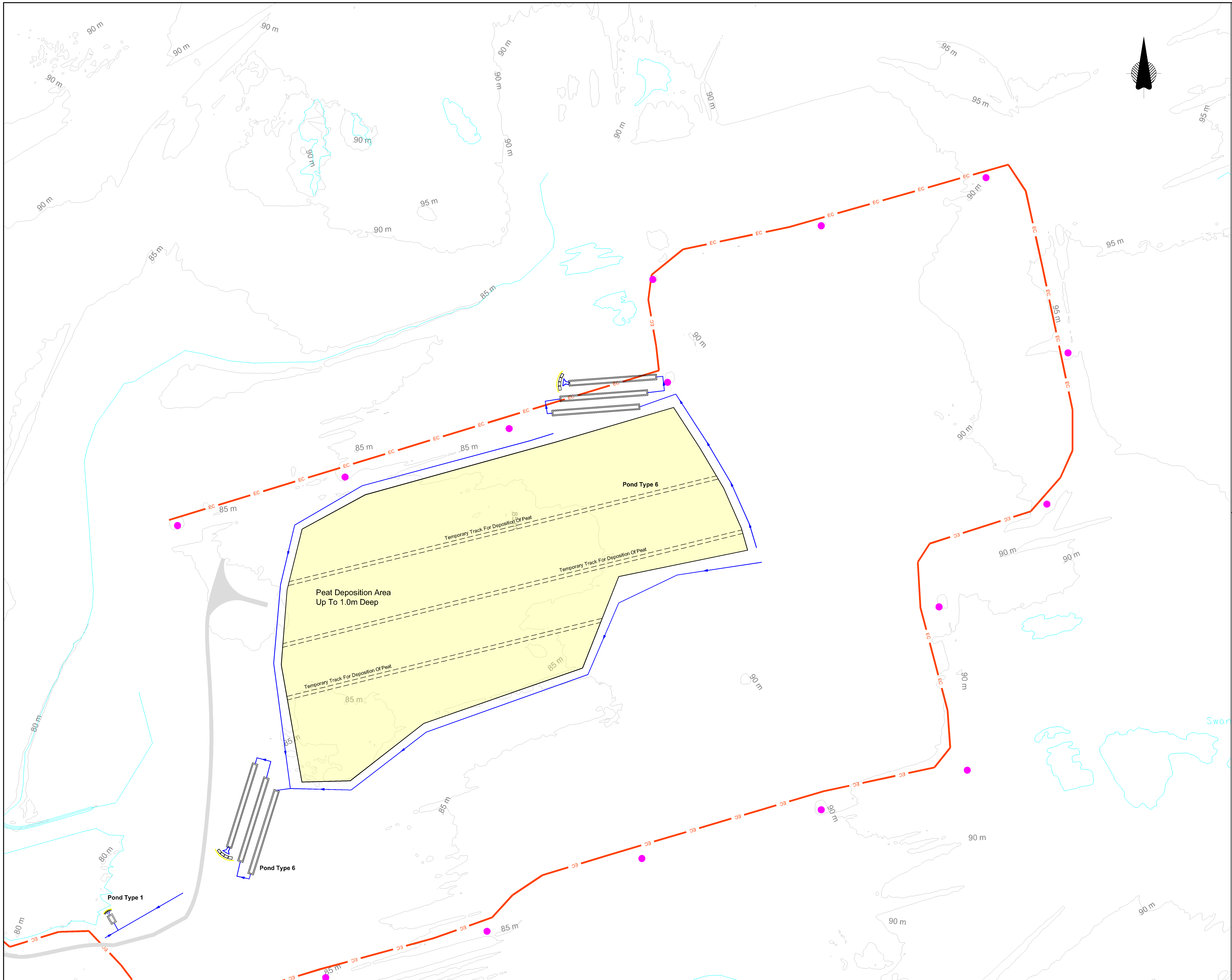

Legend:

- Site Boundary
- Proposed Turbines & Hardstandings (See drawing QR320201-P-000-042 for details)
- Proposed Access Tracks, Passing Bays, Turning Areas & Probable Track Type. (See drawings QR320201-P-000-056, QR320201-P-000-057 & QR320201-P-000-072 for details)
- Proposed Meterological Mast & Hardstanding Area (See drawing QR320201-P-000-079 for details)
- Proposed Borrow Pit
- Proposed Peat Deposition Area
- Proposed Overhead Line & Structures
- Contours
- Rivers, Lakes & Pools
- Pond Type 1 — Proposed Settlement Pond Types (See Drawings QR320201-P-000-063 & QR320201-P-000-064 for details)
- EC — Existing Underground Electrical Lines
- E — Existing Overhead Electrical Lines
- GL — Existing Gas Line
- FSP — Former Peat Operations Settling Pond
- Existing Bellacorick Wind Farm Turbines

Notes:
- For site layout sheet locations see Sheet Index Plan
- Drawing prepared using Irish Transverse Mercator (ITM) Map Grid
- For drainage details see drawings QR320201-P-000-059 to QR320201-P-000-072
- Industrial railway shown on maps has been decommissioned
- For clarity field drains formerly used for peat operations which still exist on site are not shown

Maps shown on site layout drawings:
Mayo 5000 sheets 1174, 1175, 1176, 1177, 1240, 1241, 1242, 1243, 1309, 1310, 1311,1312, 1378,1379, 1380 & 1381

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PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED
TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, Co. MAYO

Contract:

Drawing Title: PEAT DEPOSITION AREA

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

Oweninny Power Ltd

Oweninny Power Ltd Stephen Court, 18-21 St. Stephen's Green , Dublin 2, Ireland Tel: +353 (01) 7038000 Fax: +353 (0) 1 7038088
Email: oweninnypower@esbi.ie Web: www.oweninnywindfarm.ie
Registered Office: as above Registered in Ireland No. 503730

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E.O'S	P.K	N.Q	10.04.2013

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	1	A1	0	N.T.S.

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Ordnance Survey mapping includes watercourses and water features which have been transposed from historic 6 inch mapping and may no longer exist on the ground due to drainage over the decades associated with peat production operations.

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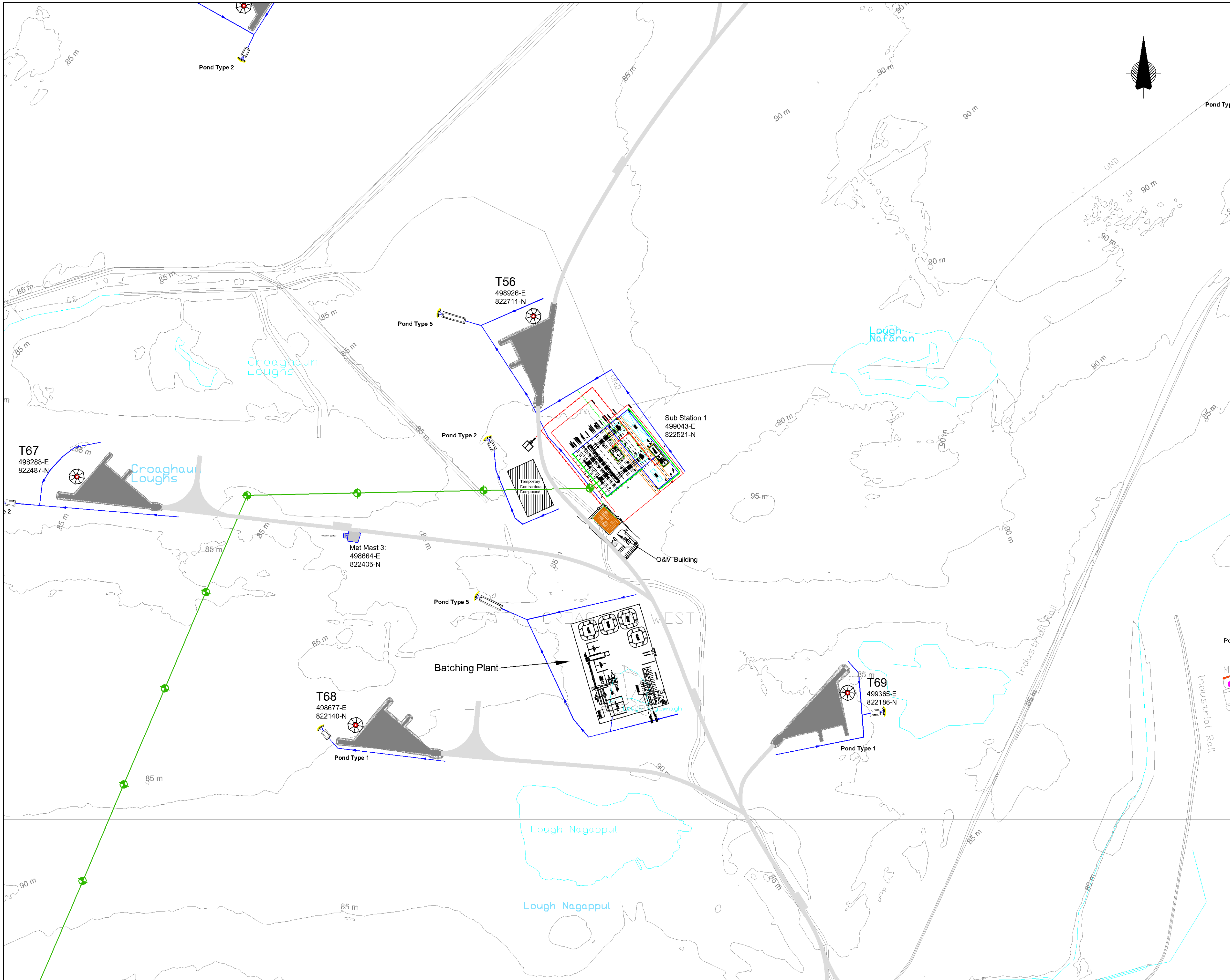

Legend:

- Site Boundary
- Proposed Turbines & Hardstandings (See drawing QR320201-P-000-042 for details)
- Proposed Access Tracks, Passing Bays, Turning Areas & Probable Track Type. (See drawings QR320201-P-000-056, QR320201-P-000-057 & QR320201-P-000-072 for details)
- Proposed Sub Stations (See drawings QR320201-P-000-043 to QR320201-P-000-050 for details)
- Proposed Meterological Mast & Hardstanding Area (See drawing QR320201-P-000-079 for details)
- Proposed Borrow Pit
- Proposed Peat Deposition Area
- Proposed Overhead Line & Structures
- Contours
- Rivers, Lakes & Pools
- Proposed Settlement Pond Types (See Drawings QR320201-P-000-063 & QR320201-P-000-064 for details)
- Existing Underground Electrical Lines
- Existing Overhead Electrical Lines
- Existing Gas Line
- Dwellings
- Former Peat Operations Settling Pond
- Forestry or Felled Areas
- Existing Bellacorick Wind Farm Turbines

Notes:

- For site layout sheet locations see Sheet Index Plan
- Drawing prepared using Irish Transverse Mercator (ITM) Map Grid
- For drainage details see drawings QR320201-P-000-059 to QR320201-P-000-072
- Industrial railway shown on maps has been decommissioned
- For clarity field drains formerly used for peat operations which still exist on site are not shown

Maps shown on site layout drawings:
Mayo 5000 sheets 1174, 1175, 1176, 1177, 1240, 1241, 1242, 1243, 1309, 1310, 1311, 1312, 1378, 1379, 1380 & 1381

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REV	DATE	REVISION DESCRIPTION	DRN	VER	APP
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PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

Client: OWENINNY POWER LTD.

Project: WIND FARM PROJECT AT OWENINNY, BELLACORICK, Co. MAYO

Contract:

Drawing Title: BATCHING PLANT AND DRAINAGE

Production Unit: CIVIL, BUILDING & ENVIRONMENTAL GROUP

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DRAWN	VERIFIED	APPROVED	APPD DATE
E.O'S	P.K	N.Q	10.04.2013

CLIENT REF	No. of Shts	SIZE	REV	SCALE
	1	A1	0	N .T.S.

DRAWING NUMBER
FIGURE 19.10

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While every effort has been made to ensure the accuracy of the information contained in the drawings, Oweninny Power Limited cannot be held responsible for errors or omissions.

Ordnance Survey mapping includes watercourses and water featurres which have been transposed from historic 6 inch mapping and may no longer exist on the ground due to drainage over the decades associated with peat production operations.

BF-DRG-012-002-001

...ormation phase 1 & phase 2 2015\chapter 19 - hydrology and sediment control\figure 19.10 batching plant area.dwg

20 INDIRECT AND INTERACTION OF IMPACTS

20.1 INTRODUCTION

The EU Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions states that

> *"Including an assessment of the indirect and cumulative impacts, and interactions in an EIA is required by legislation, contributes towards sustainable development, is good practice and aids the decision making process."*

The assessment of indirect and cumulative impacts, and impact interactions are considered to be an integral part of all stages of the process.

This chapter addresses indirect impacts and main interactions of impacts between different aspects of the environment likely to arise from the proposed Oweninny Wind Farm Development. In this respect only relevant topics which can be linked to the development are discussed and where not mentioned no potential for impact has been identified.

Mitigation measures in relation to primary impacts are outlined in the relevant Sections of the EIS. Mitigation measures are not repeated herein and only mitigation that is additional to the primary impacts is described.

Cumulative impacts have been addressed in individual chapters in the EIS and are not discussed further here.

20.2 APPROACH AND METHODOLOGY

This chapter has been prepared with specific reference to the Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002), and Advice Notes on Current Practice in the preparation of Environmental Impact Statements, (EPA, 2003) (EPA guidelines). Reference is also made to the Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions (Office for Official Publications of the European Communities, 1999) (EU guidelines) and to Guidance: Cumulative Effects of Windfarms (Scottish National Heritage, 2005).

The potential for significant cumulative and indirect impacts and interactions was examined at the screening stage of the project and any such potential impacts were identified. Where the potential for significant cumulative and indirect impacts and interactions was identified, these were included in the scope and addressed in the baseline and impact assessment studies for each of the relevant environmental media and aspects of the project. The cumulative impacts are presented in the chapters of the EIS which address the most relevant environmental media.

20.3 INDIRECT IMPACTS (Secondary Impacts)

Indirect impacts are described in the EPA Guidelines as being

> *"impacts which are caused by the interaction of effects, or by associated or off-site developments".*

For the Oweninny Wind Farm proposed development, indirect impacts are those not directly caused by the project but are associated with the development or arise from the main mitigation measures proposed in relevant chapters.

The main indirect impacts are described in the following sections and summarised in the matrix

20.3.1 Economic

There will be additional indirect temporary economic benefits arising from the construction of the Oweninny wind farm.

It is estimated that construction will require the importation of approximately 0.4 million tonnes of fill material to the site in the worst case scenario where no onsite borrow pit will be developed. This material is likely to be sourced from local quarries which in turn will result in additional employment opportunities in the area. Cement and concrete production external to the Oweninny site will also give rise to additional employment as will its transportation.

There will also be increased demand for accommodation and for a range of goods and services giving rise to temporary economic benefits for local residents, retailers and other commercial operators.

Overall there will be an indirect temporary positive economic benefit to the region during the construction phase of the project.

Additional Mitigation

No additional mitigation is required

20.3.2 Road Maintenance

The main haul route for materials to the site will be via the N59. As such, this route will be maintained to a high standard in order to accommodate the level of construction traffic expected to occur as part of this project. Arising from these maintenance activities, there will be an indirect impact on the local communities along the local road network from temporary, short term localised disturbance.

Road pavement assessment has already been identified as a mitigation measure in Chapter 14 and this will ensure that the road condition during and post construction will be maintained and restored as appropriate. The level of maintenance required will result in an overall positive indirect impact on amenity and transport from maintenance of the road.

The development of the existing site access locations to the proposed wind farm site will give rise to temporary disruption of traffic on the N59 during the construction phase and will result in short temporary loss of amenity for local residents.

Additional Mitigation

It will be the responsibility of the relevant Local Authority to inform local residents of the timing and duration of any maintenance works which will be undertaken.

Local residents will be informed well in advance of the proposed timing and duration of the works as part of an overall traffic management plan for the development construction.

20.3.3 Noise

There will be increased noise at quarrying locations and at cement and concrete production locations arising from material winning and processing of materials. However, these activities are already controlled under existing permits at these locations and a significant noise issue is not expected.

There will be some increase in road traffic noise associated with the collection and delivery of fill, cement and concrete materials at these locations also.

Additional Mitigation

Noise arising from operations of plant and machinery at external sources will be controlled by the relevant permits and plans associated with the activity.

20.3.4 Air and Climate

Emissions of CO_2, SO_2 and NO_x are normally associated with quarrying activities and cement production and there will be temporary increases of these pollutants arising from the equipment used to quarry fill material and to produce cement required for the Oweninny wind farm construction. Emissions of CO_2, SO_2 and NO_x are also associated with turbine component manufacture and delivery to the site giving rise to temporary increases during production and transport.

Additional Mitigation

These emissions will be controlled in accordance with any respective licence for these activities and their impact will not be significant.

20.3.5 Indirect impact from mitigation

Landscape

In Chapter 9 Ecology, mitigation to protect winter roosting Hen Harrier (Section 9.5.11.2) recommends that six turbines should be fitted with warning lights at hub height level to alert birds flying in poor light of their presence. These turbines are located in the south-eastern section of the site. These lights will flash in red at regular intervals between the months of November and March, and become visible at night or during low light weather conditions. Warning lights installed at height can be recognised over long distances in clear weather conditions at night. The warning lights will introduce a new source of light at height. The general landscape effects are considered moderate. The visual effects of the warning lights would be slight to moderate and intermittent in nature due to their seasonal use, dependence on weather conditions and the time of day.

Traffic

The road safety audit carried out as part of the traffic and transport assessment in Chapter 14 recommended that visibility splays from the three proposed site entrance locations be improved through removal of vegetation. This will also improve visibility splays on the N59 in the vicinity of the entrance locations a positive benefit to road traffic.

20.4 INTERACTIONS

In addition to the requirement to describe the likely significant effects of the proposed development on the different elements of the environment, it is also required to consider the interaction of those effects. All environmental factors are interrelated to some extent. An interaction matrix is provided in ***Table 20-1*** where the potential for the topic in the left hand column to have an effect on the environmental media listed in the top row of the matrix is presented. Construction stage interactions are indicated by 'C', operational phase by an 'O' and for both phases by 'CO'.

Likely interactions are summarised in Table 20-2 and discussed below.

Table 20-1: Potential interaction of effects

	Human Beings	Noise and Vibration	Terrestrial Ecology	Water and Aquatic Ecology	Landscape	Air and Climate	Geology and Soils	Roads and Traffic	Forestry	Material Assets	Cultural heritage
Human Beings		-	-	-	-	-	-	CO	-	-	-
Noise and Vibration	CO		CO	-	-	-	-	-	-	-	-
Terrestrial Ecology	-	-		-	-	-	-	-	-	-	-
Water and Aquatic Ecology	-	-	-		-	-	-	-	-	-	-
Landscape	CO	-	O	-		-	-	-	-	O	-
Air and Climate	CO	-	CO	-	-		C	-	-	-	-
Geology and Soils	-	-	C	CO	-	-		-	-	-	C
Roads and Traffic	CO	-	C	-	C	CO	-		-	-	-
Forestry	-	-	C	C	-	C	-	-		-	-
Material Assets	CO	-	-	-	-	-	-	-	-		CO
Cultural heritage											

20.4.1 Human Beings / Noise

In terms of the construction noise, any impacts arising will be short-term in nature and a perceptible increase in noise sufficient to cause harm to residential amenity will not result given the distance from the site to the existing properties in the area. In addition predicted construction noise levels at Oweninny are below relevant limit values issued by the National Roads Authority, see Chapter 7.

Turbines are typically a minimum of 1 km from any residence. Noise prediction modeling indicates that the noise limits as set out in the Department of Environment, Heritage and Local Government Planning Guidelines (Wind Farms) will not be exceeded at any noise sensitive location. Consequently, noise levels resulting from the operation of Oweninny Wind Farm will not impact significantly on human beings.

20.4.2 Human Beings / Landscape

In terms of wind farm developments, impacts on the landscape are commonly considered to be the most significant for this type of development. Photomontages (32) were generated for 27 viewshed reference points and a detailed analysis of each was presented in Chapter 11.

In addition to impacts on visual character and landscape character, impacts on human beings were considered in the context of built-up areas, recreational areas and roads (scenic routes, national primary roads, regional roads and country roads).

Settlement is generally sparse within the Primary Principal Visual Zone around the Oweninny wind farm site, but individual houses located in the landscape will experience views of the proposal. This will particularly be the case for houses on the L52925 in the central area of the site, the L52936 to the west of the site (Tawnaghmore townland), the L5292 (Shanvolahan townland) and the L5160 (Doobehy townland) to the east of the site and in the Dooleeg area. Settlement is more sparse and dispersed within the mountain ranges to the north, west and south and the majority of available views of the proposed wind farm from within this area will result often in substantial visual effects. This is due to open views of the proposal and the absence of significant vertical screening by natural or built features.

There are no known views from the towns and villages of Pontoon, Beltra, Newport, Rosturk, Mulranny, Ballycroy, centre of Bangor, Belmullet, Killala, Ballycastle, Belderg, Glenamoy and Ross Port due to intervening topography and vegetation.

Visual effects on walking routes will range from slight to moderate depending on the distance of the observer from the proposed wind farm site.

Scenic routes 16 and 18 within the Western Way will experience substantial visual effects in areas where open views are possible and are not fully or partially obstructed by intervening often coniferous commercial vegetation.

20.4.3 Human Beings / Roads & Traffic

The development will generate traffic on the N59 during the construction phase with the maximum number of traffic movements to the site being determined as being up to approximately 73 per day. Rather than occurring uniformly throughout the construction period, traffic movements will likely peak on non-consecutive days for 30 days during Phase 1 and 31 days in Phase 2 on which concrete for turbine foundations and piling will be delivered. This was calculated as being approximately 16 heavy goods vehicle movements per hour spread over the duration of each of the construction phases. A potential maximum of 44 heavy goods vehicle movements per hour on and off the site could occur at peak periods.

The N59 national secondary road has been assessed as having adequate capacity for both the Oweninny wind farm construction with over 60% spare capacity remaining.

Any local road improvements that may be necessary for delivery of wind turbine components will improve overall road safety in the long term.

20.4.4 Human Beings / Material Assets

No impacts were predicted in relation to electromagnetic interference.

In the very unlikely event of interference with television reception, all necessary measures will be undertaken by the developer in accordance with a standard protocol developed by RTÉ to fully eliminate any negative impact.

20.4.5 Ecology / Landscape

Other than the Bellacorick Iron Flush cSAC and Lough Dahybaun cSAC which are located within the Oweninny site boundary the proposed Oweninny Wind Farm is located largely outside all relevant designated Natural Heritage Areas and Natura 2000 sites in its vicinity. There will be therefore no effects arising on the existing landscape character of these external sites. The two designated sites, (Bellacorick Iron flush and Lough Dahybaun SAC) located within the study area will experience visual effects. Sites located outside of the principal zones, within the Northern Mayo Drumlin Zone and on elevated slopes and summits of the mountain ranges to the south, west and east will also experience visual effects.

Oweninny Wind Farm will be openly visible mainly from landscape designated areas, views and routes located within 1 to 10km radius from the wind farm site boundary, due to the flat or very gently undulating nature of the terrain surrounding the wind farm site and the lack of significant vertical features, as well as from elevated slopes and mountain summits located to the north, west and south. Visual effects will generally range from Moderate to Substantial. Large designated areas are not accessible by public roads and can be reached by foot only.

It should be noted that these sites are designated for their nature conservation value, which is not impacted upon by the visibility of the proposed wind farm.

20.4.6 Geology and Soils/Water

A drainage plan will be developed which will be integrated into the overall drainage of the site. This could potentially affect the rate of runoff from the site during heavy rainfall events and subsequently lead to higher peak flows in the receiving waters draining the site. This could affect the aquatic ecology of the rivers. However, an assessment made in Chapter 19 indicates that the percentage change in land use within individual river catchments is generally low, being generally less than 1% and hence no significant effect is predicted.

Sediment loss from bare areas during construction, via the drainage system could also impact on the aquatic ecology, particularly juvenile salmon and trout and to control this a Sediment and Erosion Control Plan incorporating settlement ponds and overland flow has been prepared and will be implemented, see Chapter 19.

20.4.7 Geology and Soils/Ecology

The Bellacorick Iron Flush cSAC within the site is designated for the Marsh Saxifrage a rare protected species. This species is dependent on both the groundwater level within the flush and the hydrochemistry of the flush itself. A borrow pit is proposed in an area located to the east of the Bellacorick Iron Flush cSAC and its excavation could potentially effect the water level and the hydrochemistry of the groundwater even though it is a considerable distance away. To maintain the water level the borrow pit will be wet extracted, that is the groundwater level will be maintained. A detailed hydrogeological study has also been carried out, see Chapter 18, and this predicts no impact on the hydrochemistry of the flush area.

20.4.8 Geology & Soils/Ecology

Due to the presence of peat on site, the primary geotechnical consideration is the stability of the peat on sloping ground at the site. A potentially serious adverse impact on ecology could arise if a peat slip were to occur. A Peat Stability Risk Assessment was undertaken on site which identified two substantial areas of risk. However, this risk would be significantly reduced by adopting appropriate mitigation measures during the construction stage.

20.4.9 Aquatic Ecology / Water

The site is drained westward by the Oweninny/Owenmore systems and their tributaries, by the Shanvolahan/Deel system to the southeast and the Owenmore/Cloonaghmore system to the east. There are also many small streams and drainage channels feeding into these systems within the site. In the earlier years of peat harvesting these river systems received significant sediment loads from the site during the peat harvesting operations which was alleviated in later years by installation of sediment ponds. Some sediment loss continued to occur post harvesting, but to a much lesser extent, due to large expanses of bare peat area generating suspended solids. In response to this Bord na Móna developed a bog rehabilitation programme which led to significant improvement of river water quality, see Chapter 10. The proposed works has the potential to impact on water quality during the construction phase. In the absence of suitable standard pollution control measures, the excavation and removal of soils for the construction of permanent features such as cranestands, turbine and building foundations could lead to potential pollutants entering drains, thereby affecting water quality downstream of the site. A suitable drainage system, which incorporates measures to reduce the movement of sediment, has been designed for the development in order to reduce the potential for pollution, see Chapter 19.

The construction of additional tracks over blanket bog can result in hydrological changes to adjacent peat areas. However, over 80% of the access track network will be located on shallow peat areas, mainly on ridgelines and the overall access track design has been integrated into the Bord na Móna bog rehabilitation programme. This rehabilitation programme is leading to rewetting of previously drained areas and establishment of a vegetative cover reducing peat soil loss from the site. Existing bog remnant areas have also been avoided and this coupled with the bog rehabilitation programme will ensure that hydrological change from the development will not impact on the rehabilitation programme in the long term.

20.4.10 Forestry /Ecology

No turbines are in coniferous forest but the access route will require the removal of 1.05 ha of forest. Coniferous forest is not a habitat of conservation value and is alien and, in the long-term, detrimental to the site – the removal of forest from this site is considered a neutral or positive impact from a habitats perspective.

20.4.11 Forestry /Water Quality

Felling of forest plantation can give rise to increased sediment and nutrient loss particularly on deep peat. Forest plantation in the Muing river catchment is situated on deep peat and brash decay arising from felling at this location could give rise to phosphorus release with subsequent enrichment impact on the river. Brash from this area will be removed as part of the access track construction and placed in a central peat repository within the site. At the repository area the potential for nutrient loss is low and hence the potential for significant impact on water quality low also.

20.4.12 Forestry/Air and Climate

Forest plantation acts as a carbon sink and the permanent loss of forest plantation will lead to a reduction in CO_2 being absorbed and locked up in the plantations. However, this loss is insignificant when compared to the amount of CO_2 which will be displaced by energy production from the Oweninny wind farm as opposed to conventional power production from coal, gas and oil.

20.4.13 Landscape / Material Assets

The landscape assessment concluded that Oweninny Wind Farm will alter the landscape and visual character within the landscape basin in the centre of the study area due to its extent and height. However, considering the large scale of the surrounding generally homogeneous landscape, the introduction of the wind farm will not be perceived as being out of context with the overall underlying landscape character. Large areas within the basin have been transformed by industrial peat harvesting activities in the past to fuel the now removed Bellacorick Power Station. The introduction of large scale wind turbines will therefore not be uncharacteristic when set within the attributes of the receiving landscape. It will intensify and re-establish an industrial sized energy harvesting activity. In contrast to the large scale horizontal extraction method of the past and the current small scale wind harvesting, the proposed development will result in a sustained presence of vertical man-made elements, which will form a new landmark over time.

One of the main findings of the Irish public's attitude to wind energy was that those with direct experience of wind farms in their locality do not in general consider that they have had any adverse impact on the scenic beauty of the area or on tourism. Fáilte Ireland surveys of tourist attitudes to wind farms indicates that the presence of wind farms makes no difference to most tourists' enjoyment of their holiday.

The proposed Visitor Centre at Bellacorick will provide an added attraction to tourists coming to area also helping to boost tourist interest in the general region.

20.4.14 Air & Climate / Roads & Traffic

The primary air quality issue relates to dust potentially arising from a number of activities that include construction transport within and off the site. Traffic associated with the development will also give rise to exhaust emissions during the construction phase. It is proposed to use dust covers on vehicles carrying dust producing materials and to water appropriate sections of the access routes in order to minimise any dust emissions arising. The potential impacts are not considered significant in the context of the extent of traffic movements arising.

20.4.15 Geology & Soils / Cultural Heritage

The density of known monuments on the Oweninny site is low when compared to the general region. There are a total of four sites of archaeological interest/potential, three listed as Recorded Monuments, and one listed solely in the Sites and Monuments Record (SMR) of the Archaeological Survey of Ireland as being located within the overall proposed wind farm. The locations of these areas were integrated into the overall project design and will be clearly marked and avoided during construction. Although peat has been removed from large areas of the site reducing the potential for archaeological finds excavations of soils during construction have the possibility of uncovering previously unrecorded features and material of archaeological interest and potential. Archaeological monitoring of groundwork is proposed to ensure that any such finds are fully addressed and recorded.

20.5 EPA GUIDANCE

The Environmental Protection Agency (EPA) published its Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), which are designed to accompany the Guidelines on the information to be contained in Environmental Impact Statements, also published by the EPA.

The Advice Notes contain greater detail on many of the topics covered by the Guidelines and offer guidance on current practice for the structure and content of Environmental Impact Statements. They are divided into five sections, each providing detailed guidance on specific aspects to be considered in the preparation of an EIS.

Section 3 provides guidance on the topics which would usually be addressed when preparing an EIS for a particular class of development, highlighting typical issues which arise. The projects are grouped into 33 generic types, which have similar development or operational characteristics.

Project Type 33 addresses installations for the harnessing of wind power for energy production and the guidance on interaction of impacts for this project type notes as follows:

The interaction of noise, visual impacts, access to underdeveloped areas and effects on ecology can combine to affect perceptions of the integrity of natural areas.

At Oweninny the magnitude of separate impacts on the listed environmental factors is not such as to combine to affect the perception of integrity of a natural area.

20.6 Potential to connect to Grid West

Potential to connect to Grid West

The EIS for Oweninny Wind Farm as originally applied for indicated that Phase 3 of the development is proposed to connect to the national grid via a connection point on the Grid West Project. This was stated in the Environmental Impact Statement in the Non-Technical Summary as follows:

"The project has Grid Connection Offers from EirGrid for 371 megawatts. Of this, 172 megawatts of the project has been assigned to connection capacity of the existing 110 kV Grid at Bellacorick Substation. This connection capacity is scheduled to be available at the end of 2015. The remaining capacity is not scheduled to be available until after EirGrid carries out further works to provide network capacity in the area.

It was further stated at the public information meeting at Crossmolina which was summarised in Section 1.7.1 of the EIS as follows:

“Grid Connection Issues: Some people queried the likely grid connection routes for connection to the national electricity grid. It was indicated that EirGrid had allocated 172 megawatts of the project which would be connected at Bellacorick existing substation utilising the existing 100 kV overhead lines, which would be upgraded. (Re-strung with new conductor). The remaining portion of the wind farm would be connected when the proposed EirGrid 400 kV Grid West was constructed. The exact location of the required new 400 kV substation, to which the balance of the wind farm would be connected, and transmission system route was not known at this time as it is the sole responsibility of the grid provider, EirGrid. EirGrid is in the early stages of site and route selection.”

Subsequent to the lodgement of the planning application for the Oweninny Wind Farm development, the oral hearing, and the High Court decision in O'Grianna and Others vs An Bord Pleanála , An Bord Pleanála issued a Request for Further Information (RFI) seeking information on and assessment of the proposed grid connection for Phase 3 to the Grid West Project.

As of October 2015, the location of the connection point for Phase 3 has not yet been determined.

The Project Team did consider both overhead and underground cable routes from Phase 3 of the Oweninny Wind Farm to the 6 no. substation sites under consideration currently for the Grid West Project. However in the absence of certainty as to the preferred site location it has not been possible to carry out such assessment other than at a very high level.

In terms of an overhead line, the potential to connect Oweninny Phase 3 via a 110kV circuit, (which would require steel towers and wooden pole sets and three phases of conductor) was explored. Six overhead line route corridor options and some variants of these, were identified as potential grid connection route corridors to Grid West. Export from Substation 3 within the wind farm site would require an initial 110kV underground cable to the Oweninny site boundary area, a cable interface mast and subsequently a 110kV overhead line.

In terms of an underground cable route, the potential to connect Oweninny Phase 3 via an undergrounded 110kV circuit was explored. Three main route options with 16 route corridor variants of these were identified as potentially feasible routes to connect to Grid West.

Permission for Phase 3 of the Oweninny Wind Farm is no longer sought as at this point in time the connection point for Phase 3 is not yet determined. Permission for Phases 1 and 2 is sought, in relation to which no such issue with assessment of grid connection arises.

Once the point of connection for Phase 3 to the national grid has been confirmed, it will then be possible for the Oweninny Phase 3 grid connection to be fully and completely assessed in accordance with the Environmental Impact Assessment Directive.

20.7 CONCLUSIONS

In terms of indirect and interaction of impacts no unacceptable environmental impacts are envisaged as a result of the construction and operation of the proposed Oweninny Wind Farm, provided that the recommended mitigation measures are implemented.

Table 20-2: Summary of Potential Interactions during the Construction stage

Chapter	Topic	Potential Impact	Interaction	Potential Impact	Relevant Chapter
Chapter 6	Human Beings	Increase in noise	Community	Reduction in recreational and amenity value	Chapter 7
		Landscape effects	Community	Reduction in recreational and amenity value	Chapter 11
Chapter 7	Noise	Increase in noise	Community	Reduction in recreational and amenity value	Chapter 7 and Chapter 14
		Ecology disturbance to birds	Terrestrial Ecology	Loss of Habitat or Species	Chapter 8
Chapter 8	Terrestrial Ecology	Loss of Habitat and Species	Ecology	Loss of Habitats and Species	Chapter 8
Chapter 10	Water and Aquatic Ecology	Loss of Habitat and Species	Freshwater Ecology	Loss of Habitat or Species	Chapter 10 Chapter 19
Chapter 11	Landscape	Change in Landscape character	Community	Reduced recreational amenity and residential quality	Chapter 11
Chapter 12	Air and Climate	Increase in dust and/or air emissions	Community	Reduced residential and recreational amenity	Chapter 12 and Chapter 14
Chapter 13	Geology and Soils	Impact on Hydrochemistry and water levels of protected areas	Ecology of designated areas	Loss of Habitat or Species	Chapter 8 and Chapter 18
		Impact of drainage plan on site	Groundwater and surface water	Increased peak flow from site Increased solids loss	Chapter 19 Chapter 10
		Contamination of soils and groundwater	Groundwater and surface water	Reduced amenity value	Chapter 13
		Peat slippage	Terrestrial and Aquatic Ecology	Loss of Habitat and Species	Chapter 2

Chapter	Topic	Potential Impact	Interaction	Potential Impact	Relevant Chapter
					Appendix 4
Chapter 14	Traffic& Transport	Increased traffic on the N59	Community	Reduced recreational amenity and residential quality	Chapter 14
Chapter 15	Forestry	Loss of Habitat Species	Ecology	Disturbance of birds	Chapter 9
		Felling related loss of water quality	Aquatic ecology and water quality	Reduced water quality and loss of Habitat and species	Chapter 15 Chapter 10
		Loss of carbon adsorption	Community	Increased CO_2	Chapter 12
Chapter 16	Material Assets	Loss of communication signals	Community	Reduced recreational amenity and residential quality	Chapter 16
		Loss of tourism	Community	Reduced recreational and landscape amenity	Chapter 16 and Chapter 11
Chapter 17	Cultural Heritage	Disturbance of previously unknown archaeological material	Community	Impact on cultural heritage	Chapter 17