5.0 FLORA, FAUNA AND FISHERIES

5.1 FLORA & FAUNA - INTRODUCTION

5.1.1 Background

This study comprises the terrestrial ecological component of an Environmental Impact Assessment relating to a proposed wind farm development in the Rhode area of County Offaly. Emphasis is placed on identification and assessment of habitats of conservation value, as well as breeding and wintering bird species. The study included a specific survey for bats.

This report is based on work carried out in the period 2010 to 2013

The assessment is carried out in compliance with the European Communities (Environmental Impact Assessment) Regulations, 1989-2000, and follows the Environmental Protection Agency's *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002) and the European Communities (Environmental Impact Assessment)(Amendment) Regulations 2006.

5.1.2 Local and General Information

The proposed wind farm development is spread over a large area to the north of Rhode, Co. Offaly (roughly along an 11 km axis from E to W and a 7 km axis from north to south). Access to all areas is readily available from public roads and/or tracks.

The sector to the west of the R400 road, comprising 12 turbines, is on former raised bog in the Derryarkin area. The bog at Derryiron is currently being cut and the turbines here will be on largely bare peat (namely T8, T9, T10), while other areas of former bog are converted to intensive grassland or commercial forestry. One turbine (T11) is located within a stand of birch/willow dominated woodland on cutover bog. Commercial quarries, with large ponds, occur in the Derryarkin area.

The sector to the east of the R400 road is divided by the main channel of the Yellow River. Apart from three turbines (T25, T26, T27) within commercial forestry at Corbetstown, all the turbines here are on agricultural land used for both pastoral and arable practices. Hedgerows and treelines are a feature of the landscape, along with

scattered stands of mixed or deciduous woodland and remnant bogs (such as to the west of T14 and T15).

Overall, the general area in which the wind farm will be located is dominated by agricultural land. The presence of raised bogs is a feature of the landscape though most of these have been commercially exploited by Bord na Móna or by local cutting.

5.2 METHODOLOGY

5.2.1 Habitats and Vegetation

Site visits were made to the various development areas in June 2010, July 2012 and May 2013.

At the proposed turbine locations the dominant habitats/vegetation occurring within a 50 metre radius of the turbine centre were recorded.

Habitats occurring within the site are classified according to the scheme outlined in "A Guide to Habitats in Ireland" (Fossitt 2000). 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). Vascular plant species nomenclature in this report follows Stace (2010) whilst that of mosses follows Smith (2004).

5.2.2 Birds

Breeding birds

The site was surveyed for breeding birds in the following periods: April to June 2010, July 2012 and May 2013.

As the site comprises a multitude of land units over a large area, a focused walk-over survey at each turbine location was considered the most suitable method of survey. Some of the bog areas adjoining the site were assessed for breeding birds, while the main channel of the Yellow River (east of the R500) was surveyed for Kingfisher.

Winter birds

The site was surveyed for wintering birds in winter 2012/13. General walkover surveys to record all wintering birds in the development area were carried out by single visits in late-November, early-January and February. However, when it became obvious that the Derryarkin sector was being used by significant numbers of Whooper Swans, and also waders such as Golden Plover, weekly site visits were conducted between mid January and early April 2013. The methodology used for these surveys followed the Scottish Natural Heritage Guidance document (SNH 2005). The objective was to determine the locations of feeding and roost sites, so that potential disturbance and/or displacement by the wind turbines could be evaluated. Survey was carried out by a combination of vantage point watches over the Derryarkin sector of the development site and by road transects to search for feeding sites in the hinterland of the development. All areas within a distance of at least 500m of the development were checked for feeding birds on each survey visit. In addition, site walks were carried out within fields at Derryarkin where birds were not observed feeding during the watches to search for droppings which would indicate presence at other times (including during darkness). A total of 28 hrs and 40 minutes of systematic vantage point observations over the Derryarkin site was achieved during the winter.

Emphasis was placed on early morning and late evening sessions so as to monitor the movements of the swans between feeding and roost sites.

During the winter monitoring work, particular search was made for other species of conservation importance and notably Hen Harriers.

5.2.3 Terrestrial Mammals, 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.

Mammal sightings and signs were recorded during the various habitat and bird surveys, with particular search for presence of badgers during the winter surveys.

Search was made for otter presence along the main Yellow River channel and at the proposed river and stream crossings.

Presence of the common frog and common lizard was recorded during the habitat and bird surveys.

5.2.4 Bats

A desk study into previous records of bat species in the area of the proposed development was carried out. This was based mainly on *Bat Conservation Ireland's* National Bat Distribution Database.

Site visits to the study area were made on 30th September and 1st October 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. A bat activity survey was carried out at dusk and through the night using heterodyne/frequency division detectors – Bat Box Duet and Pettersson D100. The assessment was undertaken by Mr Conor Kelleher.

Although the site surveys were undertaken in the autumn season, bats were still active due to mild weather with temperatures of 14°C in daylight hours and 12°C after dark. Winds were light and there was no rainfall at the time of survey.

5.2.5 Survey Limitations

No limitations are associated with the habitat or bird surveys as all were carried out during the optimum periods for the respective surveys and followed standard methodologies.

However, the detailed surveys for Whooper Swans were carried out only between January and early April. While the absence of survey in the early winter period (October-December) is a limitation, this is not considered a major constraint for the baseline assessment and is unlikely to significantly alter the overall evaluation of the importance of the site during the 2012/13 winter.

5.2.6 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) and the EPA *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002). 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). 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 importance of wintering wetland bird populations is evaluated according to the standard 1% thresholds for national (all-Ireland) and international importance (see Crowe 2006, Boland & Crowe 2012).

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 following impact significance criteria (EPA, 2002) are used where applicable:

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

5.2.7 Characteristics of the Development

Full technical details of the project are given in Chapter 2, Project Description. The following is a summary of the characteristics of the development:

- Total site area **1,002.234 ha**
- Development footprint **20.58 ha**
- Peat Depth Range **0 – 3.6m**. Average peat depth **0.5 m** (Whitefords, Soils & Geology Report Chapter 6)
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands, including turning area, set down area & ancillary crane area **Total Area 1,995m^2**
- Temporary construction compound, approximately **50 m x 30 m**.
- Clear fell of plantation forestry area 1.5 ha per turbine (four turbines T1; T25; T26 and T27 = 6 ha) plus part of T2 area = 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor) **Overall Clear fell area Total 10.4 ha**
- T11 scrub area to be felled = **1.5 ha**
- Construction of approximately **18,275 m** of new access tracks having a minimum finished width of 5 m with passing bays

- Upgrading of approximately **5,916 m** of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.
- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of an Substation Control Buildings and Compound on site area **1,850 m^2**
- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings **9**
- Upgrade of existing bridges **1**
- The terrain is sloping with gradients between 1:25 and 1:100.

The development site does not require a borrow pit as required stone and gravel will be sourced from local quarries.

Sensitive design has ensured that the wind farm infrastructure is largely outside areas rated as of ecological importance, especially the area of raised bog at Derryiron. The project does not encroach on any site designated for nature conservation. 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 section).

5.3 DESCRIPTION OF THE EXISTING ENVIRONMENT

5.3.1 Sites Designated for Nature Conservation

No part of the proposed development site is within an area designated for nature conservation.

The following sites of nature conservation importance occur within a 15 km radius of the proposed wind farm (see Figure 5.2).

Lough Ennell SAC (code 000685) and SPA (code 004040)

Lough Ennell is a large, limestone lake. The lake is classified as a mesotrophic system by the EPA though it had been eutrophic in the past. The site is an SAC due to the presence of the Annex I habitat alkaline fen.

Lough Ennell is one of the most important midland lakes for wintering waterfowl, with nationally important populations of Mute Swan, Pochard, Tufted Duck and Coot. At times, the lake is utilised as a roost (with limited feeding) by the internationally important midland lakes population of Greenland White-fronted Goose (ca.400 strong) (this flock is now centred at Lough Iron and seldom uses Lough Ennell or the other large midland lakes, O. Crowe pers comm.). The site also attracts Golden Plover (200) and Lapwing (673) though these feed mainly outside of the SPA site.

Lough Ennell is located approximately 10 km to the north-west of the Derryarkin sector of the site.

River Boyne and River Blackwater SAC (code 002299) and SPA (code 004232)

This large site consists of the freshwater stretches of the River Boyne as far as the Boyne Aqueduct, the Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers.

Overall, this SAC site is of considerable conservation significance for the occurrence of good examples of a range of habitats and of populations of plant and animal species that are listed on Annexes I and II of the EU Habitats Directive respectively.

The site is a SPA as it is of special importance of Kingfisher. A survey in 2010 recorded 19 pairs of Kingfishers in the River Boyne and River Blackwater SPA

At the closest, the designated river is at a distance of approximately 14 km to the northeast of the development site.

Raheenmore Bog SAC (code 000582)

Raheenmore Bog is a classic example of a largely intact raised midland bog. It is located approximately 4 km southwest of the Derryarkin sector of the site.

Mount Hevey Bog SAC (code 002342)

Mount Heavy Bog SAC is located to the northeast of Kinnegad and approximately 9 km northeast of the northeastern sector of the proposed wind farm. The site is a good example of a mostly intact raised bog.

Split Hills and Long Hill Esker SAC (code 001831)

This esker ridge crosses the N5 Dublin to Galway road between Kilbeggan and Tyrellspass. The main habitat is semi-natural woodland, though there are several areas of species rich calcareous grassland. The SAC is located approximately 7 km west of the development site.

The Long Derries SAC (code 00925)

Located just over 3 km southeast of Edenderry, the Long Derries, Edenderry SAC is part of a low esker ridge running from Edenderry to Rathdangan. It primarily consists of glacial gravels interspersed with loam and peat soil. The dominant habitat is dry calcareous grassland, of which this is a particularly good example and includes a number of rare plant species. The SAC is located approximately 11 km southeast of the development site.

Wooddown Bog NHA (code 000694)

This NHA is a good example of a relatively intact raised bog. It is located about 4 km east of Mullingar and approximately 14 km to the north-northwest of the development area.

Nure Bog NHA (code 001725)

This NHA is a good example of a relatively intact raised bog. It is located to the southwest of Lough Ennel about 4 km east of Mullingar and approximately 12 km to the north-northwest of the development area.

Milltownpass Bog NHA (code 002323)

This NHA is located about 1 km north-east of Milltownpass and just over 8 km north-east of the Derryarkin sector of the site. The NHA is a fine example of a relatively intact raised bog.

Cloncrow Bog (New Forest) NHA (code 000677)

This NHA is located approximately 1 km west of Tyrellspass and just over 5 km west of the development site. The NHA is a fine example of a relatively intact raised bog.

Black Castle Bog NHA (code 000570)

This NHA is a good example of a relatively intact raised bog and is notable for its easterly location. It is located about 3 km northwest of Edenderry, and approximately 3 km to the west of the proposed wind farm.

Molerick Bog NHA (code 001582)

This NHA is a fine example of a relatively intact raised bog. It is located about 4 km west of Longwood and approximately 10 km northeast of the northeastern sector of the proposed wind farm.

Daingean Bog NHA (code 002033)

This NHA is a good example of a relatively intact raised bog. It is located about 2 km south west of Daingean village and approximately 10 km southwest of the development site.

Rahugh Ridge (Kiltober Esker) pNHA (code 0918)

The pNHA lieas about 9 km northeast of Tullamore and runs for about 2.5 km in anortheast direction. Is a good example of an esker ridge with woodland and calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Ardan Wood pNHA (code 01711)

Ardan Wood is a crescent shaped woodland on a steep slope located about 5 km west of Kilbeggan. It is a good example of a semi-natural woodland. It is situated approximately 10 km west-southwest of the development site.

Murphy's Bridge Ridge Esker pNHA (code 01775)

The pNHA is a good example of an esker ridge with calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Royal Canal pNHA (code 02103)

The Royal Canal pNHA passes north of the proposed wind farm site (approximately 10 km from the nearest development area). The canal supports a wide range of ecological interests.

Grand Canal pNHA (code 02104)

The Grand Canal pNHA is situated to the south of Rhode and approximately 3 km south of the nearest part of the development site. The canal supports a wide range of ecological interests.

Site Name	Designation type	Distance from Landholding
Black Castle Bog	NHA	2.4km East
Grand Canal	pNHA	3km South
Raheenmore Bog	SAC, pNHA	4km South West
Cloncrow Bog	NHA	5km West
Rahugh Ridge (Kiltober Esker)	pNHA	7km Southwest
Murphy's Bridge Ridge Esker	pNHA	7km Southwest
Split Hills and Long Hill Esker	SAC	7km West
Milltown Pass Bog	NHA	8km North
Mount Hevey Bog	SAC/ pNHA	9km North West
Lough Ennell	SPA/ SAC/ pNHA	10km North West
Royal Canal	pNHA	10km North
Ardan Wood	PNHA	10km West Southwest
Daingean Bog	NHA	10km Southwest
Molerick Bog	NHA	10km Northeast
The Long Derries	SAC	11km Southeast
Nure Bog	NHA	12km North Northwest
Wooddown Bog	NHA	14km North Northwest
River Boyne & River Blackwater	SAC, SPA	14km Northeast

Table 5.1 - Designated Areas of Conservation within 15 km of the proposed site.

5.3.2 Habitats, Vegetation and Flora

A general description of the habitats and vegetation types within the entire Yellow River site is presented. This is followed by summary habitat descriptions for the turbine locations. Principal habitats are shown in Figure 5.1.

Description of habitats on site

Despite the large area over which the proposed wind farm extends, the area is characterised by a relatively low diversity of habitats. Of note is that apart from one area of raised bog none of the habitats correspond to any of the Annex I habitats of the EU Habitats Directive.

Depositing/lowland rivers (FW2)

The Yellow River is a main ecological feature of the area and is a fairly typical example of a depositing river. The river, however, has been heavily modified over time and has lost a lot of its naturalness. A full baseline assessment of the river is presented in an accompanying aquatic report.

Drainage ditches (FW4)

Drainage ditches are a frequent feature of the area, reflecting the general low-lying character of the landscape and the widespread reclamation of lands from bog. These vary in water depth and plant diversity according to the degree of recent maintenance. Widespread aquatic species present are watercress (*Nasturtium officinale)*, fool's water cress (*Apium nodiflorum),* creeping bent (*Agrostis stolonifera),* starwort *(Callitriche spp.)* and common duckweed *(Lemna minor).* Yellow flag (*Iris pseudacorus*) occurs in places. Some of the channels are overgrown by marginal scrub vegetation, especially willows and brambles.

Drainage channels, especially when long established, can provide useful habitat for local wildlife and are rated as Local conservation interest (lower value).

Improved grassland (GA1)

Improved agricultural grassland is the dominant habitat within the site. This is mostly a well managed sward with regular fertiliser application and reseeding. The grassland is used for grazing (mostly cattle and sheep) or silage production (see Plate 1).

The dominant species of improved grassland are typically perennial rye grass (*Lolium perenne*), meadow grasses (*Poa spp.*), crested dog's tail (*Cynosurus cristatus*) and Yorkshire fog (*Holcus lanatus*). Frequent herbaceous species are clovers (*Trifolium repens*, *T. pratense*), plantains (*Plantago major, P. lanceolata*), creeping buttercup (*Ranunculus repens*), meadow buttercup *(Ranunculus acris)* and common mouse-ear (*Cerastium fontanum*). Coarse weeds occur scattered throughout, including thistles (*Cirsium* spp.), docks (*Rumex* spp.), ragwort (*Senecio jacobea*) and nettles (*Urtica dioica*). Rushes, mostly soft rush (*Juncus effusus*) are present where drainage is poor but seldom dominate (less than 25% cover).

Improved grassland is a common habitat throughout Ireland and is not of any particular conservation value.

Wet grassland (GS4)

Wet grassland is a relatively scarce habitat along the route corridor, reflecting the intensity of agricultural practices. In most cases it occurs localised or scattered within larger fields of improved grassland though it is the dominant habitat at the location for T30.

The principal species associated with wet grassland are soft rush (*Juncus effusus),* creeping bent (*Agrostis stolonifera*), silverweed (*Potentilla anserina*) and creeping buttercup (*Ranunculus repens*). In wetter areas yellow flag (*Iris pseudacorus)* and meadowsweet (*Filipendula ulmaria*) may occur, along with the small rush species *Juncus articulatus* and *Juncus acutiflorus.*

While wet grassland is a widespread and common habitat in Ireland, it offers some habitat diversity in an intensively managed landscape such as within the study site. Rated as of Local importance (lower value).

Dry meadows and grassy verges (GS2)

This semi-natural grassland type is localised in the study area and is found along earthen banks and/or roadside margins. However, there are no extensive examples of the habitat. A range of grasses occur, including red fescue (*Festuca rubra*), cock's-foot (*Dactylis glomerata*), meadow foxtail (*Alopercurus pratensis*), and sweet vernal grass *(Anthoxanthum odoratum).* Herbaceous species recorded were common knapweed (*Centaurea nigra*), common centuary (*Centaurium erythraea),* bird's-foot trefoil (*Lotus corniculatus),* oxeye daisy *(Leucanthemum vulgare),* ladies bedstraw *(Galium verum),* yarrow *(Achillea millefolium*), cat's-ear *(Hypochoeris radicata),* self heal (*Prunella vulgaris*), ribwort plantain *(Plantago lanceolata),* white clover *(Trifolium repens*), and eyebright (*Euphrasia* sp).

The examples of this semi-natural grassland type within the study are small in size and generally remnants. However, they have some conservation value – rated as Local importance (lower value).

Raised bog (PB1)

A narrow strip of raised bog occurs at Derryiron to the south of turbines 8, 9 and 10 (see Plates 2 & 3). This extends from an active cut face to the Bord na Móna railway line to the south. Surface drains have been inserted into the western sector of the bog, while the eastern sector is more intact. The bog is dominated by ling heather (*Calluna vulgaris*), with cross-leaved heath (*Erica tetralix*), purple moor-grass (*Molinia caerulea*), common bog cotton (*Eriophorum angustifolium*), deer-grass (*Trichophorum cespitosum*) and bog asphodel (*Narthecium ossifragum*) also present. The moss layer varies though bog mosses (*Sphagnum spp.)* are locally common in the eastern sector.

While still uncut and retaining a typical surface vegetation, this strip of raised bog is hydrologically compromised due to the very active turbary along its northern margin and the surface drains across the western sector. Nevertheless, as raised bog is listed as an EU Habitats Directive Annex I habitat with priority status, this minor example is rated as Local importance (higher value).

Cutover bog (PB4)

T8, T9 and T10 are located on areas of recent bare peat within an area of active turbary (see Plates 3 & 4). The turbines are located close to the cut edge of the strip of raised bog already described.

While cutover bog can be of varying conservation value, the example at the turbine locations is not considered of any value as it is a recently cut surface that is still largely bare peat.

T7 is located along the margin of a small area of bog which occurs just south of the Yellow River (see Plates 5 & 6). This is an isolated bog remnant within a large field of improved grassland and it appears that the surface may have been turned/ploughed in the past (10+ years ago) as it is quite firm and very uneven (i.e. not an expected natural bog surface). The vegetation has recovered well but there is virtually no moss layer at all. While much of the surface is wet this appears more like waterlogging than natural bog wetness. Typical bog species such as ling heather, cross-leaved heath, bog cotton, deer sedge and bog asphodel are present.

The example of cutover bog at T7 is rated as Local importance (lower value).

Bog woodland (WN7)

A stand of woodland on cutover bog occurs at the location for T11 in the Derryiron area (see Plate 9). This is very much dominated by downy birch (*Betula pubescens*) and willows (most eared willow *Salix aurita)* and with gorse (*Ulex europaeus*) in varying amounts. The understorey and ground layer is usually of bramble (*Rubus fruticosus)* with a remnant bog flora of such species as ling heather (*Calluna vulgaris*). Bracken (*Pteridium aquilifolium*) also occurs in the woodland.

As this wood is on cutover bog it does not qualify as the Annex I habitat Bog woodland (which in Ireland is confined to a few relatively intact raised bogs with high water tables). Nevertheless it is a useful habitat for local wildlife and is rated at least as Local importance (lower value).

Conifer plantation (WD4)

Coniferous plantations occur in the north-western part of the Derryarkin sector and more extensively in the Carrick-Corbetstown area.

The stand at Derryarkin is Sitka spruce (*Picea sitchensis*) which is now in the closed canopy stage.

The plantations at Carrick-Corbetstown are mostly conifers, though there are some broadleaved stands (WD1) here as well.

Conifer or broadleaved plantation forest is not of conservation value from a habitat perspective

Hedgerows (WL1) and treelines (WL2)

Hedgerows or treelines occur throughout the study area and provide the principal field boundary type (other than on the reclaimed bog at Derryarkin) (see Plates 7 & 8).

The hedges are typically on earthen banks and are often accompanied by drainage ditches. The quality of hedgerows varies, from tall, well structured and diverse hedges that could often be described as treelines or even narrow strips of woodland (such as at Coolville) to very low (<1.5 m) hedges (such as within the intensively managed pasture and arable fields found on both sides of the Yellow River at Wood and Killowen).

Hawthorn (*Crataegus monogyna)* is the main hedge forming species, with ash *Fraxinus excelsior* the principal tall tree species. Blackthorn (*Prunus spinosa),* elder (*Sambucus nigra),* sycamore (*Acer pseudoplatanus),* willows (mostly grey willow *Salix atrocinerea*), and hazel (*Corylus avellana)* are fairly widespread, with holly (*Ilex aquifolium),* beech (*Fagus sylvatica)*, oak (*Quercus* spp.) and elm (*Ulmus* spp.) scattered. Brambles (*Rubus fruticosus)* are frequent in the understorey layer throughout, with wild roses (*Rosa* spp.) also present and honeysuckle (*Lonicera periclymenum)* occasional. Ivy (*Hedera helix)* is common both in the trees and in the ground layers.

A fairly typical array of herbaceous species was recorded in the ground layer of the hedgerows. These include herb robert (*Geranium robertianum),* dog violet (*Viola riviniana)*, lords and ladies (*Arum maculatum)*, ground ivy (*Glechoma hederacea),* cleavers (*Galium aparine)*, bush vetch (*Vicia sepium)*, primrose (*Primula vulgaris)*, and cow parsley (*Anthriscus sylvatica).* Ferns such as shield fern (*Polystichum setiferum)* and hart's tongue fern (*Phyllitis scolopendrium)* are fairly widespread. Coarse plants, such as nettles (*Urtica dioica)* and hogweed (*Heracleum sphondylium)* are often present along the hedge margins.

Hedgerows are an important feature of the study area and provide useful wildlife habitat in a largely agricultural landscape. Overall, hedgerows within the survey corridor are rated as having Local importance (Lower value).

Active quarries and mines (ED4)

Kilmurray quarry is an active sand and gravel facility. The complex includes some flooded quarry pits.

While not presently of conservation value from a habitats perspective, the flooded quarries provide useful habitat for aquatic birds while a colony of breeding sand martins occurs in the sand banks.

Arable land (BC1)

Arable land used intensively for cereal production is a feature of the eastern sector of the study area

Arable land is not of conservation value from a habitats perspective but can provide useful habitat for a range of farmland birds. .

Buildings and artificial surfaces BL3

The site includes a range of farm buildings and buildings associated with a commercial quarry complex at Kilmurray. Various roads and hard core tracks are scattered through the site.

Built land is not of conservation interest.

5.3.3 Vegetation descriptions at turbine locations

A summary of the principal habitat type at each turbine location is given in Table 1.

Turbine	Principal Habitat
1	Conifer plantation
2	Conifer plantation / Improved grassland
3	Improved grassland
4	Improved grassland
5	Improved grassland
6	Improved grassland
7	Improved grassland (adjoining remnant bog)
8	Cutover bog
9	Cutover bog
10	Cutover bog
11	Bog woodland
12	Improved grassland
13	Improved grassland
14	Improved grassland
15	Improved grassland
16	Improved grassland
17	Improved grassland
18	Improved grassland
19	Improved grassland
20	Improved grassland
21	Improved grassland
22	Arable
23	Arable
24	Improved grassland
25	Conifer plantation
26	Conifer plantation
27	Conifer plantation
28	Arable
29	Arable
30	Wet grassland / Improved grassland
31	Improved grassland
32	Improved grassland

Table 5.2. Principal habitats at location of each turbine.

Seventeen of the proposed turbine locations are located on improved grassland, much of which is intensively managed. One (T30) is within a field which is divided between wet grassland and improved grassland – this field merges with an area of remnant bog. A further turbine (T7) is on grassland that is along the margin of some remnant bog. Four of the turbines are in arable land (though landuse varies between arable and grassland between years). Four of the turbines are in forestry plantations, with another (T2) partly in forest. The plantations in the northern part of the site are coniferous but with broadleaved stands. Three turbines are on cutover bog, with one on bog woodland.

5.3.4 Terrestrial mammals, amphibians and reptiles

Otter (*Lutra lutra*) occurs on the Yellow River and is likely to be widespread along its tributaries. Signs were observed at the following locations in June 2010: N517 359 (main channel west of R400), N563 384 (main channel at Killowen).

Badgers *(Meles meles)* are widespread throughout the area, with signs such as feeding marks recorded in many of the grassland fields. A large sett occurs in the Derryarkin farm area.

The Irish Hare (*Lepus timidus hibernicus)* is widely distributed throughout the entire site. Foxes (*Vulpes vulpes)* are widespread within the site with several sightings and numerous signs.

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.

5.3.5 Bats

Desk study

Of the ten recorded bat species in Ireland, seven have been recorded within a 10 km radius of the study site including; common (*Pipistrellus pipistrellus),* soprano (*P. pygmaeus)* and Nathusius' (*P. nathusii)* pipistrelle, brown long-eared (*Plecotus auritus)*, Leisler's (*Nyctalus leisleri)*, Daubenton's (*Myotis daubentonii)* and Natterer's (*M. nattereri)* bats and other bat species may be expected to occur occasionally. Roosts of some of these species (soprano pipistrelle, brown long-eared and Daubenton's bats) are also known locally but these are outside of the study area as shown in Table 5.3.

Common name	Scientific name	No. of roosts	Distance from study area	Source
Soprano pipistrelle	*Pipistrellus pygmaeus*	2	2km E and 10km NW	BCIreland
Brown long-eared bat	*Plecotus auritus*	2	3km NE and 10km NW	BCIreland
Daubenton's bat	*Myotis daubentonii*	1	10km NW	BCIreland

Table 5.3 Known bat roosts within 10 km of the study area.

Field survey

Sunset on the evening of the surveys was at 19:13 and 19:10 hrs respectively and, on both occasions within twenty minutes of sunset, the soprano pipistrelle was the first bat species observed on the wing. In total, six bat species were subsequently detected on-site with the most common being the soprano pipistrelle although the common pipistrelle was also widespread throughout the area. Both pipistrelle species foraged in the shelter of hedgerows, treelines, tree-lined minor roads, woodland and scrub areas, as well as vegetated areas of the Yellow River.

Leisler's bat was detected actively foraging over and commuting across the area on both nights. Several specimens of the species were present as more than one was visibly observed flying at height and at the same time over Derryarkin on the first night and over Killowen on the second night before full darkness prevented visual observation. During the hours of darkness each night, the species was frequently detected hunting throughout the area.

Brown long-eared and Natterer's bats, two species that are difficult to detect due to their quiet echolocation calls, were both encountered hunting along the woodland and well-treed lanes at Coolville/Ballyburly. Both species were also present along the well-vegetated lanes at Carrick at the north of the study area.

Daubenton's bat was detected hunting over the Yellow River at Garr Bridge and this species is expected to occur on all the larger watercourses in the area.

Although not recorded during the surveys, the whiskered bat *M. mystacinus* is certain to occur in wooded areas such as those at Coolville/Ballyburly, a preferred habitat of the species, as it is widespread in the Irish countryside. Brandt's bat *M. brandtii*, a sibling of the whiskered bat, may also occur on-site but it is a very rare animal that has only been recorded a few times to date in Ireland. Nathusius' pipistrelle, another rare species, has been detected locally and the species may occur on-site occasionally but it was not recorded on this occasion.

The lesser horseshoe bat *Rhinolophus hipposideros* is confined to the west of Ireland and is not known to occur in County Offaly.

No bat roosting sites were found on-site during the present surveys but bat roosts are certain to be present within such a large area. Roosts of three species are known nearby.

Table 5.4 outlines the adjudged local status of each bat species and its presence within the study site.

Common name	Scientific name	Occurrence on-site	Known roosts	Source
Common pipistrelle	*P. pipistrellus*	Present	No	BCIreland/ Pers. Obs.
Soprano pipistrelle	*P. pygmaeus*	Present	Yes	BCIreland/ Pers. Obs.
Nathusius' pipistrelle	*P. nathusii*	Potential – local records	No	BCIreland
Leisler's bat	*N. leisleri*	Present	No	BCIreland/ Pers. Obs.
Brown long-eared bat	*P. auritus*	Present	Yes	BCIreland/ Pers. Obs.
Lesser horseshoe bat	*R. hipposideros*	Absent	No	BCIreland
Daubenton's bat	*M. daubentonii*	Present	Yes	BCIreland/ Pers. Obs.
Natterer's bat	*M. nattereri*	Present	No	BCIreland/ Pers. Obs.
Whiskered bat	*M. mystacinus*	Certain	No	
Brandt's bat	*M. brandtii*	Potential – rare	No	

Table 5.4 Adjudged local status of Irish bat species.

5.3.6 Amphibians and Reptiles

The common frog (*Rana temporaria)* is widespread throughout much of the site, occurring in ponded areas, drains along tracks etc.

The common lizard (*Zootoca vivipara)*, a species often found on peatlands and open areas, was not recorded and would not be expected in agricultural fields. However, it may occur on the strip of remnant bog at Derryiron.

5.4 BIRDS

5.4.1 Breeding and summering birds

A summary table of species recorded from the breeding surveys is presented in Table 5.5. The adjudged breeding status using the BTO Breeding Bird Atlas 2007-2011 criteria is given.

A total of 42 species was recorded within the site during the breeding surveys. Thirty-nine of these were considered to be in one of the three breeding categories (possible, probable, confirmed), with three species (grey heron, kestrel, black-headed gull) considered to be merely using the site but breeding elsewhere.

Breeding birds of bog and wetland habitats

The remnant area of raised bog at Derryiron and the adjoining cutover bog supports a relatively small number of breeding birds. Skylark and Meadow Pipit were by far the most widely distributed species in these habitats. Wren was the only other species recorded on the bog though Swallows fed over the surface of the bog. A pair of Stonechats bred in gorse scrub in the northern sector of the Derryiron bog area, with Linnet recorded (probably breeding nearby) in the cutover bog alongside the Yellow River channel.

A Wheatear was present on the recent cutover bog at Derryiron in May 2013 but was probably a migrant bird, while Cuckoo was heard locally. Sedge Warbler and Reed Bunting occur widely in the fringing vegetation along the Yellow River channel. Mallard and Moorhen breed at several locations along the Yellow River.

A pair of Lapwing attempted to breed in the area of recent cutover bog at Derryiron in 2010 but had abandoned the area by June undoubtedly due to the high level of disturbance from turbary activities. A single bird (possibly of a pair) was displaying here in May 2013 but again there was a high level of turbary activity nearby. Several pairs of Lapwing breed on the cutaway bog habitats to the north of the road leading to Derryarkin farm.

Sand Martins breed in a sand bank at Kilmurray quarry. In May 2013, a pair of Great Crested Grebes and a pair of Tufted Duck were on the quarry pond, along with four

Mute Swans, a pair of Moorhens and a Little Grebe. It is not known if the grebes or the Tufted Duck breed here.

A large colony of Black-headed Gulls nests on an island in a quarry lake at the Roadstone facility to the north of Derryarkin farm. An estimated 160 birds were present in 2010 and up to 400 birds in May 2013.

Breeding birds of pasture and arable habitats

Most of the grassland fields are managed intensively and support few breeding birds. Meadow Pipits were recorded in some of the less managed fields and were probably nesting locally. Starlings, Rooks and Jackdaws utilise the fields for feeding.

The arable fields, mostly cereals, provide suitable habitat for typical species of mixed agricultural lands, with Skylark, House Sparrow, Stock Dove (1 pair), Linnet and Yellowhammer (2 locations) recorded. The occurrence of Yellowhammer is of note as this is a Red List species.

Breeding birds of hedgerows, scrub and woodland

The majority of the passerine species found on site are associated with the hedgerow 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 the bog woodland north of Derryiron.

Lesser Redpoll was a widespread species, associated with scrub and conifer forest.

Breeding birds of buildings

Four species which occur on site breed in buildings within or around the site – these are Swallow, Pied Wagtail, House Sparrow and Starling.

Species	Breeding Status	Conservation Status
Little Grebe	**Possible**	**Amber**
Great Crested Grebe	**Possible**	**Amber**
Grey Heron	Non-breeder	Green
Mallard	Confirmed	Green
Tufted Duck	**Possible**	**Amber**
Kestrel	**Non-breeder**	**Amber**
Pheasant	Probable	Green
Moorhen	Confirmed	Green
Lapwing	**Possible**	**Red**
Black-headed Gull	**Confirmed locally (offsite)**	**Amber**
Woodpigeon	Confirmed	Green
Stock Dove	**Probable**	**Amber**
Cuckoo	Probable	Green
Skylark	**Confirmed**	**Amber**
Sand Martin	**Confirmed**	**Amber**
Swallow	**Confirmed (nests in buildings)**	**Amber**
Meadow Pipit	Probable	Green
Pied Wagtail	Probable	Green
Wren	Probable	Green
Robin	Probable	Green
Stonechat	Confirmed	Green
Wheatear	**Possible**	**Amber**
Blackbird	Probable	Green
Song Thrush	Probable	Green
Mistle Thrush	Possible	Green
Sedge Warbler	Probable	Green
Blackcap	Possible	Green
Willow Warbler	Confirmed	Green
Blue Tit	Confirmed	Green
Coal Tit	Confirmed	Green
Magpie	Probable	Green
Jackdaw	Confirmed	Green
Hooded Crow	Probable	Green
Starling	**Confirmed**	**Amber**
House Sparrow	**Confirmed**	**Amber**
Chaffinch	Confirmed	Green
Goldfinch	Possible	Green
Linnet	**Probable**	**Amber**
Lesser Redpoll	Probable	Green
Bullfinch	Possible	Green
Yellowhammer	**Probable**	**Red**
Reed Bunting	Confirmed	Green

Table 5.5. Breeding status of species recorded within Yellow River wind farm study area during surveys in 2010, 2012 and 2013. Red and Amber listed species (after Lynas *et al.* 2007) are highlighted.

5.4.2 Wintering birds

The wintering swans and wetland birds associated with Derryarkin Farm are discussed separately from the other birds which occur in the study area.

Wintering Whooper Swans, Golden Plover, Lapwing and Curlew

The improved grassland fields at Derryarkin farm provide suitable habitat for Whooper Swans and grassland feeding waders (Lapwing, Golden Plover, Curlew). Detailed observations of the usage of these fields through the winter are presented in **Appendix J**, with a summary in Table 5.6.

Whooper Swan

Whoopers Swans were recorded in the improved grassland fields of Derryarkin Farm in 10 of 15 winter visits between November 2012 and April 2013. Numbers ranged from 3 (plus 4 Mute Swans on same date) to 82 (though it is known that over 100 swans were present during December – S. Heery in conversation with B. Madden). The fields most often used were those adjoining the quarry complex, and especially fields no. 1 and 2 (see Figure 5.3). Swans were also recorded within fields no. 3, 4 and 5, and signs of recent usage were found in fields no. 6 and 7.

The Kilmurray quarry ponds were used by roosting swans occasionally.

These swans are part of a population that moved regularly between a cluster of feeding and roost sites in the immediate area, as follows (see Figure 5.4):

- Derryarkin farm – (within development site – fields no. 1- 4 (Figure 5.3) & site no. 1 in Figure 5.4) – used intensively for feeding, with occasional roosting on adjoining Kilmurray quarry ponds (R1 in Figure 5.4)

- Derryarkin cutaway bog – comprises the areas which adjoin Derryarkin farm to the north, northwest and northeast (site no. 3 in Figure 5.4). Provides feeding opportunities on wet bog and a safe roost site (Roadstone quarry pond – R2 in Figure 5.4)

- Grassland fields between Mongagh River and motorway (east side of R400) – general grid reference (N48 39 – site no. 4 in Figure 5.4)

- Grassland fields east side of R400 on Rochfortbridge side of motorway (grid ref. N480 407 – site no. 5 in Figure 5.4)

A further roost site is considered to exist within the Bord na Móna Drumman site (grid ref N510 400) where a series of quarry ponds occur (R3 in Figure 5.4).

The above sites are part of a larger complex of sites used by swans extending to Ballycon (south of Rhode). It appears that the swans were concentrated at the above listed sites in the Derryarkin area in the early part of the winter (to January) and then most moved to various locations near to Rhode in the later part of the winter. The reason for the shift may have been due to better feeding opportunities though high levels of disturbance from farming activities at Derryarkin may also have caused the swans to move.

During daylight, the swans fed almost continuously and generally flew only short distances within the fields in response to feeding patterns or local disturbance. All internal movements within the feeding fields were at low levels (10-15 m). Six flightlines were recorded of birds arriving or departing from the fields, with one of birds flying to the Kilmurray quarry ponds to roost (see Figure 5.5). Only one flightline was observed of birds arriving from outside of the area – this involved a group of 15 swans which arrived from the southeast at c.15.40 hrs on 24th January 2013. These birds, which were recorded from the entrance road, were descending towards fields at height of less than 30 m. A similar number was later seen roosting on the Roadstone quarry at darkness.

Of particular interest was that the swans were using nearby quarry ponds (Roadstone & Kilmurray) as night roosts. This enabled the birds to feed well after darkness and then to take a short flight to the night roost.

Up to four Mute Swans were often recorded with the Whooper Swan flock.

Golden Plover

A flock of Golden Plover was present in the Derryarkin Farm area through much of the winter. Numbers were generally in the low hundreds though a high count of 1,200 was made on 31st January 2013. The plover moved between all the fields within the site, with two records of birds in the fields at Derryiron.

Lapwing

As with Golden Plover, Lapwing was present in the Derryarkin Farm area through much of the winter. Numbers peaked at 400 on 8th January 2013.

Curlew

A regular flock of up to 45 Curlew was in the Derryarkin area throughout the winter. These birds were usually found roosting on the banks of the Kilmurray quarry pond though they also fed in the fields at times.

Date	Whooper Swan	Golden Plover	Lapwing	Curlew
22/11	19	0	0	28
29/11	11	60	0	14
21/12	16	0	0	22
08/01	45	80	400	15
21/01	82	280	240	36
24/01	0	350+	200+	42
31/01	0	1,200	140	40
04/02	0	200	180	35
12/02	0	60	160	45
20/02	3	30	30	0
01/03	0	160	55	32
07/03	18	40	85	22
13/03	38	0	0	0
26/03	26	0	0	0
02/04	13	0	0	0

Table 5.6. Numbers of Whooper Swans and grassland feeding waders at Derryarkin farm, winter 2012/13.

In addition to the swans and waders, a flock of up to 20 **Teal** was often found on a small pond within the site and sometimes on the Kilmurray quarry pond.

Large flocks of **Starlings** were regular in the fields, with an estimated 3,000 feeding on grassland on 21st January 2013.

Hen Harrier

A male Hen Harrier was recorded at Derryarkin on 26th March 2013 (see Figure 5.6). This bird flew low (<10 m) from the Derryarkin cutaway bog in a southeast direction towards Ballybeg. The bird appeared to be in foraging mode though was not observed striking any prey item.

Other wintering birds in study area

The majority of the study area comprises mixed agricultural lands, with hedgerows and treelines a feature. A list of the birds recorded on each of the three winter surveys is given in Table 5.7. Flocks of wintering finches, thrushes and larks were found throughout the area, with particularly good concentrations in areas with arable fields. Finch flocks comprised Chaffinches, Linnets, Greenfinches and Goldfinches. These often occurred in association with smaller numbers of Skylarks, Reed Buntings and Yellowhammers. Lesser Redpoll was fairly widespread throughout the area.

Redwings and Fieldfares, both wintering thrushes, occurred scattered in the fields and hedgerows and were often in the presence of Blackbirds and Song Thrushes. Flocks of Woodpigeons were widespread, along with the common crow species (Jackdaw, Rook and Hooded Crow).

Kestrel, Sparrowhawk and Buzzard were recorded throughout the area.

Snipe (usually single birds) were flushed regularly from pasture fields, especially the wetter fields. Mallard, Moorhen and Grey Heron occurred scattered in small numbers along the Yellow River channel.

Species	22-11-12	21-12-12	4-2-13	Comment
Grey Heron	2	4	2	
Mallard	8	3	10	Scattered along channels/wet fields
Buzzard	1	2	2	Coolville and Carrick
Sparrowhawk	1	1	2	
Kestrel	**1**	**1**	**1**	
Moorhen	2	1	3	
Snipe	**4**	**7**	**3**	**Well scattered in wet fields**
Skylark	**14**	**22**	**8**	**Mostly in arable fields**
Meadow Pipit	P	P	P	
Pied Wagtail	P	P	P	
Grey Wagtail	3	3	1	Associated with watercourses
Wren	4	P	P	
Robin	P	1	1	
Stonechat	1	1	2	
Blackbird	P	P	P	
Fieldfare	20	200+	150	
Song Thrush	P	P	P	
Redwing	60	120	400+	
Mistle Thrush	4	-	2	
Goldcrest	P	P	P	
Blue Tit	P	P	P	
Great Tit	P	P	P	
Coal Tit	P	P	P	
Long-tailed Tit	12	7	14	
Magpie	P	P	P	
Hooded Crow	P	P	P	
Raven	1	-	2	
Chaffinch	P	P	P	
Goldfinch	P	P	P	
Linnet	**14**	**4**	**20+**	
Lesser Redpoll	P	P	P	
Bullfinch	2		5	
Yellowhammer	**7**	**11**	**6**	**Arable fields east of R400**
Reed Bunting	8	12	6	

Table 5.7. Winter occurrences of species recorded within Yellow River wind farm study area during surveys in winter 2012/2013.

Numbers refer to the peak in each survey session. Widespread and common species are listed as present. Red and Amber listed species (after Lynas et al 2007) are highlighted. (Note that data on swans and grassland feeding waders are presented separately)

5.4.3 Evaluation of Conservation Importance of Study Area

Habitats and flora

None of the terrestrial habitats within the study area are rated as of more than Local Importance (higher value). The most important terrestrial habitat is the strip of raised

bog at Derryiron as this represents an EU Habitats Directive Annex I habitat with priority status. However, the bog is highly compromised due to intense turbary activity. Other habitats which are of some conservation value (Local Importance, local value) include the area of remnant bog adjoining the location for T7, the stand of bog woodland at T11, and the various hedgerows and treelines.

Fauna

The site supports a fairly typical mammalian fauna. The presence of otter on the Yellow River 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. The Irish Hare is listed in Annex V of the Habitats Directive. The Common Frog, a widespread species throughout the site, is listed on Annex V of the Habitats Directive.

Common name	Scientific Name	Habitats Directive Annex No.	Wildlife Act 1976 and Amendment 2000	Irish Red List Status (after Marnell et al. 2009 or et al. 2012)
Badger	*Meles meles*	-	P	Least concern
Otter	*Lutra lutra*	II, IV	P	Near threatened
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
Whiskered bat	*Myotis mystacinus*	IV	P	Least concern
Long-eared bat	*Plecotus auritus*	IV	P	Least concern
Common Frog	*Rana temporaria*	V	P	Least concern
Common Lizard	*Zootoca vivipara*	-	P	Least concern

P= Protected under Wildlife Act (1976) and Wildlife [Amendment] Act (2000)

Table 5.8 Legal status of protected fauna encountered or considered likely to occur within the study area.

The bat survey confirmed the presence of six bat species on-site and others may be expected to occur on occasion. All bat species are legally protected and are listed on Annex IV of the Habitats Directive. Leisler's bat is 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.

Birds

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 5.9.

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
Great Crested Grebe			X
Whooper Swan	X		X
Teal			X
Tufted Duck			X
Hen Harrier	X		X
Kestrel			X
Lapwing*		X	
Golden Plover	X		X
Snipe			X
Black-headed Gull**		X	
Stock Dove			X
Swift			X
Skylark			X
Sand Martin			X
Swallow			X
Wheatear			X
Starling			X
House Sparrow			X
Linnet			X
Yellowhammer		X	

* only breeding Lapwing are Red listed
** colony of Black-headed Gulls is off-site

Table 5.9. Bird species of conservation importance recorded on site, 2010-2013

While a total of 21 species of conservation importance was recorded on site, the majority of these are in the Amber list category only (i.e. of medium conservation concern in Ireland).

Three of the species of conservation importance are listed as EU Birds Directive Annex I species. The presence of both Whooper Swan and Golden Plover is significant as these species occurred within the Derryarkin sector of the study site on a regular basis. While the numbers of birds involved are substantial, the recorded peaks of 82 Whooper Swans and 1,200 Golden Plover do not reach the respective national importance thresholds of 130 and 1,700 for these species (after Boland & Crowe 2012). The sighting of a Hen Harrier is not surprising as wintering Hen Harriers occur sparsely within this wider area. The late date (26th March) would suggest the bird was on its way to the breeding grounds (probably the Slieve Bloom Mountains). The site does not have significant potential to support winter roosting Hen Harriers.

Lapwing, a Red list species, attempts to breed on site annually (Derryiron bog area) but is unlikely to be successful due to a high level of turbary activity. A Black-headed Gull colony (Red list species) of national importance occurs on the large Roadstone quarry lake close to the Derryarkin sector of the site.

Yellowhammer, a further Red List species, breeds in the area of mixed agricultural land to the east of the R400. While scarce in many areas of Ireland, Offaly is within the main range for this species. Stock Dove and Skylark, both Amber list species, occur in similar habitats as the Yellowhammer, while House Sparrow and Starling are often found breeding in the vicinity of farmsteads. During winter, Starlings occur in large flocks on improved pasture at Derryarkin.

Linnet breeds on site and also occurs in winter. Swallow breeds in buildings and may also be seen feeding over the various fields throughout the area.

Three of the Amber listed species, Little Grebe, Great Crested Grebe and Tufted Duck, were found only on the Kilmurray quarry ponds, which is also the location that supports a breeding colony of Sand Martins.

The other Amber listed species, Kestrel, Swift and Wheatear, use the site for feeding and probably breed elsewhere.

5.5 POTENTIAL IMPACTS OF THE DEVELOPMENT

5.5.1 Construction Phase

Loss of Habitats

The entire development will result in a permanent loss of habitats (i.e. covered by hardcore) estimated at 20.58 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, mainly the contractors construction lay down area and storage area.

The principal habitats affected by construction of the wind farm will be improved grassland and arable land in active agricultural use. Such habitats are not of conservation value.

Turbines T8, T9 and T10 are on bare peat in an area of recent and ongoing turbary and this habitat is not of conservation value (see Plate 4).

Turbine T7 is located along the western margin of an area of remnant bog (see Plate 6). The construction of the turbine and hardstand may impinge slightly onto the bog but this would be a very localised effect. Taking the relatively low ecological value of this bog remnant into account, the impact is not rated as of significance.

Five of the turbines will be in commercial forestry which is not of conservation value.

One turbine, T30, is in a field that is partly wet grassland. This is dominated by rushes and is of negligible conservation value.

One turbine, T11, is within an area of bog woodland at Derryiron (see Plate 9). Construction will require clearance of an area of 1.5 ha of woodland and scrub. This woodland is rated as of Local Importance (lower value) and the impact by the construction of the turbine will be significant.

The roads will largely be over agricultural land or along existing roads and tracks. Where the road runs perpendicular through a hedgerow, a section of approximately 8 m width will be cleared and if it is diagonally through it would need to be about 15m. In places, however, especially where existing roads need to be upgraded, longer strips of hedging will be removed. In total, it is estimated that the construction of the roads will require approximately 37 intersections with roads, along with the removal of hedging from along one side of a parallel track in at least two locations. This will result in the removal of 1,380 m of hedgerow and treeline (and associated drainage channels). The hedgerows, treelines and drainage channels are considered of importance in a local context and the estimated loss is rated as a significant impact.

Other Impacts on Habitats

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. While there are no additional sensitive habitats which would be disturbed, care is required at the following:

- T7 construction site to minimise disturbance to the adjoining area of remnant bog
- T11 construction site to minimise disturbance to remainder of bog woodland

The excavations for T7 may affect the hydrology of the adjoining remnant bog though, as already noted, this bog has been disturbed in the past by cutting and/or heavy burning and grazing and there is presently no Sphagnum layer. If localised drying was to occur as a result of the works, robust species such as ling heather (*Calluna vulgaris*) and deer sedge (*Trichophorum cespitosum*) would probably increase in frequency.

As the soil throughout the site is peat, it is expected that areas of bare peat 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. Alternatively, some of the disturbed areas may be replanted with agricultural grass.

Potential Impacts on Birds of Conservation Importance

Impacts on Annex I and Red Listed bird species

Whooper Swan (Annex I species)

The winter surveys showed that Whooper Swans visit the Derryarkin sector of the site on a regular basis through the winter and at times in significant numbers (though not at national importance level)..

All apart from one flightline recorded were movements within the site or to local roost and/or feeding sites (see Figure 5.5).

The swans using the site could be affected in a number of ways, as follow:

Disturbance during construction

Construction works on Turbines 1 to 7 would almost certainly deter swans from using the feeding fields at Derryarkin. This would be a significant impact for the local swan population which was heavily dependent on these fields in December 2012 and January 2013.

This impact can be avoided completely by restricting works in this sector of the site to the April to October period inclusive.

Permanent loss of habitat

The footprint of turbines T3 to T6, which are the ones on improved pasture used by swans, is 0.924 ha. This is a very small area of the grassland available to the swans in the immediate area and would not have a measureable negative impact.

Displacement from feeding areas and roost sites

Birds' avoidance responses to wind farms vary within and between species, but swans and geese are considered sensitive to these developments because they frequent open landscapes (Hotker et al. 2006). In a major review of the impacts of wind farms on swans and geese, Rees (2012) recorded displacement distances of 200-560 m for

swans. She notes, however, that long-term post-construction studies, and thus information on whether birds adapt to the change in landscape, are rare. Reference is made to one such study by Fijn et al. (2012) which specifically analysed the proportion of swans wintering in the vicinity of a wind farm before and after construction. This study found a significant drop, post-construction, in the proportion of wintering Bewick's Swans using the area where wind turbines had been installed in Polder Wieringermeer, the Netherlands (from 1,099 to 530 birds). The study found evidence of habitation, with swans feeding closer to the turbines later in the study, but with fewer birds overall present in the study area. A further long-term post-construction study on whether birds adapt to the change in landscape found that Pink-footed Geese at sites in Denmark grazed closer to wind turbines *c*.20 years after construction than 10 years previously (Madsen & Boertmann 2008). The study also found that the geese remained at a greater distance from the larger turbines.

Based on the international literature and the large size of the proposed turbines, it would seem probable that swans will avoid feeding within an area of at least 200 m (but possibly up to 500 m) of each turbine at least in the early operational phase. The relevant turbines are as follows:

- T2 – while turbine is on edge of conifer plantation, suitable grassland for feeding also occurs within a 200-500 m radius of the turbine
- T3 – turbine is within suitable grassland for feeding, with wet cutaway bog within 500 m radius to north
- T4 – turbine is within suitable grassland for feeding
- T5 – turbine is within suitable grassland, with wet cutaway bog within 500 m radius to north and west
- T6 – turbine is within suitable grassland, with scrub dominated cutaway bog (not suitable for feeding) within 500 m radius to north

Two of the turbines (T1 & T7) at Derryarkin are not in areas likely to be used by swans, as follows:

- T1 is within a conifer plantation and the swans would be unlikely to graze on grassland close to the forest edge

- T7 is located alongside remnant bog in the extreme eastern sector of a group of large fields which are used by swans. The remnant bog would not provide suitable feeding. While grassland occurs to the south and west, this is close to an access road and no swans were recorded here during the winter surveys.

It is probable that the wintering swans will no longer use the Kilmurray quarry ponds for roosting due to the proximity of two of the turbines (T4 & T6) but the larger Roadstone quarry to the north is unlikely to be affected as the nearest turbines (T5 + T6) are more than 500 m from it.

Overall, it is expected that feeding swans will be displaced from suitable grassland and wet bog feeding habitats around five of the turbines and that the Kilmurray quarry ponds may no longer be used as a roost site. It is not known whether, or in what space of time, the swans may habituate to the presence of the turbines and, indeed, Rees (2012) highlighted the need for post-construction studies in this respect.

While the impact of potential displacement from feeding habitat and a roost site is significant for the local swan population, the following points are noted:

1. The Derryarkin area is not a natural or traditional wintering site for swans and it can be assumed that they are only present in this area because of the presence of intensive agricultural land for feeding and man-made quarry ponds for roosting.

2. There is already a significant level of disturbance in these fields due to regular farming and quarrying activities and the swans seem to have no problem resorting to other feeding sites in the wider area when disturbed.

3. Even without allowing for a degree of habituation to the presence of the turbines, there will still be substantial areas of improved grassland available to provide feeding in the immediate area. It is the intention of the local landowners to continue the current farming practices at all grasslands in the vicinity of T2 to T6 (excluding those used as part of the wind farm and those lands required to facilitate continuation of the commercial quarry activity),

and therefore the lands will continue to be agricultural grassland, basically a well-managed, low sward (see mitigation section).

Barrier effect

Rees (2012) cites eight published studies of flight behaviour which reported changes in flightlines for swans or geese initially seen heading towards turbines, at distances ranging from a few hundred metres to 5 km (the larger distances were by birds on migration); 50-100% of individuals/groups avoided entering the area between turbines, but in some cases the sample sizes were small. One of the studies, from the Hellrigg wind farm in the UK (cluster of four 80 m turbines), involved Whooper Swans with an estimated avoidance distance of >200 m. Commenting on studies to assess the barrier effect, Rees writes "*Avoidance of turbines should be related to whether or not flights were initially in line with the wind farm, rather than in relation to all bird movements in the area, as including the latter artificially boosts sample sizes used for calculating avoidance rates*."

As Derryarkin is not within a regular flight line by Whooper Swans, such as a route used by migrating birds or by birds commuting from a roost to a feeding site (or vice versa), it is considered that a potential 'barrier effect' impact is not relevant in this case. It is also noted that the layout for the proposed turbines is not on a linear plan or involves small clusters and that the turbines will be in the region of 500 m apart, which would encourage flying birds to pass between them.

Collisions with turbines

Jenkins et al. (2010) notes that theoretically, relatively large, heavy and socially interactive birds (e.g. swans and geese) are more susceptible to collision than small, light and relatively large-winged birds with acute vision. In a review of impacts of wind farms on swans and geese, Rees (2012) found that 72 swans or geese were reported as collision victims at 46 wind farms, but most (39 birds) were reported at 23 German wind farms where such data are collated, and even there only usually for c. 1 year post-construction. Two of the casualties were Whooper Swans, 25 were Mute Swans and four were unidentified swan species. While the review by Rees demonstrates that collisions do occur, she points out that swans and geese have good eyesight and that the review indicates that high levels of avoidance do occur.

During the short days of the mid-winter period, and especially during cold weather, Whooper Swans attempt to maximise available time spent feeding – this was well demonstrated during the present study when the swans continued to feed in virtual darkness and sometimes their departure from the fields only detected by their calls. For Whooper Swans, Brazil (2003) notes that during their typical very low-altitude flights between roosting and foraging sites they are, particularly in poor light, very much at risk from objects such as telephone and power lines and trees. Collisions are a particularly significant cause of swan mortality, accounting for 33-44% of casualties (Brazil 2003). It is noted, however, that most of the recorded collisions were with power lines or cables which the birds just cannot see. Although swans have a wide field of monocular vision to each side, suitable for detecting disturbance in any direction, they have only a narrow zone of binocular vision to the front and rear, and it appears they are rather poor at detecting thin horizontal objects ahead of them.

At Derryarkin, it is considered that swans feeding in local fields would be highly aware of the presence of the turbines in daylight and during normal weather conditions. Also, local flights within the feeding fields and to or from the night roost sites would normally be at low levels (less than 30 m) and well below the rotor sweep of the turbines (51.5 m distance from ground to blade sweep). Indeed, Larsen and Clausen (2002) found that on the basis of recorded heights of flocks in flight, wind parks with medium-sized turbines posed a greater risk than those with large rotors. From the available evidence, it is concluded that at Derryarkin there is some risk of collision with the turbines mainly when swans are commuting between feeding and roost sites in poor light or perhaps inclement weather. However, the risk is rated as being low because of the typical low altitude of the flight lines compared to the height of the rotor sweep. Mitigation to minimise the risk is suggested by the use of hazard warning lights on turbines 1 to 7 to make them more visible to the swans.

There will be no overhead power lines associated with the turbines and hence no risk of colliding with lines.

Golden Plover (Annex I species)

The winter surveys showed that Golden Plover visit the fields in the Derryarkin and, to a lesser extent, the Derryiron sectors of the site on a regular basis through the

winter and at times in significant numbers (peak of *c.*1,200). The birds use the fields for feeding purposes.

As with the Whooper Swans, construction work during the winter period is likely to cause disturbance to the Golden Plover. This can be easily mitigated by restricting works in this sector of the site to the April to October period inclusive (restrictions at Derryiron are not considered necessary as plover were recorded in these fields on only 3 occasions during the winter and in relatively small numbers).

Loss of potential feeding habitat is not considered a significant issue as the loss is very small in relation to the size of the fields.

While the issue of potential displacement from a zone around turbines has been raised in locations where Golden Plover breed, it seems that displacement has not been identified in the international literature as an issue with wintering birds. It would seem unlikely that flocks of wintering birds would avoid areas with turbines and, indeed, flocks of Golden Plover regularly utilise fields with large pylons carrying electric lines.

Similarly, the issue of collision appears not to have been identified in the literature as an issue for wintering Golden Plover using grassland fields. As Golden Plover are small, light-weight birds with excellent manoeuvrability, it is considered that the risk of collision is negligible or at most low, and unlikely to be significant at the population level.

Hen Harrier (Annex I species)

The winter surveys recorded a single male Hen Harrier foraging close to the proposed T7 location but did not detect the presence of any winter roosts on site or in surrounding areas. Hen Harrier is likely to be an occasional visitor to the wider area and will forage across farmland as well as semi-natural habitats such as cutover bog, wet grassland, scrub and woodland. Most foraging in winter is at low altitudes (invariably less than 20 m) and well below the rotor sweep of the turbines (51.5 m above ground level).

On the basis that Hen Harrier is at most a scarce and occasional winter visitor to the site, and taking into account the typical low height of foraging birds, it is not expected

that the presence of the turbines would have a deterring effect on the movement of Hen Harriers in the area or would pose any significant risk of collision.

Lapwing (Red List species)

The baseline surveys showed that Lapwing (1 pair) attempts to nest on the cutaway bog at Derryiron on an annual basis. However, success is extremely unlikely due to the high degree of disturbance from turbary activities in recent years.

Construction works for T8, T9 and T10 would cause disturbance to prospecting or nesting birds from March through to possibly July (should nesting be successful). Mitigation is required to ensure that the works do not interfere with a nesting attempt.

Black-headed Gull (Red List species)

A Black-headed Gull colony of national importance occurs on an island in the Roadstone quarry lake to the north of the Derryarkin sector of the site. Occasional sightings of Black-headed Gulls were made on the proposed wind farm site, especially at the Kilmurray quarries.

T5 (the nearest turbine) is at an approximate distance of 600 m from the breeding colony and it is possible that disturbance from noise and/or the visual presence of workers etc could be caused to the birds during construction works at this turbine in the period April to July. However, disturbance from construction activities at such a distance is unlikely to be significant, especially as there will be no access by workers or machinery anywhere near the nesting area. Further, there is already substantial background noise from quarry activities, Bord na Móna rail traffic and nearby motorway traffic.

As a group, gulls are not considered to be in the high risk collision category as they normally have a relatively slow, buoyant flight with good manoeuvrability.

Yellowhammer (Red List species)

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). While Yellowhammers will experience some loss of habitat (arable land, hedgerows), the

amount involved is hardly significant in the context of the wider area and is not expected to affect the local Yellowhammer population. The presence of the operational turbines is unlikely to deter Yellowhammers from using the local fields.

Impacts on Amber Listed bird species

Four of the amber listed birds (Little Grebe, Great Crested Grebe, Teal & Tufted Duck) are aquatic species associated with the Kilmurray quarry ponds. Impacts on these species by the proposed development (either during construction or operation) are considered unlikely.

Snipe occurs widely through the site area during winter and is not expected to be affected by the proposed development.

Potential Impacts on Terrestrial Mammals

Otter

The assessment for Otters showed that they occur along the main channel of the Yellow River though may also use tributary streams.

As the development includes a 50 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.

Where crossing points over rivers and streams are required, bridges or open bottom culverts will be used which will not impede the movement of otters.

Badger

Badgers are considered to be widespread in the area. Principal impacts by the proposed development are loss of feeding habitat and possible disturbance to setts.

The loss of relatively small amounts of pasture and arable habitats, which provide feeding habitat for badgers, is not considered a significant impact as such habitats occur abundantly throughout the study area.

While the present surveys did not indicate the presence of badger setts at the turbine locations within fields, further assessment is required at turbines located in woodland and also along sections of the road which need to be upgraded (see mitigation). Any disturbance to a badger sett would require appropriate mitigation.

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.

Potential Impacts on Bats

The most favourable bat habitats on-site are the deciduous woodlands, larger watercourses and their riparian vegetation, scrub areas and tree-lined minor roads, all of which offer shelter for swarming insects on which bats feed. The areas of bog (intact, degraded and recolonising) are windswept, open landscapes that are poor for these animals although sheltered areas of scrub within the bogs may be reached by bats by following drainage channels or nearby hedgerows. The present survey of bat activity within the study area has confirmed the presence of six 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), which travels considerable distances (up to 13.4km has been recorded in Ireland, Shiel *et al.* 1999) between roosts and foraging areas. The species has evolved for fast flight in excess of 40km/h (Dietz *et al.* 2007) 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) but which has been known to reach heights of

500m (Bruderer and Popa-Lisseanu 2005). 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.

Wind turbines are a known risk to bats (for example see Arnett *et al.* 2008 & Baerwald *et al.* 2008, Johnson *et al.* 2003) and the *EUROBATS Secretariat* has recently published guidelines on bats and wind farm projects (Rodrigues *et al.* 2008) to ensure bats are considered as part of development proposals. Currently, these are the only applicable guidelines for bats and wind farms/turbines for Irish wind farm and turbine developments as the Irish Government has yet to produce national guidelines. However, *Bat Conservation Ireland* published wind turbine/wind farm development bat survey guidelines in December 2012 (Version 2.8).

Adjudged likely impact of the proposed development on bats

The planned wind farm development is to be sited within an area of bog and agricultural grasslands currently over-flown by Leisler's bat and whose woodland, scrub, hedgerow, treeline and watercourse habitats are currently in use by at least six bat species. Although there are no published results of a study of bat mortality from Irish wind turbines, considering recent research from mainland Europe and North America, there is an increasing amount of detailed published evidence that wind turbines cause bat fatalities. However, many of these turbine/bat mortality studies are

at wind farms with significantly large numbers of turbines and often 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 here. Also, although it is known that Nathusius' pipistrelle migrates from Scandinavia to Scotland and to the north of Ireland and back again (Russ et al. 2001), apart from this species, there is currently no evidence that internal or external bat migration routes of other bat species exist elsewhere in Ireland. Nevertheless, risks to bats from wind turbines have to be acknowledged and it is possible that some bat mortality may occur due to the planned development. Mitigation measures are therefore recommended to reduce the likelihood of adverse impacts on local bat populations.

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 local frog population.

The Common Lizard is likely to be found on areas of bog throughout the study area. The construction and operation of the wind farm is not expected to have any adverse impacts on the local lizard population as none of the bog areas within the site will be affected.

Potential Impacts on Designated Sites

As no part of the development site is within, or adjoins, a designated area, and as the nearest designated site (Black Castle Bog NHA) is a distance of just over 2 km away, it is concluded with certainty that the proposed development will not have adverse impacts on any Natural Heritage Area or proposed Natural Heritage Area.

Possible impacts on all Natura 2000 sites within a distance of 15 km of the development site are considered in the accompanying Appropriate Assessment Screening report.

Cumulative Impacts with Other Wind Farms

Mount Lucas wind farm is located approximately 10 km south of the proposed Yellow River development. Mount Lucas is currently under construction and comprises 28 turbines with an output of 79.2 MW.

Apart from Mount Lucas, there are no other wind farms in the wider area (next wind farms are Carrig and Skehanagh in Co Tipperary, approximately 65 km to the southwest).

As there is a substantial distance between the development site and Mount Lucas, and considering the generally low terrestrial ecological interests of the area, it is concluded that there would be no significant cumulative impact on terrestrial ecological interests as a result of the proposed development.

5.6 MITIGATION MEASURES

5.6.1 Construction Phase Mitigation

Mitigation by Avoidance

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 the scheme:

- Exclusion of turbines from the strip of intact (but partly drained) raised bog at Derryiron.

- Relocation of T7 to the margin of the bog remnant (away from the central area).

Measures to Maintain Habitat Integrity

The following measures will be taken to ensure that habitat integrity is maintained as far as is feasible.

T11 location

As this turbine is within an area of bog woodland, care is needed to minimise the construction footprint. At the start of construction, the required work area will be marked out and fenced so as to prevent accidental incursions into the adjoining woods. An ecologist will inspect the site in the company of the project engineer.

T7 location

As this turbine in along the margin of a bog remnant, care is needed to minimise the construction footprint. At the start of construction, the required work area will be marked out and fenced so as to prevent accidental incursions into the bog. An ecologist will inspect the site in the company of the project engineer.

Hedgerow and tree removal

Care will be taken to minimise the removal of hedge sections and trees and also to prevent disturbance to root systems.

Hedgerow and tree replacement

The permanent removal of hedgerows and trees (mostly for road construction) will be compensated for by a replanting scheme using similar species (though native species will be used instead of exotics such as sycamore). Suggested species include ash (*Fraxinus excelsior)*, hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), native holly (*Ilex aquifolium*), and oak (*Quercus robur*).

It is proposed that an area of land equivalent to that being lost by hedgerow removal will be added to the total area of land to be acquired for commercial forestry replanting. With an estimated length of 1,360 m of hedgerow removal, and taking an average hedge width of 6 m, it is calculated that 8,160 m^2 will be required to compensate for hedgerow loss.

Compliance with the Wildlife Acts

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.

The above restrictions will apply to the removal of all trees, hedging and areas of woodland or scrub.

Should clearance be required within the closed season, advice will be sought from the National Parks & Wildlife Service.

Measures for breeding Lapwing

Should works be commenced on the cutaway bog at locations for T8, T9 & T10 during the period March to July, a survey for nesting Lapwing will be carried out. Should a breeding territory be found, works will be delayed in an area of up to 500 m from the nest location until the nesting attempt is complete (as determined by further survey).

Measures for Whooper Swans

Seasonal restrictions on construction

Construction of turbines 1 to 7 will be outside of the period November to March (inclusive) so as to avoid disturbance to wintering swans.

Use of warning lights on turbines

Hazard warning lights (similar to aircraft warning lights) will be placed on the hubs of turbines 1 to 7 so as to minimise risk of collision during poor light conditions or inclement weather (fog etc.). These lights will be in use from November to March inclusive. It is recommended that the lights should be programmed to come on for 90 minutes before and after sunset and for 90 minutes before and after sunrise.

Maintenance of grassland for feeding swans

As discussed, it is considered likely that the Whooper Swans will avoid feeding in areas close to the turbines. The avoidance distances may be from 200 m (or even less)

to possibly up to 500 m, though these distances are likely to diminish as the birds become accustomed to the presence of the turbines.

As the fields presently provide optimum feeding for the swans, it is the intention of the local landowners to continue the current farming practices at all grasslands in the vicinity of T2 to T6 (excluding those used as part of the wind farm and those lands required to facilitate continuation of the commercial quarry activity), and therefore the lands will continue to be agricultural grassland, basically a well-managed, low sward, which will provide feeding for Whooper Swans.

Monitoring of swans

The usage of the Derryarkin fields by wintering swans, including the benefits of the mitigation measures outlined above, will be monitoring in the winter prior to construction and then for a period of up to 5 years post construction. Particular attention will be given to the distances feeding swans approach to the turbines. Flight lines to and from the site will be recorded. The population will be monitored in the context of the wider population (similar to the surveys as carried out for the present project). These monitoring reports will be submitted to NPWS on an annual basis.

During the surveys, other wetland birds on site, and particularly Golden Plover, will be recorded.

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 and to provide unhindered access for fish along watercourses, will suffice for the needs of otters.

Measures for Badgers

Badger presence on site was established during the baseline surveys, including the presence of one large sett at Derryarkin farm. However, dense vegetation precluded

search in the bog woodland at the T11 location and in the conifer plantations. Also, the hedgerows to be impacted for road construction were not assessed.

As required under the Wildlife Acts, mitigation is required to ensure that active setts are not disturbed. The following approach is recommended:

Prior to hedge or tree clearance, a survey for presence of badgers will be carried out in the vicinity of the impact locations by an ecologist with experience of badger survey. This will 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 (within the context of the Wildlife Acts). If a sett(s) is found, mitigation may include application to NPWS for a licence to close active setts 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 woodland, the ecologist may be required to be on site to monitor for setts during the actual tree clearance works. Should an active 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 closure of active setts is not permitted during the December to June period).

Measures for Bats

The following specific measures will be followed to protect bats on-site.

Retention of trees

Any trees and treelines along approach roads and planned site access tracks should be retained where possible. Retained trees shall be protected from root damage by machinery by an exclusion zone of at least 7 metres or equivalent to canopy height.

Such protected trees shall be fenced off by adequate temporary fencing prior to other works commencing.

Removal of trees

Trees may be impacted due to construction and upgrading of roads to accommodate the project. Mature deciduous trees, which are to be removed, shall first be inspected for potential bat roosts. Trees shall ideally be felled in the period late August to late October, or early November, in order to avoid disturbance of any roosting bats as per *National Roads Authority* guidelines (NRA 2006a and 2006b). Tree felling shall be completed by mid-November at the latest as bats roosting in trees are very vulnerable to disturbance during their hibernation period (November – April). Trees with ivy (*Hedera helix)* cover, once felled, shall be left intact on-site for 24 hours prior to disposal to allow any bats beneath the foliage to escape overnight.

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.

Bridges

Any local bridge proposed for strengthening works prior to use for haulage of construction materials for this development, shall 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 within a bridge then some crevices beneath it shall be retained for their continued use according to best practice bat mitigation measures for bridge works (see *Billington and Norman 1997, Highways Agency 2001, Joint Nature Conservation Committee 2004, National Roads Authority 2006a/2006b* and *Shiel 1999*). Any re-pointing or pressure grouting of bridges shall only proceed after an inspection of the structure for bats and, should bats be found, an application for a derogation licence to legally allow works on or near a bat roost shall be made to the *National Parks and Wildlife Service*.

Vegetation-free buffer zone

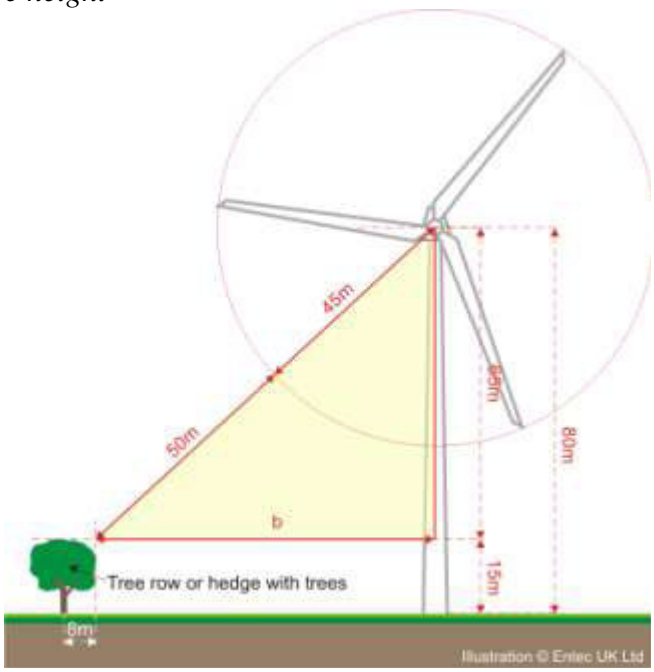
Bats commuting and foraging along on-site linear features such as hedgerows, treelines and woodland edge boundaries shall be safeguarded by providing a 50 m *minimum* buffer zone between the rotors of planned turbines and the nearest vegetation to reduce the risk of collision and/or barotrauma.

Note that this 50 m buffer distance should be measured from the vegetation to *the tip of the rotor blades,* **not** *to the base of the turbine*. The following is noted (from Carlin and Mitchell-Jones 2012): *It is incorrect to measure 50m from the turbine base to habitat feature at ground level as this would bring the blade tips very close to the canopy of a tall hedgerow tree and potentially put bat populations at risk. Instead, it is necessary to calculate the distance between the edge of the feature and the centre of the tower (b) using the formula:*

$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$

where, (in metres):

bl = blade length
hh = hub height
fh = feature height



For the example above, b = 69.3m

This is in line with current UK (Carlin and Mitchell-Jones 2012) 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. It should be noted, however, that the EUROBATS guidelines for wind development projects specify that this vegetation-free buffer zone should be a minimum of *200m*. Buffer zones can be provided by either siting a turbine so that its rotors are a minimum of 50 m away from existing vegetation or, if this is not possible, by felling any tree within 50 m of rotors (but any such tree loss should be offset by compensatory planting elsewhere). Such cleared vegetation should be managed and maintained during the operational life of the development.

The proposed locations of turbines 13 and 14 at Coolville are immediately adjacent to the most favourable bat habitat on-site therefore these two turbines especially should be sited as far away as possible (50 m upwards) from the nearest treelines/woodland. Likewise, Turbine 11, at Derryiron, which is proposed to be sited in bog woodland should be positioned as close to the woodland edge as practicable and a 50 m vegetation-free buffer zone should be cleared and maintained around it.

5.7 CONCLUSION

The proposed development site has relatively low ecological interests, with the presence of wintering Whooper Swans and Golden Plover, Otters and various bat species considered the most important features of the area.

It is considered that the careful planning and design of the wind farm layout, along with appropriate mitigation as required, will minimise ecological impacts and all species of conservation importance will continue to have a presence in the area after the works are complete. In particular, it can be objectively shown that none of the designated sites within the wider area of the site will be affected in any way.

It is concluded that the proposed project will not result in any residual significant impacts on the terrestrial ecology of the area.

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5.9 AQUATIC ECOLOGY - INTRODUCTION

5.9.1 Background

Biosphere Environmental Services has commissioned Conservation Services - Ecological & Environmental Consultants to carry out a freshwater ecological assessment for the proposed wind farm at Rhode, County Offaly.

The aims of the assessment are:

- To assess the present fishery value, invertebrate fauna, aquatic flora, water quality, habitat value and general ecological condition of streams and rivers in the vicinity of the proposed development and provide baseline data against which any future changes can be assessed
- To assess the general status of the streams from an ecological and fisheries perspective in the context of their wider catchment based on survey data, published sources, EPA data, and on consultation with Inland Fisheries Ireland, NPWS and Marine Institute
- To assess the potential impact of the proposed development on water quality and aquatic flora and fauna
- To recommend mitigation measures where potential negative impacts are predicted

Assessment of potential impact on aquatic mammals, amphibians and birds is included in the terrestrial ecology report.

5.9.2 Relevant Legislation

The main legal constraints on the proposed development in relation to aquatic flora, fauna, habitats and fisheries are:

The Local Government (Water Pollution) Act, 1977 (and associated regulations)	Prohibits the entry of unlicensed polluting matter into waters
European Communities Environmental Objectives (Surface Waters) Regulations 2009	The Regulations give legal status to the criteria and standards to be used for classifying surface waters in accordance with the ecological objectives approach of the Water Framework Directive. The classification

	of the Water Framework Directive. The classification of waters is a key step in the river basin management planning process and is central to the setting of objectives and the development of programmes of measures. Waters classified as 'high' or 'good' must not be allowed deteriorate. Waters classified as less than good must be restored to at least good status within a prescribed timeframe. The environmental targets or goals and the programmes of measures to be included in river basin management plans must therefore reflect these requirements.
The Fisheries (Consolidation) Act, 1959 as amended by the Fisheries (Amendment) Act, 1962	Prohibits: 1. The entry of deleterious matter into waters. (Deleterious matter is defined as any substance that is liable to injure fish, their spawning grounds or their food, or to injure fish in their value as human food.) 2. Obstructing the passage of salmon, trout or eels or their smolts and fry 3. Injury or disturbance of the spawn or fry of salmon, trout or eels or to their spawning or nursery areas
Fisheries (Amendment) Act 1999	Requires the regional fisheries board to have regard for the need for the conservation of fish and other species of fauna & flora habitat and biodiversity of inland fisheries and ecosystems. Under this Act the Regional Fisheries Board has the responsibility to protect and conserve all freshwater fisheries within its area of jurisdiction. It is the stated policy of the Regional Fisheries Boards that "*every river, stream, canal, lake, pond and reservoir must be regarded as constituting and/or supporting a Fishery under the meaning of the Fisheries Acts unless otherwise regarded by the Boards*."
The Freshwater Fish Directive 78/659/EEC as transposed into Irish law under E.C. (Quality of Salmonid Waters) Regulations 1988 (S.I. No. 293 of 1988)	Lays down standards for the quality of designated waters and requirements for monitoring.
The Wildlife Act 1976	Prohibits damage to protected species which includes certain freshwater aquatic species.
The Habitats Directive (92/43/EEC) as transposed into Irish law under the E.C. (Natural Habitats Regulations 1997 (S.I. No. 94 of 1997)	Lists certain species (Annex II) and habitats (Annex I) which require to be protected within SACs. Annex II species include crayfish, salmon, and all three Irish species of Lamprey.
Water Framework Directive (2000/60/EC)	The Water Framework Directive requires the achievement of at least good ecological status and the maintenance of existing status in all surface waters, which in the Irish context is generally taken

	to mean achieving salmonid water quality standards regardless of whether the watercourse is designated under the Salmonid Regulations.
Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage	The Environmental Liability Directive specifies that Member States should, inter alia, establish a civil liability regime whereby operators of specified activities which cause environmental damage are financially liable for remedying this damage. The Directive also aims to hold those responsible for certain activities which have caused an imminent threat of environmental damage liable for taking preventive actions.

Table 5.10 Relevant legislation

5.10 METHODOLOGY

5.10.1 Selection Of Waterbodies And Sites For Assessment

All watercourses were assessed which are marked on the EPA mapping of streams (http://maps.epa.ie/internetmapviewer/mapviewer.aspx) and which are within 1km down gradient from any part of the proposed wind farm site where works will be carried out. As EPA mapped streams commonly includes streams/drains which are too small to be useful salmonid habitat, and as general guidelines are presented for procedures at any watercourse crossing, the survey is adequate to ensure that all measures necessary to prevent significant impacts are identified. Potentially affected watercourses are shown on Figure 5.7.

5.10.2 Habitat Assessment

Habitat assessment was carried out between 25th and 29th of October 2012 and on 13 May 2013.

Stream habitat assessment was carried out on c.23km of stream/river habitat i.e. adjacent to and for at least 1km downstream of all elements of the proposed development which could potentially impact on watercourses. Each watercourse section assessed was examined by boat or by walking and/or wading the channel.

Each section was assessed in terms of:

1. Stream width and depth
2. Substrate type

3. Flow type

4. Dominant bank-side vegetation

5. In-stream vegetation

6. Estimated degree of shade

Salmonid, lamprey and crayfish habitat quality was assessed, taking into account the environmental features 1-6 listed above. Based on these observations and more detailed criteria outlined in Sections 5.2.3 – 5.2.5 below, the value of each river section for the different life stages of salmonids and lamprey and Crayfish was estimated. Locations for identification of habitat assessment locations were recorded as Irish Grid References using a GPS. Photographs were taken to illustrate the habitat quality in each section.

5.10.3 Assessment of Salmonid Habitat Quality

Habitat quality for in-stream invertebrate and plant communities, and for fish, and riparian birds and mammals, is primarily a function of 'naturalness' and diversity. The more diverse the stream habitat in terms of substrate, flow rate, depth, riparian vegetation, light conditions etc., the richer the biological community is likely to be, and the more suitable it is likely to be for salmonid fish (trout and salmon).

Assessment of the quality of salmonid spawning habitat, nursery habitat and adult habitat is based on personal expertise developed over a period of 16 years of electrofishing and on published information such as the following:

1. Favourable locations for salmon spawning are likely to occur where the gradient of a river is 3% or less (Mills 1989).

2. Preferred current velocity for spawning is within the range 25–90 cm s^{-1}, with a water depth in the range 17–76 cm (Hendry & Cragg-Hine 1997).

3. Typical spawning sites are the transitional areas between pool and riffle where flow is accelerating and depth decreasing, where gravel of suitable coarseness is present and interstices are kept clean by up-welling flow (Peterson 1978, Bjorn & Reiser 1991).

4. Salmon fry and parr occupy shallow, fast-flowing water with a moderately coarse substrate with cover (Symons & Heland 1978, Baglinière & Champigneulle 1986).

5. Deep or slow-moving water, particularly when associated with a sand or silt substrate, does not support resident juvenile salmonids (Wankowski & Thorpe 1979, Baglinière & Champigneulle 1986).

6. Suitable cover for juveniles includes areas of deep water, surface turbulence, loose substrate, large rocks and other submerged obstructions, undercut banks, overhanging vegetation, woody debris lodged in the channel, and aquatic vegetation (Heggenes 1990; Bjorn & Reiser 1991; Haury *et al*. 1995).

7. The juxtaposition of habitat types is also important. The proximity of juvenile habitat to spawning gravels may be significant to their utilisation. In addition, adults require holding pools immediately downstream of spawning gravels in which they can congregate prior to spawning. Cover for adult salmon waiting to migrate or spawn can be provided by overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water and surface turbulence (Bjorn & Reiser 1991).

8. Bjorn & Reiser (1991) suggest that proximity of cover to spawning areas may be a factor in the selection of spawning sites by some salmonid species.

5.10.4 Assessment of Lamprey Habitat Quality

Lamprey habitat preferences change with the stages of their life cycle. They show a preference for gravel-dominated substratum for spawning. After hatching the larvae swim or are washed downstream by the current to areas of sandy silt in still or slow flowing water where they burrow and spend the next few years in tunnels. Lampreys therefore require mainly silt and sand dominated substratum for nursery habitat. Other important environmental characteristics for optimal ammocoete habitat are shallow waters with low water velocity, and the presence of organic detritus and/or plant material. Sub-optimal habitat supporting only a few individuals may consist of a few square centimetres of suitable silt in an open, comparatively high-velocity, boulder-strewn streambed. Spate rivers, with high flow velocities, tend to support fewer ammocoetes because they contain smaller areas of stable sediment (Maitland 2003).

5.10.5 Assessment of Crayfish Habitat Quality

White-clawed crayfish are typically found in watercourses of 0.75 m to 1.25 m deep, but the species may occur in very shallow streams (about 5 cm of water) and in deeper, slow-flowing rivers (2.5 m). The white-clawed crayfish typically occupies cryptic habitats under rocks and submerged logs, among tree roots, algae and macrophytes, although it usually emerges to forage for food. Juveniles in particular may also be found among cobbles and detritus such as leaf litter. Adults may burrow into suitable substrates, particularly in the winter months. In habitats with flowing water the white-clawed crayfish may be found associated with:

1. Undermined, overhanging banks.
2. Sections exhibiting heterogeneous flow patterns with refuges.
3. Under cobbles (juveniles) and rocks in riffles, and under larger rocks in pools.
4. Among roots of woody vegetation, accumulations of fallen leaves and boulder weirs.
5. Under water-saturated logs. (Holdich 2003)
6. Peay (2000) lists the following habitat features as favoured by crayfish:
7. Slow-flowing glides and pools (provided there are refuges), localised velocity of 0.1m/s or less
8. Loose boulders (>25cm) or other similarly sized material
9. Boulders or large cobbles in groups with crevices between them
10. Deep crevices in bedrock
11. Underlying substrate of fine gravel/sand with some pebbles
12. Submerged refuges in stable banks (e.g. natural crevices, stone block reinforcement or stable, slightly undercut banks with overhanging vegetation, large tree roots, etc).
13. Un-mortared stone revetting which protects banks from erosion

14. Stands of submerged and emergent aquatic plants.

5.10.6 Biological Water Quality Assessment

Stream Invertebrate Sampling

The following sampling sites were established for biological water quality assessment (see Figure 5.8).

Sampling Site No.	Grid Reference
A	N 52261 39968
B	N 55371 40800
C	N 51880 35966
D	N 54977 37829
E	N 58130 38620
F	N 55254 38239

A five-minute kick and stone wash sample was taken at each of the water quality assessment sites (ISO 7828:1985). Each sample was retained in a large plastic bag at the sampling site. Sample processing and preservation was carried out under laboratory conditions within 24 hours of sampling. Mud was removed from each sample by sieving under running water through a 500µ sieve. Sieved samples were then live sorted for 30 minutes in a white plastic sorting tray under a bench lamp (ISO 5667-3:1994) and if necessary using a magnifying lens. Macroinvertebrates were stored in 70% alcohol. Preserved invertebrates were identified to the level required for the EPA Q-rating method (Clabby *et al,* 2006) using high-power and low-power binocular microscopes when necessary. The preserved samples were archived for future examination or verification. Based on the relative abundance of indicator species, a biotic index (Q-rating) was determined for each site in accordance with the biological assessment procedure used by the Environmental Protection Agency (Clabby *et al* 2006) and more detailed unpublished methodology (McGarrigle, Clabby and Lucey pers. comm.)

Biotic Index	Water Framework Directive Ecological Status	Quality Status	Condition*
Q5	High	Unpolluted Waters	Satisfactory
Q4-5	High		Satisfactory
Q4	Good		Satisfactory
Q3-4	Moderate	Slightly Polluted Waters	Unsatisfactory
Q3	Poor	Moderately Polluted Waters	Unsatisfactory
Q2-3	Poor		Unsatisfactory
Q2	Bad	Seriously Polluted Waters	Unsatisfactory
Q1-2	Bad		Unsatisfactory
Q1	Bad		Unsatisfactory

*"Condition" refers to the likelihood of interference with beneficial or potential beneficial uses

Table 5.11 Biological Assessment biotic index (Q-rating)

Sampling for water quality assessment was carried out 25th – 27th October 2012 except for Site F which as sampled on 13th May 2013.

5.10.7 Significance Of Potential Impacts

Impacts are defined on the basis of severity of impact on aquatic species and/or habitats. Species protected under national and European legislation are given special consideration. Because of their amenity, commercial and legal status, salmonid fish (trout and salmon) are given special consideration. Assessment of the importance of a potential impact takes into account not only the ecological considerations in the immediate vicinity of the potential impact, but also geographical and wider catchment considerations. If spawning and nursery habitat of a species are limiting factors in short supply in a particular river system, then impacts on them will have an importance out of proportion with their apparent 'face value'.

If an aspect of a proposed development is judged likely to have a measurable negative effect on salmonid fish populations or any rare or protected species, it would be classified as a significant potential impact. The criteria for assessing the significance

of impacts on flora, fauna and fisheries are as follows. (For details of water-body categories see section 5.2.8.)

A Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	SEVERE	SEVERE	SEVERE
Localised	MAJOR	MAJOR	SEVERE	SEVERE

B Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	MAJOR	SEVERE	SEVERE
Localised	MODERATE	MODERATE	MAJOR	MAJOR

C Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MODERATE	MODERATE	MAJOR	MAJOR
Localised	MINOR	MODERATE	MODERATE	MODERATE

D Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MINOR	MINOR	MODERATE	MODERATE
Localised	NOT SIGNIFICANT	MINOR	MINOR	MINOR

E Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	NOT SIGNIFICANT	NOT SIGNIFICANT	MINOR	MINOR
Localised	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT

Table 5.12 The criteria for assessing the significance of impacts on flora, fauna and fisheries, NRA (2006)

In line with the EPA guidelines (EPA 2002) the following terms are defined when quantifying duration:

- Temporary: Up to 1 year
- Short-term: From 1 to 7 years
- Medium-term: 7 to 15 years

- Long-term: 15 – 60 years
- Permanent: over 60 years

For the purposes of this report 'localised' impacts on rivers are loosely defined as impacts measurable no more than 250 metres from the impact source. 'Extensive' impacts on rivers are defined as impacts measurable more than 250m from the impact source. Any impact on salmonid spawning habitat or nursery habitat where it is in short supply, would be regarded as an extensive impact as it is likely to have an impact on the salmonid population beyond the immediate vicinity of the impact source.

5.10.8 Classification Of Importance Of Freshwaters

Rating

A **Internationally Important**

Habitats designated as SACs for Annex II species under the EU Habitats Directive. Major Salmon river fisheries. Major salmonid lake fisheries.

B **Nationally or Regionally Important**

Other major salmonid waters and waters with major amenity fishery value. Commercially important coarse fisheries. Waters with important populations of species protected under the Wildlife Act and/or important populations of Annex II species under the EU

C **High Value, locally important**

Small water bodies with known salmonid populations or with good potential salmonid habitat, or any population of species protected under the Wildlife Act and/or listed Annex II species under the EU Habitats Directive. Large water bodies with some fisheries value.

D **Moderate value, locally important**

Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any stream with an unpolluted Q-value rating.

E **Low value**

Water bodies with no current fisheries value and no significant potential fisheries value. Habitat diversity low and degraded.

NRA (2006)

5.10.9 Limitations Encountered

It was intended to carry out an electrofishing survey as part of the present EIS and a Section 14 permit was obtained to electrofish the potentially affected sections of the Yellow River and Mongagh/Castlejordan River. It was however found that the potentially affected main channels of the Yellow River and Mongagh/Castlejordan River (arterially drained channels) are too deep for the backpack electrofishing method. Inland Fisheries Ireland were consulted in this regard and responded: "*IFI have no requirement for electrofishing as we will assume that In the absence of electrofishing the precautionary principle would be applied and mitigation measures put in place on the assumption that salmonid fish are present.*" (N. McGloin e-mail of 17/5/13).

5.10.10 Characteristics of the Development

The proposed development will include the following key elements, any/all of which could cause negative impacts on the aquatic environment in the absence of adequate mitigation:

- Total site area 1,002.234 ha
- Development footprint 20.58 ha
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands, including turning area, set down area & ancillary crane area Total Area 1,997m^2
- Temporary construction compound, approximately 50 m x 30 m.
- Clear fell of forestry area 1.5 ha per turbine (five turbines T1; T25; T26 and T27 = 6 ha) + T2 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor)
- T11 clear felling 1.5 ha of scrub
- Construction of approximately 18,275 m of new access tracks having a minimum finished width of 5 m with passing bays.
- Upgrading of approximately 5,916 m of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.

- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of an Substation Control Buildings and Compound on site area 1,850 m^2
- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings 9
- Upgrade of existing bridges 1

5.11 RECEIVING ENVIRONMENT

5.11.1 General Catchment Information

The site of the proposed Yellow River wind farm is located entirely within the south western section of the catchment of the Boyne River, one of Ireland's largest river catchments, draining an area of about 2,500km² in the central and eastern part of Ireland. The potentially affected watercourses are the Mongagh/Castlejordan River and its tributary the Yellow River (See Figure 5.7). The Mongagh/Castlejordan River rises near Tyrrellspass and Rochfortbridge and it flows for 19 km through Co. Westmeath in an easterly direction before joining with the Yellow River just upstream of Clongall Bridge, near Castlejordan. The Yellow River rises north of Daingean Co. Offaly and flows in an easterly direction for approximately 13 miles before entering the Boyne 3 miles above Ballyboggan Bridge. The area of the proposed wind farm in the Yellow River catchment is c. 5km upstream of the River Boyne confluence. The area of the proposed wind farm which drains directly to the Castlejordan River is c. 9km upstream of the River Boyne confluence. The confluence with the River Boyne is c.14km upstream of the section of the River Boyne designated as a Special Area of Conservation.

Fishery Value

The River Boyne is a designated salmonid water under the European Communities (Quality of Salmonid Waters) Regulations of 1988 (S.I. No. 293, 1988). The Boyne

system is listed as a salmon, grilse and brown trout fishery by Whelan (1989). O'Reilly (2002) states: "(The Boyne) *is one of the country's premier game fisheries and both the Boyne and its tributaries offer a wide range of fishing for spring salmon and grilse; sea-trout and brown trout .... The prime salmon angling water is now found between Navan and Drogheda and on a stretch of the Kells Blackwater immediately upstream of Navan. .... Nowadays, the river gets very few of big three-sea-winter fish from 20 to 30 lb. These fish generally arrive early in February and March. Smaller spring fish, averaging about 10 lb., arrive in April and early May. Water permitting, the grilse come into the river in July. The river gets a further run of fish in late August and September and this run would appear to last long after the season closes. ..... The river usually gets an excellent run of sea-trout. … The fishing extends up as far as Slane bridge. Sea-trout have been found as far as Navan and even Trim, but not in sufficient quantities to warrant fishing specifically for them. ..... The River Boyne and its tributaries hold superb stocks of wild brown trout. There is probably more trout fishing now on the main river than before drainage schemes were implemented, but some sections of good fishing were lost on the tributaries. Some rehabilitation works have been carried out.*"

O'Grady (1991) states that "*The salmonid populations use this (the Boyne/Blackwater) catchment as a single integrated system. …Spawning sites for salmon and trout are confined almost exclusively to the tributary catchments - there are very limited gravel deposits in the main channel. The tributaries function as nursery areas for the two salmonid species and the larger of these channels also support substantial populations of resident brown trout.*"

O'Grady (1998) states that "*There is a sea trout population in the Boyne. Returning adults are caught by anglers in significant numbers in the lower reaches of the main channel downstream of Navan.*"

Inland Fisheries Ireland states: "*The Yellow River has good stocks of Brown Trout. With regard to the Castlejordan or Mongagh River, … as well as having stocks of Brown Trout, its Rochfortbridge tributary contain good stocks of Salmon*". (e-mail 1/8/12 from Noel McGloin Inland Fisheries Ireland). The Rochfortbridge Stream was also identified as a salmon spawning area in Mott McDonald Pettit (2009) which states: "*Following consultation with the Eastern Regional Fisheries Board (ERFB), it was confirmed that the Rochfortbridge Stream, which joins the Mongagh River …, has salmonid spawning potential and adult salmon and salmon redds have been*

observed in the Rochfortbridge Stream." The Rochfortbridge Stream joins the Mongagh River about 2.5km upstream of the proposed Yellow River wind farm site. Whereas the proposed Yellow River wind farm could not directly impact on this stream, salmon must annually run up the Mongagh river adjacent to the proposed wind farm site to access the stream.

A recent study of trout genetics in the Boyne catchment has found that: "*The Mongagh (River) and Kinnegad (River) stocks are ..very different genetically in nature to the populations in tributaries in the middle reaches of the catchment. …Three tributaries in the upper catchment (Mongagh, Kinnegad and Deel) make no contribution the mixed stock in the main stem angling zone*."

(www.fisheriesireland.ie/EREP/brown-trout-genetics-in-the-boyne-catchment.html)

Water Quality

EPA biological water quality monitoring data 1971 – 2012 for the Yellow River, Castlejordan/Mongagh River and the main channel of the River Boyne are presented in **Appendix J**.

After the most recent published round of monitoring of the Yellow (Castlejordan) river (2012) EPA concluded: "*Assessment: The Yellow (Castlejordan) River was in a satisfactory ecological condition in the upper (0070) and lower reaches (0300) in September 2012, however the dominance of pollution tolerant macroinvertebrate species indicated continuing unsatisfactory ecological conditions at Garr Bridge (0100)* ."

After the most recent published round of monitoring of the Castlejordan River (2012) EPA concluded: "*The complete lack of sensitive macroinvertebrate fauna, dominance of pollution tolerant species, abundant instream macrophyte growth and excessive siltation indicated unsatisfactory poor ecological conditions in the upper reaches (0040) of the Castlejordan river in September 2012. The dominance of pollution tolerant macroinvertebrate species and abundant macrophyte growth continues to indicate moderate ecological conditions at Baltinoran Bridge (0100). Good ecological conditions persist in the lower reaches (0190) however calcification and compaction of the substratum was noted".*

Ecological Importance

The River Boyne is part of the River Boyne and River Blackwater Special Area of Conservation (SAC No. 2299 see site synopsis in **Appendix J**). The Conservation Objective of the SAC is: "*To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected: Lampetra fluviatilis (River Lamprey), Salmo salar (Salmon), Lutra lutra (Otter), Alkaline fens, Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicionalbae)*" (www.npws.ie)

Salmon

The River Boyne and River Blackwater SAC site synopsis states that "*Atlantic Salmon (Salmo salar) use the tributaries and headwaters as spawning grounds. … Atlantic Salmon run the Boyne almost every month of the year. The Boyne is most important as it represents an eastern river which holds large three-sea-winter fish from 20 –30 lb. These fish generally arrive in February with smaller spring fish (10 lb) arriving in April/May. The grilse come in July, water permitting. The river gets a further run of fish in late August and this run would appear to last well after the fishing season."*

Lamprey

A survey of Lamprey in the Boyne system (O'Connor 2006) found that "*significant populations of river/brook lampreys occur throughout the River Boyne catchment. It is likely that populations in the lower reaches of the river include Lampetra fluviatilis populations while Lampetra planeri is likely to be the dominant species in more up-river areas. Sea lampreys were not confirmed during the current survey*." Regarding the Yellow River/ Mongagh River part of the Boyne catchment, O'Connor (2006) states: "*River/brook lamprey (probably Lampetra planeri) were confirmed from this catchment. Lampreys are present at an overall favourable conservation status level*." Whereas *Lampetra planeri* (Brook Lamprey) are listed in Annex II of the Habitats Directive, the species is not a qualifying interest the River Boyne and River

Blackwater SAC which is located c.20km downstream of the proposed wind farm development.

Crayfish

Crayfish (*Austropotamobius pallipes*) were previously widespread in the Boyne system; however Demers & Reynolds (2002) stated that: "*no crayfish were found in most of the catchment. They were only present in the Kells Blackwater subcatchment. This may be due to an earlier outbreak of the fungal plague caused by Aphanomyces astaci*." Demers & Reynolds (2002) also indicated that whereas crayfish were found in the Castlejordan/ Mongagh River in 1977-1986, none were found in 2000. The re-establishment of the crayfish in the Mongagh/Yellow rivers catchment is indicated by Reynolds (2007) who reported them in the Castlejordan, and is also indicated in current records for the species in both the Castlejordan/Mongagh River and in the Yellow River downstream of the confluence with the Castlejordan (www.biodiversityireland.ie). Crayfish are protected under the Wildlife Act and are listed in Annex II of the Habitats Directive; however they are not a qualifying interest in the River Boyne and River Blackwater SAC which is located c.20km downstream of the proposed wind farm development.

On the basis of its designation as a SAC and on the basis of its status as a major salmon fishery, the Boyne system as a whole is classified as of international importance.

5.11.2 Potentially Affected Waters

HABITAT ASSESSMENT

Location of habitat sections and habitat ratings for each section are presented in Figures 9-20.

Yellow River Main Channel

Section Y1 – Yellow River Main Channel

Location	N49398 26291 to N49650 36450
Length	c.400m
Description	Stream 3-5m wide and 20-50 cm deep. Straight channel consisting mostly of fast glide with short sections of riffle over substrates of slightly compacted gravel, sand and mud. Bankside vegetation consists of Reed Canary Grass, Gorse and grasses.

Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Fair
Salmonid Nursery Habitat	Fair - Good	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	Fair - Good	Lamprey Spawning Habitat	Fair - Good

Riffle and glide flow over gravel & sand

Straight channel with marginal Phalaris

Section Y2 – Yellow River Main Channel

Location	N49650 36450 to 51701 35970		
Length	c.2km		
Description	Uniform canalised channel with steep sides and variable bankside cover with willow, *Phalaris* and gorse. Heavy shade by hawthorn and willow towards downstream end of section. Moderately dense in-stream *Potamogeton* in places. Flow mostly uniform glide.		
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Poor - Fair	Lamprey Nursery Habitat	Fair (tentative rating)
Salmonid Spawning Habitat	Poor - Fair	Lamprey Spawning Habitat	Poor - Fair

Slow uniform glide

Section with moderately dense *Potamogeton*

Uniform glide
Dense bankside cover of *Phalaris*

River bank poached by cattle
Heavier bankside cover of hawthorn and willow at downstream end of section

Section Y3 – Yellow River Main Channel

Location	N51701 35970 to N51950 35960		
Length	c.200m		
Description	River c.8m wide with depths of 20-40 cm. Flow consisting of fast run and riffle. Substrate predominated by sand and mud with some cobble and gravel. Shade by bankside hawthorn and willow (c.65%).		
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Fair	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	Poor - Fair	Lamprey Spawning Habitat	Poor - Fair

Fast run and riffle

Section Y4 – Yellow River Main Channel

Location	N51950 35960 to N52783 36212		
Length	c.1km		
Description	Uniform straight channel, mostly deep glide with a few sections of run/riffle. Moderate cover by bankside hawthorn, and gorse. Much of substrate not visible; where visible consists of sand and mud with some cobble and gravel.		
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Fair	Lamprey Nursery Habitat	Poor
Salmonid Spawning Habitat	Fair	Lamprey Spawning Habitat	Fair

Deep glide

Riffle & run

Section Y5 – Yellow River Main Channel

Location	N54726 37701 to N58171 38646			
Length	c.4km			
Description	Mostly uniform glide (width c. 15m) with a few sections of more rapid run. Canalised river with high steep banks. Scattered bankside willow. Marginal *Phalaris* well developed. Deeper substrates poorly visible, shallower substrates consist of muddy sand and gravel with limited cobble.			
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat		Fair
Salmonid Nursery Habitat	Poor - Fair	Lamprey Habitat	Nursery	Fair (estimated)
Salmonid Habitat	**Spawning** Poor - Fair	Lamprey Habitat	Spawning	Poor - Fair

Scattered bankside willows

Steep sided canalised river

Slow uniform glide

Short section of more rapid run flow

Yellow River Tributaries

Section YT1 – Derryiron Stream West (Yellow River Tributary)

Location	N50756 36065 to N50858 36306			
Length	c.300m			
Description	Bog drain			
Salmonid Adult Habitat	None	Crayfish Habitat		None - Poor
Salmonid Nursery Habitat	None	Lamprey Habitat	Nursery	None - Poor
Salmonid Habitat	**Spawning** None	Lamprey Habitat	Spawning	None


Shallow drain with dense vegetation


Deeper ponded drain

Section YT2 – Derryiron Stream East (Yellow River Tributary)

Location	N51146 35820 to N51737 35733		
Length	c.1km		
Description	Steep sided bog drain mostly with imperceptible flow. Substrate of peat with very small occurrence of gravel on peat. Width 1.5 to 3m.		
Salmonid Adult Habitat	None	Crayfish Habitat	None
Salmonid Nursery Habitat	None - Poor	Lamprey Nursery Habitat	None - Poor
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	None - Poor


Slow flowing bog drain


Limited area of gravel on peat


Uniform slow flowing drain

Section YT3 – Derryiron Stream East (Yellow River Tributary)

Location	N51737 35733 to N51831 35954		
Length	c.250m		
Description	Straight channel 6-8m wide consisting of glide over silty peaty sand. Dense in-stream *Rorripa* and *Apium*. Moderate bankside shade of birch, willow and hawthorn.		
Salmonid Adult Habitat	Fair	Crayfish Habitat	Poor

Salmonid Nursery Habitat	Poor – Fair	Lamprey Nursery Habitat	Poor
Salmonid Spawning Habitat	Poor - Fair	Lamprey Spawning Habitat	Poor - Fair


Dense in-stream growth of Apium & Rorippa


Glide over silty, peaty sand.

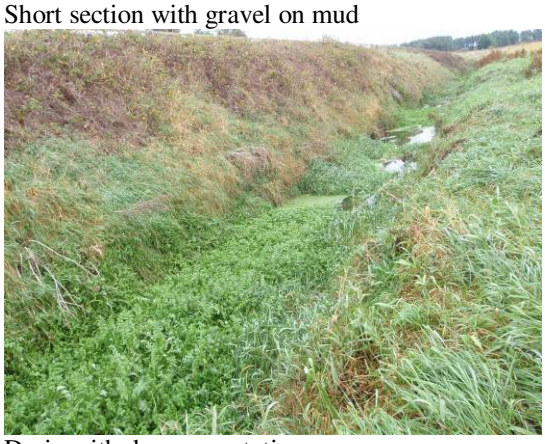
Section YT4 – Coolcor Stream (Yellow River Tributary)

Location	N52691 34570 to N52089 34705
Length	c.1km
Description	Short section of muddy glide with very limited muddy gravel at upstream end of section. Mostly steep sided drain with deep mud and dense growths of aquatic plants. Very slow flow.

Salmonid Adult Habitat Potential	None	Crayfish Habitat Potential	Fair
Salmonid Nursery Habitat Potential	None	Lamprey Nursery Habitat Potential	Fair
Salmonid Spawning Habitat Potential	None	Lamprey Spawning Habitat Potential	None


Short section with gravel on mud


Muddy drain


Drain with dense vegetation


Drain with dense vegetation

Section YT5 – Coolcor Stream (Yellow River Tributary)

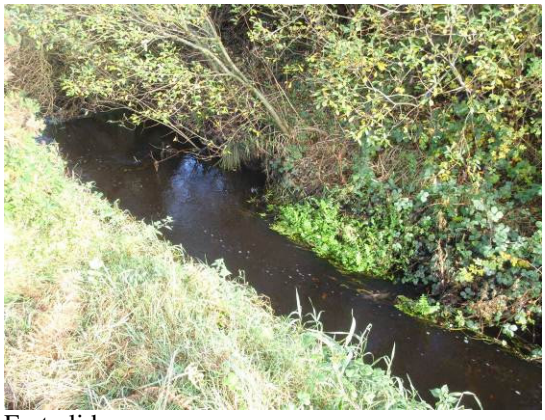
Location	N52089 34705 to N52270 35250		
Length	c.700m		
Description	Canalised muddy glide c.8m wide. Instream vegetation (*Rorippa*, *Apium* and *Sparganium erectum*) well developed in parts.		
Salmonid Adult Habitat	Fair	Crayfish Habitat	Poor - Fair
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	Fair
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Glide with well-developed in stream vegetation

Slow uniform glide

Section YT6 - Coolcor Stream (Yellow River Tributary)

Location	N52270 35250 to N52355 35507		
Length	c.300m		
Description	Rapid glide on muddy substrate. Moderate bankside shade of willow and gorse		
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Poor	Lamprey Nursery Habitat	Poor - Fair
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	None - Poor



Fast glide

Section YT7 - Srah Stream (Yellow River Tributary)

Location	N54076 35512 to N54191 36027		
Length	c.500m		
Description	Muddy drain heavily shaded by birch and willow.		
Salmonid Adult Habitat	None	Crayfish Habitat	None - Poor
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Muddy drain

Section YT8 - Srah Stream (Yellow River Tributary)

Location	N54191 36027 to N54326 36636
Length	c.650m
Description	Stream 1 – 2m wide consisting mostly of muddy sandy glide with a few short poor riffles. Heavily shaded by hawthorn, birch and ash.

Salmonid Adult Habitat	None - Poor	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Poor	Lamprey Nursery Habitat	Poor
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	None - Poor


Short section of poor riffle


Muddy glide with dense instream vegetation

Section YT9 - Srah Stream (Yellow River Tributary)

Location	N54326 36636 to N64014 37089
Length	c.500m
Description	Muddy sandy glide c.2m wide with very little muddy riffle on cobble. Heavy shade by willow, birch, hazel, hawthorn & blackthorn. Dense in-stream *Apium* in less shaded sections.

Salmonid Adult Habitat	None - Poor	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Poor - Fair	Lamprey Nursery Habitat	Fair - Good
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	Poor


Muddy sandy glide


Short section of muddy riffle on cobble

Section YT10 - Wood Stream West (Yellow River Tributary)

Location	N55017 37576 to N54977 37829			
Length	c.250m			
Description	Steep sided, slow flowing field drain. Depth 2-5cm and width c.1m. Heavily shaded by hazel, hawthorn, ash and oak. Dense *Rorippa* and *Apium* in less shaded sections. Muddy substrate with some heavily silted gravel and cobble in the lowest c.50m.			
Salmonid Adult Habitat	None	Crayfish Habitat		Poor
Salmonid Nursery Habitat	Poor	Lamprey Nursery Habitat		Poor
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat		Poor

Dense aquatic vegetation

Slow flowing field drain

Section YT11 - Wood Stream East (Yellow River Tributary)

Location	N55461 37787 to N55400 37930			
Length	c.150m			
Description	Muddy drain heavily shaded in parts by willow, oak, ash & beech. Dense growths of *Apium* and *Rorippa* in less shaded sections.			
Salmonid Adult Habitat	None	Crayfish Habitat		Poor
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat		None
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat		None

Drain with dense Apium & Rorippa

Section YT12 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N53432 38819 to N54120 38759		
Length	c.750m		
Description	Mostly uniform muddy glide with dense in-stream growths of *Apium* in sections. Moderate to heavy shade by hawthorn, willow and bramble. Short section of riffle on muddy gravel and cobble at the downstream end of the section.		
Salmonid Adult Habitat	None - Poor	Crayfish Habitat	Poor
Salmonid Nursery Habitat	Poor – Fair	Lamprey Nursery Habitat	Poor – Fair
Salmonid Spawning Habitat	Poor – Fair	Lamprey Spawning Habitat	Poor - Fair

Glide heavily shaded by bramble, willow and hawthorn

Dense instream growth of Apium

Glide on mud

Short section of riffle on muddy cobble & gravel

Section YT13 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N54120 38759 to N54150 38879		
Length	c.100m		
Description	Uniform glide on mud, sand and gravel. Low level of shade by bankside grass, hawthorn and gorse.		
Salmonid Adult Habitat	None - Poor	Crayfish Habitat	Poor - Fair
Salmonid Nursery Habitat	Poor	Lamprey Nursery Habitat	Fair
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	Poor

Glide on substrate of mud with some sand and gravel

Section TY14 – Corbetstown Bridge Stream (Yellow River Tributary)

Location	N53937 39576 to N53592 39410		
Length	c.350m		
Description	Very small stream width c.30cm and depth c. 4cm on sand & mud substrate. Moderate shade by willow. Dense *Apium* towards downstream end of section.		
Salmonid Adult Habitat	None	Crayfish Habitat	None
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Very small stream on mud and sand substrate

Dense growths of *Apium*

Section YT15 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N53592 39410 to N53550 39403		
Length	c.100m		
Description	Small stream c.1m wide and 3cm deep on substrate of cobble, gravel and mud.		
Salmonid Adult Habitat	None	Crayfish Habitat	None
Salmonid Nursery Habitat	Poor	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	None

Riffle on muddy cobble

N.B Section of stream between Section YT15 and YT16 was inaccessible.

Section YT16 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N53809 39134 to N54341 38869		
Length	c.700m		
Description	Slow flowing, steep sided muddy drain 2m wide with dense growths of *Apium nodiflorum*. Moderate shade by willow and hawthorn. Substrate of mud with some surface sand and fine gravel		
Salmonid Adult Habitat	None	Crayfish Habitat	Poor
Salmonid Nursery Habitat	None - Poor	Lamprey Nursery Habitat	Fair
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Dense growth of *Apium*

Slow flowing watercourse

Substrate of mud with some surface sand & fine gravel

Section YT17 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N54373 38852 to N55264 38242		
Length	1.5km		
Description	Stream c.3m wide and 5 -15cm deep. Mostly glide over sand & mud with some poor sections of riffle on muddy sand, gravel and cobble. Heavy shade by hawthorn, willow, ash and brambles.		
Salmonid Adult Habitat	Poor	Crayfish Habitat	Poor - Fair
Salmonid Nursery Habitat	Fair	Lamprey Nursery Habitat	Fair
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	Poor

Glide over sand and mud substrate

Poor riffle on muddy sand, gravel & cobble

Section YT18 – Corbetstown Bridge Stream (Yellow River Tributary)

Location	N55264 38242 to N55548 38162		
Length	c.350m		
Description	Stream c.3m wide and 10 – 25cm deep consisting mostly of glide on sand, gravel and cobble. Heavy shade by ash, hawthorn, beech and willow.		
Salmonid Adult Habitat	Poor – Fair	Crayfish Habitat	Poor – Fair
Salmonid Nursery Habitat	Fair	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	Fair	Lamprey Spawning Habitat	Fair

Section YT19 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N55548 38162 to N55619 38125		
Length	c.150m		
Description	Small stream with mixture of glide and riffle on substrates of cobble, sand and gravel. Heavily shaded by ash and hawthorn in upper section, un-shaded in lowest section		
Salmonid Adult Habitat	Fair	Crayfish Habitat	Fair - Good
Salmonid Nursery Habitat	Fair - Good	Lamprey Nursery Habitat	Poor
Salmonid Spawning Habitat	Fair	Lamprey Spawning Habitat	Fair

Riffle & glide on cobble, sand & gravel

Glide on sandy substrate

Less shaded lower section

Riffle area just upstream of confluence with Yellow River

Section YT20 – Killowen Stream (Yellow River Tributary)

Location	N56458 38224 to N56737 38435		
Length	c.400m		
Description	Stream 2-3m wide. Mostly glide with some riffle on sand, gravel and cobble. Moderate shade by hawthorn and holly.		
Salmonid Adult Habitat	Fair	Crayfish Habitat	Fair
Salmonid Nursery Habitat	Fair - Good	Lamprey Nursery Habitat	Poor
Salmonid Spawning Habitat	Fair	Lamprey Spawning Habitat	Fair

Shallow glide and riffle on sand, gravel & some cobble

Glide on sandy substrate

Riffle on sandy cobble

Section of riffle just upstream of confluence with Yellow River

Mongagh/Castlejordan River Main Channel and Tributaries

Section M1 – Mongagh/Castlejordan River Main Channel

Location	N52255 39931 to N52300 41125		
Length	c.1.3 km		
Description	Mostly slow deep glide with dense *Rorippa*, *Potamogeton*, *Sparganium erectum* & *Callitriche* sp.		
Salmonid Adult Habitat	Poor	Crayfish Habitat	Fair
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	Fair (estimated)
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Deep glide with dense *Potamogeton*

Dense marginal *Rorippa*

Section M2 - Mongagh/Castlejordan River Main Channel

Location	N52300 41125 to N55371 40800		
Length	c.3.75km		
Description	Slow to medium glide 15-20m wide and c.1.5m deep. Substrate mostly muddy sand (where visible). *Potamogeton* sp. With 25-60% cover in much of the channel and dense *Phalaris* and *Rorippa* in margins		
Salmonid Adult Habitat	Fair	Crayfish Habitat	Poor – Fair
Salmonid Nursery Habitat	None – Poor	Lamprey Nursery Habitat	Fair
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	None - Poor

Slow deep glide with dense in-stream *Potamogeton*

Slow glide with dense *Phalaris* in margins

Section MT1 – Major Bog Drain – (Mongagh River Tributary)

Location	N52414 39582 to N52255 39931		
Length	c.400m		
Description	Ponded bog drain c.30m wide.		
Salmonid Adult Habitat	None	Crayfish Habitat	None
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	None
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None

Large ponded bog drain

Culvert discharge to Mongagh River

5.11.3 Water Quality

Biological water quality at all sites is shown on Figure 21 (See Figure 5.8 for site names).

SITE A

The invertebrate community at this site merits a Q-rating of Q2-3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	Limnephilidae	2
	Phryganea sp.	11
	Sericostoma sp.	1
Group C - Moderately Pollution Tolerant	*Potamopyrgus antipodarum*	1
	Hydropsyche sp.	5
	Haliplidae	1
	Chironomidae	4
Group D - Very Pollution Tolerant	Sphaeriidae	c.170
	Asellus aquaticus	88
	Sialis sp.	3
Group E - Most Pollution Tolerant	None Recorded	

Table 5.13 Biological water quality at SITE A

SITE B

The invertebrate community at this site merits a Q-rating of Q2-3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	*Athripsodes sp.*	1
	Goera sp.	3
Group C - Moderately Pollution Tolerant	*Potamopyrgus antipodarum*	1
	Baetis rhodani	4
	Hydropsyche sp.	13
	Chironomidae	1
	Simuliidae	4
Group D - Very Pollution Tolerant	*Asellus aquaticus*	c.120
Group E - Most Pollution Tolerant	None Recorded	
Not assigned to an indicator group	Lumbricidae	3
	Lumbriculidae	2

Table 5.14 Biological water quality at SITE B

SITE C

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	*Protonemura sp.*	2
Group B - Moderately Pollution Sensitive	*Lepidostoma sp.*	1
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	7
	Baetis rhodani	4
	Hydropsyche sp.	15
	Rhyacophila sp.	3
	Elmidae	20
	Chironomidae	3
	Tipulidae (Pediciidae)	12
Group D - Very Pollution Tolerant	*Asellus aquaticus*	10
	Glossiphonia sp.	1
Group E - Most Pollution Tolerant	None Recorded	
Not assigned to an indicator group	Lumbricidae	6
	Lumbriculidae	4

Table 5.15 Biological water quality at SITE C

SITE D

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	*Heptagenia sp.*	7
Group B - Moderately Pollution Sensitive	Limnephilidae	1
	Sericostoma sp.	6
Group C - Moderately Pollution Tolerant	*Gammarus duebeni*	70
	Hydropsyche sp.	22
	Rhyacophila sp.	1
	Elmidae	4
	Chironomidae	1
	Simuliidae	1
	Tipulidae (Pediciidae)	9
Group D - Very Pollution Tolerant	*Asellus aquaticus*	1
Group E - Most Pollution Tolerant	Tubificidae	2
Not assigned to an indicator group	Lumbriculidae	2

Table 5.16 Biological water quality at SITE D

SITE E

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	*Heptagenia sp.*	1
Group B - Moderately Pollution Sensitive	*Agapetus sp.*	1
	Limnephilidae	1
	Sericostoma sp.	3
	Silo sp.	1
Group C - Moderately Pollution Tolerant	*Ancylus fluviatilis*	2
	Potamopyrgus antipodarum	5
	Gammarus duebeni	38
	Baetis rhodani	5
	Hydropsyche sp.	11
	Elmidae	87
	Simuliidae	4
	Tipulidae (Pediciidae)	18
Group D - Very Pollution Tolerant	*Erpobdella sp*	2
	Glossiphonia sp.	1
	Asellus aquaticus	8
Group E - Most Pollution Tolerant	None recorded	
Not assigned to an indicator group	Lumbricidae	1
	Lumbriculidae	29

Table 5.17 Biological water quality at SITE E

SITE F

The invertebrate community at this site merits a Q-rating of Q3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	*Baetis muticus*	8
	Agapetus sp.	4
	Limnephilidae	26
	Sericostoma sp.	3
Group C - Moderately Pollution Tolerant	Tricladida	1
	Piscicola geometra	1
	Gammarus duebeni	35
	Hydracarina	1
	Baetis rhodani	11
	Hydropsyche sp.	6
	Plectrocnemia sp.	3
	Dytiscidae	2
	Elmidae	6
	Gyrinidae	2
	Chironomidae	4
	Tipulidae (Pediciidae)	2
Group D - Very Pollution Tolerant	*Haemopis sanguisuga*	1
	Asellus aquaticus	51
Group E - Most Pollution Tolerant	Tubificidae	7
Not assigned to an indicator group	Lumbriculidae	4
	Ceratopogonidae	2

Table 5.18 Biological water quality at SITE F

Fishery Value

Recent genetic studies of trout in the Boyne catchment have found that there are five different families of trout in the catchment one of which is located in the Kinnegad/Mongagh/Yellow River part of the catchment. The study also concluded that the contribution of fish from individual tributaries to the main stem stock is very variable and bears no relationship to the size of the individual sub catchment. It was concluded that the trout from the Mongagh/Kinnegad population "*make little or no contribution to the main stem population. These fish are staying at home!!*". Whereas the genetic diversity of the trout from the Mongagh/Kinnegad population adds ecological value to the trout populations in this section of the catchment, it appears that this population does not make a significant contribution to the angling value of the main channel of the Boyne.

(www.fisheriesireland.ie/Press-releases/a-pioneering-study-of-the-genetic-makeup-of-brown-trout-stocks-in-the-boyne-catchment.html)

Yellow River Main Channel: IFI states that the Yellow River has good stocks of Brown Trout. The most upstream section of the Yellow River assessed was c.400m long Section Y1 which flows adjacent to proposed Turbine 7. This section had the best salmonid spawning and nursery habitat recorded in the surveyed section of the Yellow River with Fair – Good quality being recorded for all salmonid life stages. All the other potentially affected sections of the Yellow River consist of a uniform canalised channel with steep sides and variable bankside cover. The flow is mostly glide with a few limited sections of run and riffle. Most of this channel constitutes adult salmonid habitat of fair – good quality and mediocre salmonid nursery and spawning habitat. Applying the precautionary principle, it is assumed that section Y1 has a significant population of juvenile brown trout. Salmon are known to run up the Castlejordan river to spawn in Rochfortbridge Stream; the precautionary principle is therefore applied and for the purposes of mitigation it should be assumed that salmon may also run up the Yellow River in small numbers, and that juvenile salmon are present in Habitat Section Y1, where Fair – Good spawning habitat was recorded. Based on the habitat and water quality recorded in this survey, it is concluded that the remaining main Yellow River sections are likely to have a fair population of adult trout and low densities of juvenile salmonids.

Castlejordan/Mongagh River Main Channel: The c.5km of channel assessed for the present report consists of uniform glide with substrate mostly muddy sand (where visible). This section of channel has no significant salmonid spawning or nursery habitat and constitutes adult salmonid habitat of mediocre quality. IFI states that as well as having stocks of Brown Trout, this river has good stocks of salmon in its Rochfortbridge tributary. As the Rochfortbridge tributary is upstream of the proposed wind farm, it is certain that adult salmon annually migrate upstream past the proposed wind farm site to the spawning areas in the Rochfortbridge tributary, and salmon smolts migrate downstream past the site en route to the sea.

Tributaries: The fish habitat value of the potentially affected tributaries was found to be generally low; however a few short sections of channel were found to have significant salmonid habitat.

Derryiron West Stream	No significant salmonid habitat value
Derryiron East Stream	No significant salmonid habitat value
Coolcor Stream	No significant salmonid spawning or nursery habitat value. Adult trout habitat value fair in Section YT5 (700m) and fair–good in Section YT6 (300m).
Srah Stream	No significant salmonid habitat value
Wood West Stream	No significant salmonid habitat value
Wood East Stream	No significant salmonid habitat value
Corbetstown Bridge Stream	Significant salmonid habitat value only in lowest 500m where nursery and spawning habitat value was fair in Section YT18 (350m) and in Section YT19 salmonid nursery habitat value was fair – good and spawning habitat value was fair. Trout were observed in this section of stream and applying the precautionary principle it should be assumed that juvenile salmon may be present in the lowest section of the stream.
Killowen Stream	The potentially affected section (YT20 (400m) has fair adult trout habitat quality, fair - good salmonid nursery habitat and fair salmonid spawning habitat quality. On the basis of the habitat quality and applying the precautionary principle it is assumed that this section of stream has a significant population of brown trout and may also have juvenile salmon.

Ecological Value

Yellow River and Mongagh/Castlejordan Main Channel: Three Habitats Directive Annex II species are known to occur in in the main channels of the Yellow and Castlejordan Rivers: these are River/Brook Lamprey (*Lampetra* Sp.), Crayfish (*Austropotamobius pallipes*) and Atlantic Salmon *(Salmo salar)*. Regarding the

Yellow River/ Mongagh River part of the Boyne catchment O'Connor (2006) states: "*River/brook lamprey (probably Lampetra planeri) were confirmed from this catchment. Lampreys are present at an overall favourable conservation status level.*" Whereas *Lampetra planeri* (Brook Lamprey) are listed in Annex II of the Habitats Directive, the species is not a qualifying interest of the River Boyne and River Blackwater SAC which is located c.20km downstream of the proposed wind farm development. The re-establishment of the crayfish in the Mongagh/Yellow rivers catchment is indicated by Reynolds (2007) who reported them in the Castlejordan, and is also indicated in current records for the species in both the Castlejordan/Mongagh River and in the Yellow River downstream of the confluence with the Castlejordan (www.biodiversityireland.ie). Crayfish are protected under the Wildlife Act and are listed in Annex II of the Habitats Directive, however they are not a qualifying interest in the River Boyne and River Blackwater SAC. Salmon are reported in the Castlejordan River by IFI (see Fisheries Value Section) and are a qualifying interest in the River Boyne and River Blackwater SAC.

No crayfish were recorded at any of the sites assessed for invertebrate fauna in the present survey. On the basis of the habitat assessment carried out for this report, it is concluded that crayfish habitat in the potentially affected sections of the Yellow and Castlejordan rivers is generally of relatively poor quality, and crayfish are therefore likely to be present at relatively low density. Fair lamprey nursery habitat was widespread in the main channels assessed; however habitat suitable for lamprey spawning was found to be scarce. O'Connor (2006) found "good numbers" of juvenile lamprey at Sheep Bridge but low density (1 per 5m²) at Garr Bridge on the Yellow River. Given the poor lamprey spawning habitat in the main channel, it is likely that the good juvenile lamprey density at Sheep bridge consists of lamprey spawned in the Corbetstown Bridge and/or the Killowen tributaries which are upstream of Sheep Bridge.

This section of the Boyne catchment is known to have a population of salmon, thereby making it a significant part of the Boyne fishery and relevant to maintaining/attaining favourable conservation status of salmon in the River Blackwater & River Boyne SAC, in which salmon is a qualifying Annex II interest. These channels are therefore classified as of regional importance.

Tributaries:

Stream	Description	Ecological Value
Derryiron West Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Derryiron East Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Coolcor Stream	Section YT4 & YT5 (1.7km) fair crayfish and fair lamprey nursery habitat. Based on habitat quality and applying precautionary principle, crayfish and brook lamprey assumed to be present.	High Local Value
Srah Stream	Section YT9 (500m) fair – good lamprey nursery. Based on habitat quality and applying precautionary brook lamprey assumed to be present.	Moderate Local Value
Wood West Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Wood East Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Corbetstown Bridge Stream	Approx. 2km of fair lamprey nursery habitat. Crayfish habitat quality generally of mediocre quality but with c150m of fair – good crayfish habitat in the lowest section (YT19). Based on habitat quality and applying precautionary principle, crayfish and brook lamprey assumed to be present.	High Local Value
Killowen Stream	Habitat Section YT20 c.400m of fair crayfish habitat and fair lamprey nursery habitat. Based on habitat quality and applying	High Local Value

precautionary principle, crayfish and brook lamprey assumed to be present.

5.12 DO NOTHING IMPACT

If the proposed development does not proceed, the "Do nothing Scenario" is that the ecological and fishery value of the potentially affected rivers and streams is likely to remain as described in Section 5.3, apart from some improvement in water quality to good ecological status, as would be required under the European Communities Environmental Objectives (Surface Waters) Regulations 2009.

5.13 POTENTIAL IMPACTS OF THE DEVELOPMENT

The potential significant impacts of the proposed development on aquatic ecology could be:

1. Pollution of watercourses with suspended solids due to runoff of silt from construction areas.
2. Pollution of watercourses with nutrients due to ground disturbance during construction and during clear felling of 10.4 ha of forestry plantation
3. Pollution of watercourses with nutrients due to decomposition of brash after forest clear felling
4. Pollution of watercourses during construction phase with other substances such as fuels, lubricants, waste concrete, waste water from site toilet and wash facilities, etc.
5. Pollution of watercourses with surface drainage water from paved areas and road surfaces.
6. Hydrological impact due to changes in the flow rates of streams/rivers.
7. Permanent loss of habitat due to culverting or bank/stream alteration.
8. Obstruction to upstream movement of aquatic fauna due to culverting
9. Obstruction of upstream fish movement during construction of river/stream crossings.

Potential impacts are described under two headings:

1. An assessment of the potential environmental impact of the proposed wind farm during the period of construction.

2. An assessment of potential long-term effects of the operational phase of the proposed wind farm on freshwater invertebrate fauna, flora, fish and habitats.

5.13.1 Construction Phase

Pollution of streams with suspended solids

In the absence of adequate mitigation any element of the wind farm construction which involves excavation or soil placement has potential for suspended solids contamination of surface waters. The main elements of the proposed development that pose a risk of suspended solids pollution are the turbine foundation bases, the c.17.7 km of new site roads, the upgrading of 7.1km of existing site roads, the laying of electrical and communications cabling, the construction of the grid control building and the temporary construction compound. (The location of turbines and roads in relation to watercourses is shown on Figure 5.8). Any works proposed in areas with significant depths of peat may also pose risks of serious environmental impact due to peat failure or slippage resulting in contamination and possible scouring of watercourses.

Suspended sediment due to runoff of soil from construction areas, forestry clearance operations or due to disturbance of fine sub-surface sediments in the course of instream construction and excavation, can have significant negative impacts on invertebrate and plant life and on all life stages of salmonid fish. Peat soils have high erodability (Forest Service 2008) and may be less amenable to removal by conventional settlement ponds unless properly sized to allow for peat particles.

- Suspended sediment can settle on spawning areas, infill the intragravel voids and smother the eggs and alevins (newly hatched fish) in the gravel.

- Bed Load (coarse material transported along the bottom of the 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 the stream, impairing the ability of fish to find food items.

- Settled sediments can smother and displace aquatic organisms such as macroinvertebrates (including crayfish), reducing the amount of food items available to fish.

- Increased levels of sediment can displace fish out of prime habitat into less suitable areas. (Chilibeck *et al* 1992)

- 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. (Solbe 1988)

In the absence of adequate mitigation measures, contamination of water courses with suspended solids, with the resultant potential impact on salmonid spawning and nursery areas, is one of the most significant potential aquatic ecological impacts of the proposed development, and would be classified as a moderate potential impact on all potentially affected streams.

A peat stability assessment has been carried out and it has been concluded that no significant risk of peat failure will be caused by the proposed development. (Whiteford GeoServices Peat Slide Risk Assessment Report)

Pollution Of Watercourses With Nutrients Due To Ground Disturbance During Construction And During Clearfelling Of Conifers

The main potential sources of nutrient inputs to freshwater due to ground disturbance are:

1. Nutrients adsorbed or chemically bound to eroded suspended solids

2. Leaching of fertilisers used during the forestry operation

Nutrients adsorbed or chemically bound to eroded suspended solids

Several studies in the United States have found increases in both nitrogen and phosphorus export into streams following ground disturbance, particularly in association with organic particles (Golladay & Webster 1988; Likens *et al* 1970). Giller *et al* (2002) concluded that phosphates released into streams after forestry 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. Busman *et al* (2002) found that "*phosphorus in soils is almost entirely associated with soil particles. When soil particles are carried to a river or lake, phosphorus will be contained in this sediment.. … Phosphate in soils is associated more with fine particles than coarse particles. When soil erosion occurs, more fine particles are removed than coarse particles, causing sediment leaving a soil through erosion to be enriched in phosphorus*". It is therefore concluded that in the context of the Yellow River Wind Farm site the main potential source of nutrient enrichment of surface waters due to soil disturbance will be nutrients associated with eroded soil particles.

Leaching of fertilisers used during the forestry operation

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 recognised for at least three decades. (Cummins & Farrell 2003). In the Irish context Daly *et al* (2001) and Styles (2004) concluded that peat soils have limited capacity to chemically bind phosphorus and create any phosphorus reserves. Daly & Styles (2005) 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*."

A substantial proportion of the area of forestry to be felled i.e. in Derryarkin and Corbetstown (Sites 1 & 2) are unlikely to have received any fertiliser application and definitely not in the last 10 years. The third site at Corbettstown is situated 50:50 on the boundary of an old field and rough pasture area. It is possible that the rough pasture area received an application of fertiliser when the site was planted 8 years

ago. The maximum rate permitted under the Forest Service Scheme for such a site type is Ground Rock Phosphate (14% P) at 250Kgs/Ha. The old field part of the plot is precluded from any application of fertilizer.

As the peat soils in the areas to be felled that have not been fertilised within the last 8- 10 years (if at all) it is likely that most of the phosphorus applied to the plantations have by now leached from the system or been assimilated into biomass. (Jennings O'Donovan Pers. Comm).

Pollution of watercourses with nutrients due to decompositon of brash after forestry clearfelling

"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).

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; Kennedy 2005; Campbell & Foy 2008; Rogers et al 2008). 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).

In a study of a peat soil forest catchment in the Burrishoole river system Rodgers et al (2008) 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. Rodgers et al (2008) state that "Yanai (1998) hypothesised that the elevated P concentration in the study stream caused by the clearfelling and harvesting could last years because of the slow decay process rates. In this study, about 19 months after the clearfelling and harvesting operations were complete, 100 µg TRP/l were found in the water at the downstream station."

Pollution of streams/rivers with other substances associated with the construction process

The potential exists for a range of serious pollutants to enter watercourses during construction. For example any of the following will have deleterious effects on fish, plants and invertebrates (including crayfish) if allowed to enter watercourses.

- Raw or uncured concrete and grouts
- 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

Obstruction to fish movement during construction

As all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works there will be no obstruction to upstream fish movement during construction.

5.13.2 Operational Phase

Pollution Of The Streams With Surface Runoff From Completed Development

The operation of a turbine development produces no discharges and, other than lubricants, uses no chemicals; the risk of significant pollution from paved areas after the construction is completed would appear to be minimal. Nevertheless due care and

best practice will be required to prevent any contamination of surface waters with hydrocarbons.

EIFAC (Svobodova *et al* 1993) states that "*a sensory assessment is preferred to toxicological analysis in determining the highest admissible amounts of oil and oil products that can be present in water; on this basis the highest admissible concentrations are in the range of 0.002 to 0.025 mg per litre*".

Harmful effects include:

- The prevention of gaseous exchange at the water surface, leading to reduced dissolved oxygen in the underlying water (Solbe 1988)

- In the case of turbulent waters the oil becomes dispersed as droplets into the water. In such cases, the gills of fish can become mechanically contaminated and their respiratory capacity reduced (Svobodova *et al* 1993).

- Oil products may contain various highly toxic substances, such as benzene, toluene, naphthenic acids and xylene which are to some extent soluble in water; these penetrate into the fish and can have a direct toxic effect. It is generally agreed that the lighter oil fractions (including kerosene, petrol, benzene, toluene and xylene) are much more toxic to fish than the heavy fractions (heavy paraffins and tars) reduced (Svobodova *et al* 1993).

The wind farm will have the potential for ongoing pollution of watercourses with suspended solids (for impact see Section 5.5.1 above) due to eroding of road surfaces and drains.

Hydrological Impacts

Following completion of the wind farm, unless adequately mitigated, the rate and amount of surface water runoff from the site may be greater than at present due to removal of peat, felling of areas of forestry, excavation of drains and more rapid runoff from surfaced areas. There is the possibility of significant changes in the flow regimes of drains on site and streams to which these drains flow.

Should they occur, major changes in hydrology reflected in significant changes in peak and minimum flows would have significant effects on instream flora and fauna, both directly and through the effects of increased erosion.

Permanent Loss Of Habitat Due To Culverting, Road Construction & Road Upgrading

Stream/River Crossings

The proposed wind farm road network crosses streams/rivers shown on EPA stream mapping (www.epa.ie) at ten locations (see Figure 5.22).

Crossing No.	Stream/River	Grid Ref.	Salmonid Spawning Habitat	Salmonid Nursery Habitat	Salmonid Adult Habitat
C1	Yellow River	250444, 236339	Poor - Fair	Poor - Fair	Fair - Good
C2	Derryiron Stream West	250839, 236275	None	None	None
C3	Derryiron Stream East	251775, 235747	Poor - Fair	Poor -Fair	Fair
C4	Corbetstown Bridge Stream	253800, 239124	None	None- Poor	None
C5*	Corbetstown Bridge Stream*	254354, 238857	Poor	Fair	Poor
C6	Wood Stream West	255006, 237548	None	Poor	Poor
C7	Yellow River	255054, 237857	Fair - Good	Poor - Fair	Poor - Fair
C8	Wood Stream East	255456, 237778	None	None	None
C9	Yellow River	255982, 238270	Fair - Good	Poor - Fair	Poor - Fair
C10	Killowen Stream	256552, 238276	Fair	Fair - Good	Fair

***Existing road crossing to be upgraded**

Table 5.19 Salmonid Habitat Quality At Proposed Stream/River Crossings

All stream/river crossings will be by way of clear span bridging with no in-stream works; there will therefore be no significant impact on in-stream habit.

Loss of riparian (bank-side) habitat due to construction

All proposed new site tracks/roads will be constructed no less than 50m from all EPA mapped watercourses except in the immediate vicinity of proposed watercourse crossings. As bankside habitat on the proposed wind farm site is generally of low or moderate quality, the resulting loss on streamside habitat will not be significant.

Obstruction to upstream movement of aquatic fauna due to culverting

The proposed wind farm road network intersects streams shown on EPA stream mapping (www.epa.ie) at ten locations (see Figure 22). All crossing will be by means of single span bridging with support structures set back from the river bank. There will therefore be no potential post construction impact on upstream movement of aquatic fauna.

5.14 MITIGATION MEASURES

5.14.1 Construction Phase Mitigation

Reduction and prevention of suspended solids pollution

General Recommendations

Release of suspended solids to all watercourses should be kept to a minimum. Total suspended solids in discharges should not exceed 30 mg/l in the case of all EPA mapped watercourses (i.e. streams shown on Figure 5.7). This limit should apply to direct discharges to these waters. Non-salmonid drains receiving runoff should not exceed 30 mg/l suspended solids at the point where they join the salmonid watercourses.

The following additional recommendations are made from the Aquatic Ecological perspective and it is recognised that the specific means by which suspended solids in discharges to streams will be prevented from exceeding 30 mg/l is a matter of detailed engineering design.

The key factors in erosion and sediment control are to intercept and manage off- and on-site runoff, and maximise the distance between construction areas and sensitive watercourses. This limits the potential for soils to be eroded and enter streams in runoff. Runoff and surface erosion control is more effective and less expensive than sediment control with sediment control ponds only.

The following general guidelines for erosion and sediment control, which are largely based on Goldman *et al* (1986), should be followed:

1. Schedule development close to watercourses to minimise risk of potential erosion by, where possible, planning construction activities during drier months, halting construction during periods of heavy precipitation and run-off to minimise soil disturbance, and restrict vehicular and equipment access or provide working surfaces/pads.

2. Retain existing vegetation where possible and physically mark clearing boundaries on the construction site.

3. Revegetate denuded areas, particularly cut and fill slopes and disturbed slopes as soon as possible. Use mulches or other organic stabilisers to minimise erosion until vegetation is established on sensitive soils. However it should be noted that re-sodding is essential on upland and lowland peatlands, as reseeding is likely to be unsuccessful and exposed peat is liable to erode. Non-development site vegetation should not be introduced on semi-natural sites such as peatlands. (DOEHLG 2006)

4. Divert runoff away from denuded areas.

5. Minimise the length and steepness of slopes where possible.

6. Minimise 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, and lining unavoidably steep interceptors or conveyance ditches with filter fabric, rock or polyethylene lining to prevent channel erosion.

7. Retain eroded sediments on site with erosion and sediment control structures such as sediment traps (mobile or constructed), silt fences and sediment control ponds.

8. Access roads should be constructed or topped with a suitable coarse granular material and if possible organic topsoil should be stripped prior to access road construction.

9. No stream diversions are proposed; however, in the case of temporary watercourse diversions (such as to facilitate culvert installation), the diversion should be excavated in isolation of stream flow, starting from the bottom end of the diversion channel and working upstream to minimise sediment production. The temporary channel should be constructed in such a way as to minimise suspended solids released when the river is re-routed. Upon completion the bank should be stabilised around the temporary diversion.

10. Prior to construction consultation should take place with IFI regarding the details of bridge and/or open arch stream/river construction. Other than single span temporary bridges with no instream structures, no temporary stream crossings or temporary culverting should take place without the prior agreement of Inland Fisheries Ireland.

11. Machinery should never cross a watercourse by entering it .

12. Construction likely to generate suspended solids upstream of significant sections of salmonid nursery habitat should not take place between the beginning of October and the end of April. Specifically this would refer to works in the vicinity of Section Y1 of the Yellow River main channel, the Corbetstown Bridge stream downstream of Corbetstown Bridge and in the vicinity of Killowen Stream

13. A monitoring programme should be established which will include visual inspection of silt traps and settlement ponds. A visual inspection programme of the site should be carried out daily during construction to monitor integrity and general performance of silt traps, settlement ponds and erosion control

measures. A log of visual inspections will be maintained and any identified issues will be brought to the contractors attention for immediate action.

Recommendations for construction of turbine pads, laying of site cables and upgrade of roads/tracks

1. The drainage system with settlement ponds, soak-aways, and interceptor drains should be installed prior to any excavation work along access roads to be constructed.

2. Settlement ponds/ silt traps should be installed towards the end of drainage channels, however, where practicable these should not be closer than 100m to the receiving watercourse.

3. Machinery and vehicles used in track construction should be operated from the track as it is constructed. Excavation machinery should be operated from access roads and trench digging machinery should be operated from bog mats where appropriate.

4. Surface vegetation turves should be laid out, stored and watered for restoration use after construction, in suitably designated areas. The stored turves should be used to reinstate turbine foundations etc following construction.

5. If, during excavation, spoil is to be stored or is likely to fall onto the adjacent bog surface, the bog surface should be protected with shuttering boards or geotextile.

6. At locations where excavated materials are stored, french drains should surround and intercept surface runoff from materials mounds and distribute this water to the controlled drainage system in place.

7. The excavated material should be laid alongside the trench for use in reinstatement following the laying of the cables. Silt runoff from excavated material to surface waters should be prevented using methods outlined above, and any water pumped from trenches should be passed through a suitable silt removal facility before discharge to surface waters.

Recommendations for Forestry Clearfelling

The following recommendations should be applied to all watercourses including drains:

1. Vegetated riparian buffer zones where they exist should be maintained and where possible left undisturbed to prevent or reduce the input of nutrients.

2. Drainage channels should never form a direct connection between the clearfell area and the stream (i.e. bypassing of buffer strips should not occur in any way). If it is not possible to get machines on to a clearfell site to block all drainage channels which empty directly into a stream, straw bales placed in these drains to act as filters may be an option to reduce the input of sediment. However, care must be taken to prevent the release of trapped sediment when the bales are removed.

3. Care should be taken to prevent bank collapses and slippages. Any risk of bank collapse and slippage should be identified and eliminated prior to commencement of clearfelling operations.

4. Silt traps should be installed at locations that will intercept run-off to streams.

5. Machinery roads/tracks should be kept away from watercourses to avoid them becoming a direct route of sediment input. Where tracks have been created on slopes, small offlets should be dug at intervals to prevent water running directly down the slope.

6. If erosion and soil inputs to streams/rivers occur, be prepared to modify operating procedures immediately (including cessation of the operation if necessary) and install silt traps as appropriate. However, it is strongly recommended that installation of silt traps always occurs prior to commencement of clearfelling operations.

Mitigation of Pollution of watercourses with nutrients due to ground disturbance

As much of the potential nutrient input to streams during ground disturbance due to construction of forestry clear-felling is associated with suspended soil particles, the measures outlined in the '*Reduction and prevention of suspended solids pollution'* section apply equally to prevention of nutrient inputs to streams.

Mitigation Of Pollution Of Watercourses With Nutrients Due To Decaying Brash

If left on site brash should be moved at least 20m from all watercourses including drains.

Stacking and loading of timber should not be carried out in proximity to a watercourse, and ideally should be located on dry ground.

Reduction or elimination of pollution of the streams with other substances associated with the construction process

The following guidelines should be followed:

1. Turbines footprints will be located a minimum of 50m from EPA mapped streams & rivers.

2. Raw or uncured waste concrete should be disposed of by removal from the site.

3. Only ready-mixed concrete should be used during the construction phase, with all ready-mixed concrete being delivered from batching plants in sealed concrete delivery trucks.

4. Only the chute of the concrete delivery truck should be cleaned on site, using the smallest volume of water necessary. Concrete trucks should be directed back to their batching plant for washout.

5. So as to avoid spillage concrete should not be transported around the site in open trailers or dumpers. All concrete used in the construction of turbine bases should be pumped directly into the shuttered formwork from the delivery truck.

6. The arrangements for concrete deliveries to the site should be discussed with suppliers before commencement of work, agreeing routes, prohibiting on-site washout and discussing emergency procedures.

7. Clearly visible signs should be placed in prominent locations close to concrete pour areas, stating that washout of concrete lorries is not permitted on the site.

8. Large concrete pours should be avoided where prolonged periods of heavy rain are forecast and covers should be available for freshly placed concrete to avoid the surface washing away in heavy rain.

9. Wash down water from exposed aggregate surfaces and cast-in-place concrete should be trapped on-site to allow sediment to settle out and reach neutral pH before clarified water is released to the stream or drain system or allowed to percolate into the ground.

10. Fuels, lubricants and hydraulic fluids for equipment used on the construction site should be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to best codes of practice.

11. Fuelling and lubrication of equipment should be carried out in a specially bunded area.

12. Any spillage of fuels, lubricants or hydraulic oils should be immediately contained and the contaminated soil removed from the site and properly disposed of.

13. Waste oils and hydraulic fluids should be collected in leak-proof containers and removed from the site for disposal or re-cycling.

14. Hardstandings or crane platforms will be required in the vicinity of each turbine position to allow two cranes to work in the vicinity of a turbine. During turbine foundation construction, the crane platform also serves as a storage area for material (e.g. reinforced steel) and machinery. Runoff from the platforms should be to a drainage system which includes silt removal.

15. Prior to any work close to water courses ensure that all construction equipment is mechanically sound to avoid leaks of oil, fuel, hydraulic fluids and grease.

16. All pumps using fuel or containing oil should be locally and securely bunded when situated within 25m of waters or when sited such that taking account of gradient and ground conditions there is the possibility of discharge to waters.

17. Where site works involve the discharge of drainage water to receiving surface waters, temporary oil interceptor facilities should be installed and maintained.

18. Appropriate spill control equipment, such as oil soakage pads, should be kept within the construction site to deal with any accidental spillage and emergency response procedures should be put in place.

19. Foul drainage from site offices etc. should be removed to a suitable treatment facility.

Location of sites for use as storage areas, machinery depots, site offices, temporary access roads or the disposal of spoil

In general such sites should be located as far as is practicable from watercourses. In general any site which is at least 50m from the nearest watercourse may be chosen. Disposal of spoil should not be carried out in any location where runoff can occur into watercourses.

Prevention of Obstruction to fish movement during construction

As all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works there will be no significant obstruction to upstream fish movement during construction.

Procedure for Contractors

Following on consultation which has taken place during the design and pre-development phase of the project, contractors should establish contact with Inland Fisheries Ireland before works commence, and there should be ongoing liaison with IFI throughout the construction process. Contractors should be in possession of, and familiar with the contents of "*Control of water pollution from construction sites - Guidance for consultants and contractors*" published by the Construction Industry Research and Information Association (CIRIA 2001) (e-mail enquiries@ciria.org.uk).

Contractors should 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.

5.14.2 Operational Phase Mitigation

Mitigation Of Pollution Of Watercourses With Contaminated Water Draining From The Proposed Development

1. Kerbs should be incorporated into the design of the bridges/crossings to prevent roadway run-off directly into streams.

2. A sustainable drainage system should be installed on the new road, which will prevent significant pollution to surface receiving waters.

3. As virtually all treatment options require proper maintenance in order to function properly, and as some can become a source of pollution if not properly maintained, a program of regular cleaning, maintenance and inspection of the road runoff treatment system should be adopted to ensure it functions correctly.

Mitigation Of Hydrological Impacts

1. Flow attenuation should be included in the wind farm design if necessary to ensure that no significant increase in peak stream/river flows is caused by the proposed development.

2. Natural drainage patterns should 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.

3. Where necessary to avoid bank erosion and significant changes to watercourse flow patterns, energy breaks should be installed to reduce the velocity of the outfalls from drains to receiving waters.

4. Water abstraction from watercourses for any purpose should only take place at locations, in a manner and during a time period agreed with Inland Fisheries Ireland.

Mitigation Of Habitat Loss

One of the most effective methods of minimising loss of stream and riparian habitat during developments such as forestry clearance for construction, new road construction etc. is the establishment of riparian buffer zones: areas of land and vegetation adjacent to watercourses that are to remain in an undisturbed state, throughout and after the development process (Chilibeck *et al* 1992). Riparian buffer zones are valuable not only because riparian vegetation is a vital component of a healthy stream ecosystem, but because this vegetation acts as an effective screen/barrier between the stream and the development area, intercepting runoff and acting as an effective filter for sediment and pollutants from the development area. Where development is to take place close to rivers/streams, a riparian buffer zone should be clearly marked and its significance explained to machinery operators.

Loss or degradation of in-stream habitat will be avoided as all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works.

Mitigation Of Obstruction To Upstream Movement Of Aquatic Fauna Due To Construction Of Culverts/ Culvert Replacement

1. All crossings of EPA mapped streams will be by way of clear span bridges.

2. Culversion of any other watercourses or drains to facilitate road/track crossings should in the case of box culverts be at least 30 cm below the streamgrade and in the case of pipe culverts should be at least 1.2 times the

bankfull width of the watercourse + 0.5m and should be embedded to a depth of at least 25% of the pipe diameter.

3. Culverts should be installed at the stream gradient otherwise they may result in a change in water velocities which may create a drop below the culvert or may create a hydraulic jump at the end of the culvert.

4. Culverts should not be aligned so that culvert outflows are directed into a watercourse bank.

5. The culvert should be installed so that it has a constant slope through its length except for the appropriate camber allowance where settlement is anticipated.

5.15 MONITORING

Biological monitoring should be carried out at Sites A – F (See Section 5.2.6 & Figure 5.8) immediately prior to commencement of construction, and repeated on completion of the construction.

5.16 CONCLUSION

If all recommended mitigation measures are implemented in full, there will be no significant impact on fish or other surface water flora and fauna.

5.17 MATRIX OF IMPACTS / MITIGATION / RESIDUAL IMPACTS

	IMPACTS DURING CONSTRUCTION				LONG-TERM IMPACTS		
Potentially Impacted Watercourse	**Suspended Solids Pollution**	**Other Pollutants**	**Nutrient inputs**	**Obstruction to fish movement during construction**	**Potential Loss of Habitat**	**Potential Obstruction to Movement of Aquatic Fauna**	**Pollution in Run-Off**
Yellow River Main Channel	Moderate	Moderate	Moderate	Not Significant	Not Significant	Not Significant	Minor
Mongagh/Castlejordan Main Channel	Moderate	Moderate	Moderate	None	None	None	Minor
Derryiron Stream West	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Derryiron Stream East	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Coolcor Stream	Moderate	Moderate	Moderate	None	None	None	Minor
Shrah Stream	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Wood Stream West	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Wood Stream East	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Corbetstown Bridge Stream	Moderate	Moderate	Moderate	Not Significant	Not Significant	Not Significant	Minor
Killowen Stream	Moderate	Moderate	Moderate	No Significant	Not Significant	Not Significant	Minor
Mongagh Major Bog Drain	Not Significant	Not Significant	Not Significant	None	None	None	Not Significant

Table 5.20 Summary Of Potential Impacts In The Absence Of Mitigation Measures

Potentially Impacted Watercourse	Minimise pollution generated during construc-tion process (see note 1)	Max. suspended solids in discharges to surface water 30 mg/l	Construction time constraints	Single span bridge with no in-stream structures	All crossings should maintain habitat continuity (see note 3)	Minimise pollution generated during and after forestry felling (see note 4)	Minimise pollution from runoff from access roads and other paved areas (see note 5)	Avoid significant hydrological changes to existing streams (see note 6 below)	Leave strips of >10m from river bank where works are planned close to streams (see note 7)
Yellow River Main Channel	✓	✓	✓ (see note 2)	✓		✓	✓	✓	✓
Mongagh/ Castlejordan Main Channel	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	No works proposed within 50m
Derryiron Stream West	✓	✓		✓			✓	✓	✓
Derryiron Stream East	✓	✓		✓			✓	✓	✓
Coolcor Stream	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	✓
Srah Stream	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	No works proposed within 50m
Wood Stream West	✓	✓		✓			✓	✓	✓
Wood Stream East	✓	✓		✓			✓	✓	✓
Corbetstown Bridge Stream	✓	✓	✓ (see note 2)	✓		✓	✓	✓	✓

Potentially Impacted Watercourse	Minimise pollution generated during construc-tion process (see note 1)	Max. suspended solids in discharges to surface water 30 mg/l	Construction time constraints	Single span bridge with no in-stream structures	All crossings should maintain habitat continuity (see note 3)	Minimise pollution generated during and after forestry felling (see note 4)	Minimise pollution from runoff from access roads and other paved areas (see note 5)	Avoid significant hydrological changes to existing streams (see note 6 below)	Leave strips of >10m from river bank where works are planned close to streams (see note 7)
Killowen Stream	✓	✓	✓ (see note 2)	✓			✓	✓	✓
Mongagh Major Bog Drain	✓			No Crossings Proposed	No Crossings Proposed		✓		
All other watercourses and drains	✓				✓		✓		

Table 5.21 Summary Of Mitigation Measures

Note 1: See report Sections 5.6.1

Note 2: Construction likely to generate suspended solids in the vicinity of Section Y1 of the Yellow River main channel, the Corbetstown Bridge stream downstream of Corbetstown Bridge and in the vicinity of Killowen Stream should not take place between the beginning of October and the end of April unless otherwise agreed with Inland Fisheries Ireland.

Note 3: Pipe culverts should have diameter at least 1.2 times the bankfull width of the watercourse + 0.5m and be embedded to a depth of at least 25% of the pipe diameter. Box culverts should be embedded at least 30cm below the existing watercourse bed.

Note 4: Follow guidelines in Section 5.6.1.

Note 5: Follow guidelines in Section 5.6.2 above.

Note 6: Follow guidelines in Section 5.6.2 above.

Note 7: To apply except at actual stream crossing points. Turbines and new roads/tracks will not be located within 50m of EPA mapped watercourses and a buffer zone of 10m will be established around all man made drains

	IMPACTS DURING CONSTRUCTION				LONG-TERM IMPACTS		
Potentially Impacted Watercourse	**Suspended Solids Pollution**	**Other Pollutants**	**Nutrient inputs**	**Obstruction to fish movement during construction***	**Potential Loss of Habitat**	**Potential Obstruction to Movement of Aquatic Fauna**	**Pollution in Run-Off**
Yellow River Main Channel	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Mongagh/ Castlejordan Main Channel	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Derryiron Stream West	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Derryiron Stream East	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Coolcor Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Shrah Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Wood Stream West	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Wood Stream East	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Corbetstown Bridge Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Killowen Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Mongagh Major Bog Drain	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Table 5.22 Residual Impacts if all mitigation measures are fully implemented

5.18 REFERENCES

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