9. Fisheries

Introduction

9.1 This chapter describes the fisheries interests of the watercourses draining the Proposed Corlacky Hill Wind Farm, hereinafter referred to as 'the Proposed Wind Farm Development', and considers the potential effects of the construction, operation and decommissioning of the development on these interests. The assessment consists of a desk based assessment using available published and online information in combination with data and observations collected in the field. The specific objectives of the chapter are to:

- describe the fisheries baseline;
- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the potential effects, including direct, indirect and cumulative effects;
- describe the mitigation measures proposed to address likely significant effects;
- assess the residual effects remaining following the implementation of mitigation.

9.2 The assessment has been carried out by Paul Johnston Associates, an independent fisheries consultancy specialising in freshwater fisheries in Ireland. Paul Johnston holds a BSc (Hons) in Zoology and a PhD in Fisheries Ecology; he is also registered member of the Institute of Fisheries Management (MIFM) and Chartered Environmentalist (CEnv).

9.3 The practice has completed a wide range of assignments in the areas of environmental impact assessment, fisheries development and catchment management. This includes fisheries assessments in connection with a series of land-based wind farm developments in Northern Ireland.

9.4 **Figures 9.1 - 9.8** are referenced in the text where relevant.

Legislation, Policy & Relevant Guidance

Fisheries Administration

9.5 Under the provisions of the Fisheries Act (NI) 1966, the Department of Culture, Arts and Leisure (DCAL) has responsibility for the conservation, protection, development and improvement of salmon and inland fisheries of Northern Ireland.

Legislation

EU Legislation

9.6 EU and local legislation relevant to fisheries and the water environment in the area of the Proposed Wind Farm Development includes the following:

- EC Habitats Directive (92/43/EEC);
- EU Water Framework Directive (2000/60/EC) [incorporating standards from the Fish Directive [Consolidated] (2006/44/EC) – this Directive was repealed in 2013];
- European Eel Regulation (EC) 1100/2007.

Domestic Legislation

- Fisheries (Northern Ireland) Act 1966
- Drainage (Northern Ireland) Order 1973
- Environment (Northern Ireland) Order 2002
- Nature Conservation and Amenity Lands (Amendment) (Northern Ireland) Order 1989
- Water (Northern Ireland) Order 1999
- Water Environment (Water Framework Directive) (Northern Ireland) Regulations 2003
- Wildlife (Northern Ireland) Order 1985
- Wildlife and Natural Environment Act (Northern Ireland) 2011.

Policy

9.7 Policy with regard to Atlantic salmon and European eel in this region is set out in the following:

- Atlantic Salmon Management Strategy for Northern Ireland and the Cross-Border Foyle and Carlingford catchments to meet the objectives of NASCO resolutions and agreements, 2008–2012 (DCAL)
- Neagh/Bann River Basin District Eel Management Plan (DCAL/AFBI/Lough Neagh Fishermen's Co-operative Society Ltd).

Guidance

9.8 Specific guidance relevant the Proposed Wind Farm Development includes the following:

- Requirements for Protection of Fisheries Habitat during Development Works at River Sites (DCAL)
- Culvert Design and Operation Guide (C689) (CIRIA, 2010)
- Environment Agency Policy Regarding Culverts: Technical Guidance on Culverting Proposals (EA, 1999).
- PPG1: General guide to the prevention of pollution
- PPG2: Above ground oil storage tanks
- PPG3: Use and design of oil separators in surface water drainage systems
- PPG4: Treatment and disposal of sewage where no foul sewer is available
- PPG5: Works and maintenance in or near water
- PPG6: Working at construction and demolition sites
- PPG7: Refuelling facilities
- PPG8: Safe storage and disposal of used oils

- PPG13: Vehicle washing and cleaning
- PPG18: Managing fire water and major spillages
- PPG21: Pollution incident response planning
- PPG26: Storage and handling of drums & intermediate bulk containers.

Scope of Assessment

9.9 The fisheries assessment has involved desk study, field work, data processing and analysis and interpretation using professional judgement. The key receptors are the headwaters of the Knockoneill River which drain the area within the Preliminary Site Boundary, hereinafter referred to as 'the Site'.

9.10 Existing fisheries data and relevant conservation information on the Knockoneill and Clady rivers is assimilated and supplemented through a bespoke fisheries survey of the Site covering the principal watercourses draining the area.

9.11 The fisheries survey of these watercourses includes:

- An outline fish habitat assessment;
- A semi-quantitative juvenile fish stock assessment.

9.12 The sensitivity of each watercourse with regard to fisheries has been assessed according to a methodology for environmental sensitivity outlined in the Design Manual for Roads and Bridges, specifically with regard to effects on the water environment (DMRB, 2009). Potential effects of the construction, operation and decommissioning phases of the Proposed Wind Farm Development were then assessed. This assessment was based primarily on the potential effects on resident fish stocks either directly or upon their habitats.

Consultation

9.13 The principal consultee during the study was DCAL as the competent authority for fisheries matters in the local waters. Consultee responses are summarised in **Table 9.1**.

Table 9.1: Consultee Responses

Consultee		Summary of Response	Addressed in Assessment
Department of Culture Arts and Leisure (DCAL)	Inland Waterways and Fisheries	Advised that the Clady River is an index river informing DCAL policy in relation to the Department's Salmon Management Strategy and the recent salmon conservation measures; and consistently exceeds its conservation level for salmon since monitoring of adult salmon returns began in 2011. Data provided on monitoring of adult and juvenile fish stocks. Advice on culvert design and timing of installation.	9.56-9.60 9.69-9.78 9.137-9.140 9.145; 9.147
The Hon. The Irish Society	(Owner of fishing rights)	No specific issues raised.	N/a

9.14 Consultations were also conducted with other sub-consultants on the project, notably in relation to hydrology and drainage issues which are contained within **Chapter 10: Geology and Water Environment** of this ES.

Assessment Methodology

Baseline Characterisation

Study Area

9.15 The study area focussed on the streams draining the area within the Site, all of which are headwaters of the Knockoneill River. Field survey work was carried out on these streams both within the Preliminary Site Boundary and immediately downstream.

9.16 The desk assessment includes an evaluation of fisheries in downstream reaches of the Knockoneill River and the Clady Water which links to the Lower Bann River **(Figure 9.1)**.

Desk Study

9.17 A desk study was carried out to assimilate baseline information relating to salmonid fisheries, ecological status (under WFD) and water quality (chemical and biological) for the study area. The following sources were consulted/used:

- DCAL – Inland Fisheries Group
- Northern Ireland Environment Agency (NIEA) – Water Management Unit (WMU) (Rivers and Lakes Team) www.doeni.gov.uk/niea/water/wfd.htm
- NIEA - Protected Areas www.doeni.gov.uk/niea/protected_areas_home
- Joint Nature Conservation Committee (JNCC) www.jncc/defra.gov.uk

Field Survey

Water Chemistry

9.18 A series of basic water quality parameters were measured within the Site using portable meters to provide an outline profile of chemical quality.

9.19 Turbidity was measured using a EUTECH NT-100 turbidimeter which records in Nephelometric Turbidity Units (NTU). pH was measured using a WTW 3110 pH meter, dissolved oxygen with a Hanna Oxy-Check oxygen meter, and conductivity with a Hanna HI86303 conductivity meter; temperature measurements were made with both the pH and oxygen meters.

9.20 Turbidity was used as a proxy indicator of suspended solids as it can be measured quickly in the field using a turbidimeter. However there is no universal relationship between turbidity and suspended solids, and accurate computation of suspended solids concentrations from turbidity would require that a calibration exercise be carried out on a site-specific basis.

Fisheries Habitat

9.21 An outline assessment of the streams draining the Site was carried out in April and July 2015 and consisted of walkover surveys recording general characteristics to provide an outline assessment for these watercourses. This was then complimented through a fish stock survey by electrofishing.

9.22 The descriptive terminology used in the survey is based on the Life Cycle Unit method (Kennedy, 1984) currently used by DCAL and the Loughs Agency. Habitat type is recorded as:

- Nursery (shallow rock/cobble riffle areas for juvenile fish - fry/parr);
- Holding (deeper pools/runs for adult fish);
- Spawning (shallow gravel areas for fish spawning);
- Unclassified (unsuitable for fish – shallow bedrock areas or heavily modified sections of channel).

Juvenile Fish Stocks

9.23 Monitoring of fish stocks by DCAL tends not to include sampling sites in the upper reaches of tributaries in most river systems. Therefore, this part of the fisheries assessment considered the principal streams draining the Site and set out to obtain details on salmonid distribution in reaches not covered in routine sampling by DCAL.

9.24 A juvenile fish stock survey of the Knockoneill River and relevant tributaries was carried out by electrofishing at selected locations in August 2015.

9.25 Electrofishing was carried out according to a semi-quantitative methodology described by Crozier and Kennedy (1994). The procedure involves two operators fishing continuously in an upstream direction for five minutes at each sampling location, using a single anode backpack electrofishing set (24V DC input; 250V, 100W 50 Hz DC output). All fish were caught using a dip net and retained for inspection and then returned to the water live. Any additional Age 0 salmonids seen but not captured were also recorded. This method is consistent with Loughs Agency monitoring procedures.

Assessment of Effects

9.26 The assessment of effects was derived from methodologies outlined by:

- the Design Manual for Roads and Bridges specifically with regard to Road Drainage and the Water Environment, Volume 11, Section 3, Part 10 HD45/09 (DMRB, 2009);
- Institute of Environmental Management and Assessment guidelines (IEMA, 2004).

Sensitivity Criteria

9.27 Desk study and site inspections were carried out with regard to each watercourse draining the Site to assess fisheries status and potential effects. The Fisheries Importance/Site Sensitivity of each watercourse was graded, broadly in line with the guide to estimating the importance of water features outlined in the Design Manual for Roads and Bridges (2009) as outlined in **Table 9.2**.

Magnitude of Effect

9.28 The magnitude of effect was assessed according to the criteria set out in **Table 9.3** and includes a consideration of the timescale of the effect (short, medium or long term).

Significance Criteria

9.29 The correlation of magnitude against the sensitivity of the receptor determines a qualitative expression for the significance of the effect on the basis of a standard matrix shown in **Table 9.4**. The greater the sensitivity or value of a receptor or resource, and the greater the magnitude of the impact, the more significant the effect.

Table 9.2: Estimating the Sensitivity/Importance of Receptors (DMRB, 2009)

Sensitivity	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on a regional or national scale	WFD Class 'High'. Site protected/designated under EC or UK habitat legislation (SAC, ASSI, salmonid water)/Species protected by EC legislation. Watercourse containing salmon and supporting a nationally important fishery or river ecosystem.
High	Attribute has a high quality and rarity on a local scale	WFD Class 'Good'. Species protected under EC or UK habitat legislation. Watercourse containing salmon or trout and supporting a locally important fishery or river ecosystem.
Medium	Attribute has medium quality and rarity on a local scale	WFD Class 'Moderate'. Watercourse containing trout and upstream of locally important fishery or river ecosystem.
Low	Attribute has low quality and rarity on a local scale	WFD Class 'Poor'. Watercourse without salmon or trout but upstream of locally important fishery or river ecosystem.
Negligible	Attribute has very low quality and rarity on a local scale	WFD Class 'Poor'/unspecified.

Table 9.3: Estimating the Magnitude of Effect on Receptors

Magnitude	Criteria	Type and Scale of Effect
Major	Results in loss of attribute and/or quality and integrity of the attribute	Loss or extensive change to a fishery. Loss or extensive change to a designated Nature Conservation Site. Major alteration to fish population levels in catchment as a whole, through fish mortality, habitat destruction or barrier to migration. Duration: long-term (>5 years).
Moderate	Results in effect on integrity of attribute, or loss of part of attribute	Partial loss in productivity of a fishery. Appreciable alteration to fish population levels in specific sub-catchment or zone. Duration: medium-term (1-5 years).
Minor	Results in some measurable change in attribute's quality or vulnerability	Minor loss in productivity of a fishery. Minor alteration to fish population levels in specific

Magnitude	Criteria	Type and Scale of Effect
		sub-catchment or zone. Duration: short-term (up to 1 year).
Negligible / No impact	Results in effect on attribute, but of insufficient magnitude to effect the use or integrity	Unlikely to affect the integrity of the water environment. No measurable alteration to fish population levels.

Table 9.4: Estimating the Significance of Potential Effects (DMRB, 2009)

Sensitivity	Magnitude of Impact			
	Major	**Moderate**	**Minor**	**Negligible**
Very High	Very Large	Large/Very Large	Moderate/Large	Neutral
High	Large/Very Large	Moderate/Large	Slight/Moderate	Neutral
Medium	Large	Moderate	Slight	Neutral
Low	Slight/Moderate	Slight	Neutral	Neutral

9.30 The five significance categories with typical effects are shown in **Table 9.5**. Effects evaluated as being Moderate, Large or Very Large are considered to be significant for the purpose of the EIA in line with the EIA Regulations and will require mitigation. Those effects assessed as Slight or Neutral are not considered to be significant in terms of the EIA.

Table 9.5: Descriptors of the Significance of Effect Categories (DMRB, 2009).

Significance category	Descriptors of effects
Very large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

Baseline Conditions

Outline

9.31 The study focussed on the stream network draining the Site, all of which are headwaters of the Knockoneill River. Field survey work was carried out on these streams both within the Site and immediately downstream.

Catchment Status

Designated Sites

9.32 There are no site designations either under European or local legislation relating to aquatic habitats or species in the Knockoneill/Clady river catchment. The Site is hydrologically connected to Bann Estuary SAC (Special Area of Conservation) through the Knockoneill, Clady and Lower Bann rivers. However this represents a distance of approximately 55 km via these channels which effectively rules out any potential effects on the SAC. Please refer to Appendix 6.4, Information to Inform a Habitats Regulations Assessment, for more details.

EU Water Framework Directive

Local River Catchments

9.33 The Site is located in the Knockoneill River sub-catchment of the Clady River. The Knockoneill River flows in a south easterly direction meeting with the Grillagh River to form the Clady, which then proceeds to join with the Lower River Bann at Portglenone **(Figure 9.2)**. The Knockoneill, Clady and Lower Bann are assigned to the Neagh Bann River Basin District (RBD) under the WFD **(Figure 9.1)**. Neagh Bann is an international RBD which incorporates the River Bann system including Lough Neagh and its tributaries, all rivers draining into Carlingford Lough and the Co Louth rivers draining to the East coast.

River Basin Management Plans

9.34 To achieve the ecological objectives of the WFD River Basin Management Plans (RBMPs) have been implemented through a series of Local Management Areas (LMAs) during the 2010 to 2015 planning cycle.

9.35 The Site lies entirely within the Lower Bann LMA, with all of the application area located in the waterbody defined as Knockoneill River (UKGBNI1NB030301069). Proceeding downstream from the Site there is sequential hydrological connection between the following waterbodies in the Lower Bann LMA (ecological status as assessed in 2014 is noted):

- Knockoneill River (UKGBNI1NB030301069): Moderate
- Clady River (UKGBNI1NB030301079): Moderate
- Clady River (UKGBNI1NB030301078): Moderate
- River Bann (UKGBNI1NB030301149): Moderate Ecological Potential

9.36 The most recent assessment for these waterbodies in 2014 is summarised in **Table 9.6** which indicates the overall classification and status with regard to each of the principal parameters monitored.

9.37 From the end of 2015 the number of water bodies within the Lower Bann LMA will be reduced from 41 to 33, and three Clady River waterbodies will be merged to form a single entity as Clady River (UKGBNI1NB030308233).

9.38 For the next planning cycle to 2021 NIEA has developed draft RBMPs for each River Basin District including the Neagh Bann RBD. These documents set out the latest assessment of pressures and impacts on the water environment, describe the progress NIEA has made towards achieving objectives for 2015 and explain the significant water management issues that still need to be addressed. After consultation the final 2015-2021 RBMPs were produced in December 2015 as updates of the RBMPs published in 2009.

Table 9.6: Classification of individual quality elements contributing to overall WFD status of relevant water bodies in Lower Bann LMA, 2014 (Source: NIEA)

Parameter	Knockoneill (Ref 1069)	Clady (Ref 1079)	Clady (Ref 1078)	River Bann (Ref 1149)
Ammonia	High	High	High	High
Benthic Invertebrates	Good	Moderate	Moderate	Moderate
Dissolved oxygen	High	High	High	High
Macrophytes	-	High	High	Moderate
pH	High	High	High	High
Phytobenthos	Moderate	Moderate	Moderate	Moderate
SRP	High	High	High	High
BOD*	Good	High	High	Good
Temperature*	High	High	High	Good
Hydrological regime	High	High	High	Moderate
Morphological conditions	Moderate	-	-	-
Overall Status	Moderate	Moderate	Moderate	MEP

Register of Protected Areas

9.39 The Register of Protected Areas is compiled in accordance with Article 6 of the WFD. Areas are identified as those requiring special protection under existing national or European legislation and this includes areas designated for the protection of economically significant aquatic species such as those areas designated under the EC Freshwater Fish Directive (78/659/EEC).

9.40 The EC Freshwater Fish Directive (Consolidated) 2006/44/EC (FWFD) sets physical and chemical water quality objectives for salmonid waters and cyprinid waters, specifically with regard to dissolved oxygen, ammonia, pH and total zinc.

9.41 The main stem channel of the Clady River and the Knockoneill River up to Swatragh were designated as “salmonid” under the Surface Waters (Fish Life Classification) Regulations (Northern Ireland) 1997, which implements the EC Freshwater Fish Directive. In 2003 this designation was expanded to include several tributaries and extended to the source of the Knockoneill River.

9.42 The Fish Directive was repealed by the WFD at the end of 2013, and the ecological status defined in the WFD sets the same protection to waterbodies designated for fish under the original directive. Areas designated under the Fish Directive have become areas designated for the protection of economically significant aquatic species under WFD and placed on the Register of Protected Areas.

Water Quality Monitoring

9.43 Chemical and biological quality of individual water bodies have been monitored by NIEA WMU on a monthly basis since 2009 to comply with statutory monitoring for WFD reporting. There are two monitoring stations on the Knockoneill River downstream of Swatragh approximately 4.5 km and 10.5 km from of the Site **(Figure 9.3)**; the most recent monitoring programme was in 2009 and 2010.

Chemical Quality

9.44 Summary results for a selection of chemical quality parameters at the Knockoneill River monitoring site are presented in **Table 9.7**. It should be noted that this sampling location is approximately 10.5 km downstream of the Site.

Table 9.7: Selected Chemical Monitoring Data from Knockoneill River, 2009-10 (Source: NIEA)

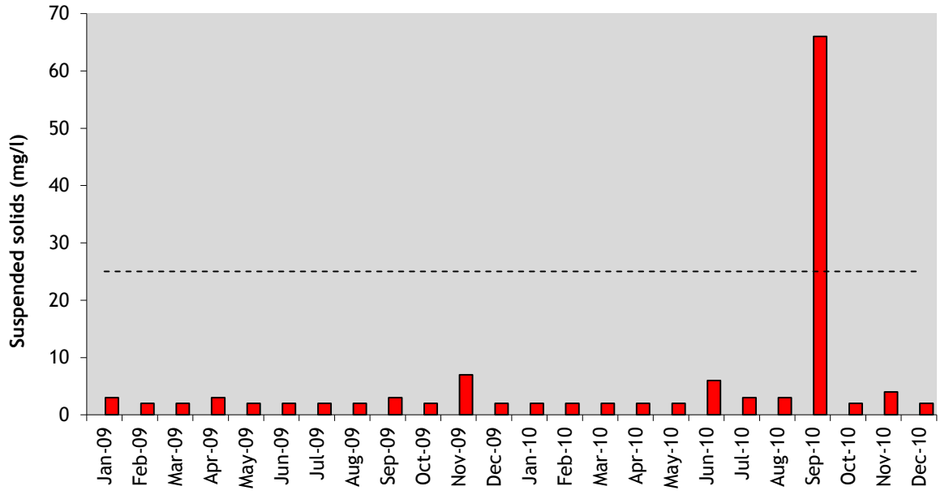
Knockoneill River (C896037)		pH	Cond (µs/cm)	DO (mg/l)	DO (%)	BOD (mg/l)	NH3 (mg/l)	P-Sol (mg/l)	S.Solids (mg/l)
2009	Min	7.4	136	9.6	88	<1	<0.001	0.02	<2
	Max	8.8	350	13.4	115	2	0.004	0.11	7
	Mean	8.0	261	11.5	99	1.6	0.001	0.04	3
2010	Min	7.4	88	8.7	74	<1	<0.001	0.02	<2
	Max	8.8	369	12.8	128	5.5	0.006	0.09	66
	Mean	7.9	249	10.8	93	2.3	0.002	0.04	8

9.45 In general, pH appears to be relatively stable and remains within a range satisfactory for salmonid fisheries - the variation in pH is most likely related to flow conditions. Dissolved oxygen readings are mostly high and biological oxygen demand consistently low reflecting an absence of organic inputs.

9.46 Conductivity is an indication of the amount of dissolved salts in the water and typically increases in a downstream direction as a river flows through progressively richer lowland areas picking up different materials and receiving inputs from various tributaries and discharges. At this location the variation in conductivity is again probably related to flow conditions.

9.47 Of particular relevance to salmonid fish and aquatic habitats is suspended sediment as it has significant potential to impact on both. The variation in suspended solids at the NIEA monitoring site on the Knockoneill River is illustrated in **Chart 9.1**.

Chart 9.1: Monthly Measurements of Suspended Solids in the Knockoneill River, 2009-10 (Source: NIEA)



9.48 During the sampling period the level of suspended solids was generally below 5 mg/l at this location and exceeded the WFD guideline for salmonid fish (25 mg/l) only once in 24 samples over two years from the Knockoneill River. These figures are indicative of generally low levels of sediment run-off in this catchment where any peaks in suspended solids are likely to be due to spate conditions following periods of heavy or sustained rainfall.

Biological Quality

9.49 Summary results for biological quality monitoring in the Knockoneill River under the BMWP system in 2009/10 are presented in **Table 9.8**. This is the most recent data available for this sampling station which is approximately 4.5 km downstream of the Site.

Table 9.8: Biological Monitoring Data of Knockoneill River, 2009-10 (Source: NIEA)

Site Code	Grid Ref	Date	BMWP score	No. Taxa	ASPT
10405	C855063	30/03/2009	90	17	5.29
		23/09/2009	83	16	5.19
10915	C896037	03/03/2010	111	20	5.55
		15/09/2010	92	19	4.84

9.50 In general terms these results reflect a Good standard of biological quality as was indicated in the WFD classification for this site with regard to invertebrates.

Significant Freshwater Species

9.51 This section outlines the current status of Annexe II freshwater species and other species of conservation interest.

Atlantic salmon

9.52 The salmon is an anadromous species having both a freshwater stage and a marine stage to its life cycle. The species is listed under Annexe II of the Habitats Directive and was added to the UK Biodiversity Action Plan (BAP) list in 2007 as a priority species for conservation action. More recently the salmon achieved an IUCN threat status of Vulnerable in the Irish Red List No 5 (King *et al*, 2011).

9.53 Adult salmon mature at two to four years of age and spawning generally takes place in November or December notably in the upper reaches of suitable tributaries. The young fish remain in freshwater for one or two years before migrating to sea as smolts during April and May. After a phase of intense feeding and rapid growth in the sea, many salmon will return to freshwater in the following year as one sea-winter fish (grilse), while a proportion may remain at sea for another year to return as two sea-winter fish.

9.54 Northern Ireland's Atlantic salmon management strategy is aligned to the agreement reached by the North Atlantic Salmon Conservation Organisation (NASCO) and its Parties to adopt and apply a precautionary approach to the conservation, management and exploitation of the salmon resource and the environments in which it lives. Northern Ireland, through the UK and EU, is a Party to NASCO.

9.55 Atlantic salmon stocks in general are in serious decline and southern stocks, including some in North America and Europe, are threatened with extinction. As a conservation measure DCAL introduced a series of regulations in March 2014 to implement mandatory catch and release for salmon angling and to prohibit commercial salmon netting.

9.56 The Clady is one of seven Index Rivers utilised by DCAL to provide the basis for salmon management throughout Northern Ireland. Each river has been chosen to represent a different catchment type and provides key information on stock levels to inform regional policy.

Lamprey

9.57 There are three species of lamprey in Northern Ireland:

- Brook lamprey (*Lampetra planeri*)
- River lamprey (Lampetra fluviatilis)
- Sea lamprey (Petromyzon marinus)

9.58 Sea and River lampreys are parasitic and migrate between the freshwater and marine environments, returning to freshwater to breed. In contrast, Brook lamprey are resident freshwater throughout their life cycle and are non-parasitic. Brook lamprey are widely distributed in Northern Ireland but River and Sea lamprey have a more limited distribution (Goodwin *et al*, 2009).

9.59 All three species are designated under Annex II of the EU Habitats Directive (Directive 92/43/EEC) although none are listed as a site selection feature in five large river SACs in Northern Ireland.

Eel

9.60 The European eel is not listed under Annexe II but has recently been added to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species in the category of Critically Endangered (King *et al*, 2011).

9.61 The eel is a catadromous species, breeding in the sea and migrating to freshwater in order to grow before returning to the sea to spawn. It is believed that all European eels spawn in the Sargasso Sea in the middle of the North Atlantic Ocean.

9.62 The larvae drift in the plankton for up to three years towards the coasts of Europe. They then undergo metamorphosis into glass eels, subsequently elvers, which migrate up freshwater systems in large numbers. In freshwater they may take up to 20 years to reach sexual maturity as silver eels which then migrate back to sea.

9.63 The European eel is not listed in the EC Habitats Directive but the stock has been in rapid decline throughout its range since around 1980. This has led to the passing of the European Eel Regulation (EC) 1100/2007 which aims to establish measures for the recovery of the stock through action by Member States to implement Eel Management Plans in each eel river basin, in this case the Neagh Bann River Basin District.

9.64 There is no data available on the distribution of eel in the Knockoneill River and Clady catchment.

Salmon Stock Data

9.65 The Clady and its two main tributaries, the Knockoneill and the Grillagh, support significant stocks of Atlantic salmon and brown trout. As noted above the system has been selected by DCAL as one of seven index rivers for monitoring of salmon stock status in Northern Ireland.

Conservation Limits

9.66 A key factor in assessing the status of salmon stocks is determination of Conservation Limits for individual river systems. The Conservation Limit for Atlantic salmon is defined by NASCO as: *the spawning stock level that produces long term average maximum sustainable yield as derived from the adult to adult stock and recruitment relationship*. In simpler terms the Conservation Limit for a river is the number of spawning salmon required to ensure that salmon are reproducing in sufficient quantities to produce the next generation of fish.

9.67 An electronic fish counter was installed in 2011 for monitoring of adult fish runs to the river each year – data for the last three years is shown in **Table 9.9**. The counter became operational in August 2012 and the figure for that year is therefore a partial count.

Table 9.9: Adult salmon records from fish counter on Clady River, 2012-14 (Source: DCAL)

Month	Net upstream fish movements		
	2012	2013	2014
Jan	n/a	17	-7
Feb	n/a	0	0
Mar	n/a	-2	0
Apr	n/a	-6	7
May	n/a	-5	-6
Jun	n/a	18	9
Jul	n/a	71	5
Aug	n/a	86	182
Sep	n/a	238	-4
Oct	n/a	696	397
Nov	n/a	24	63
Dec	n/a	0	25
Total	**642**	**1137**	**671**

9.68 However, the total for each year exceeds the calculated conservation limit for the Clady (Kennedy, *pers comm*), although this is considerable variation in the figures. The monthly counts indicate the seasonal nature of the salmon run with a peak in the period August to October which is associated with rainfall and river levels.

Juvenile Fish Stocks

Monitoring

9.69 Trends in abundance of juvenile fish in the Index Rivers are monitored by DCAL using a semi-quantitative electrofishing methodology which was developed in Northern Ireland by Crozier & Kennedy (1994). A total of 39 sites are surveyed in the catchment each year including 18 on the Knockoneill River; the survey sites are illustrated in **Figure 9.3** with salmon data for 2010-14 shown in **Table 9.10**.

9.70 The data reflects the distribution of salmon spawning in the system and indicates an increasing level of spawning throughout with significant densities of fry extending upstream

of the Swatragh area. In some years the presence of fry at sites 1 and 2 reveals salmon spawning immediately downstream of the Site.

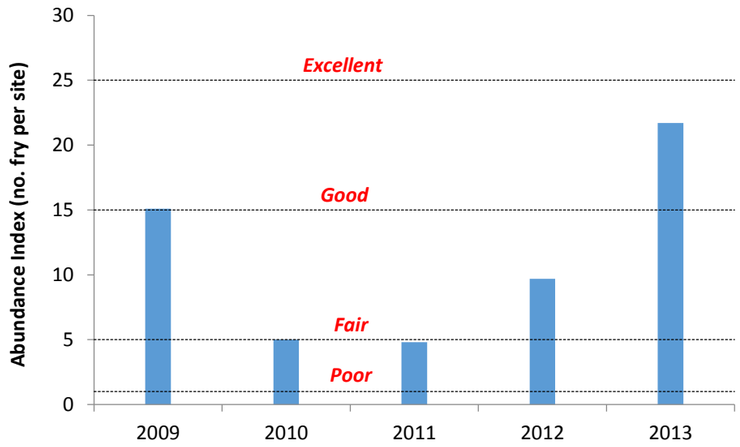
Abundance Index

9.71 A selection of key survey sites are utilised by DCAL to provide an Abundance Index for the river as a backup figure in the assessing compliance with the conservation limit. The Abundance Index for 2009-13 is illustrated in **Chart 9.2** with abundance categories *Poor* to *Excellent* as determined for salmon fry by Crozier & Kennedy (1994). Average salmon fry abundance at these reference sites has been in the *Fair* category with an increase in 2013 to *Good* classification.

Table 9.10: Numbers of salmon fry caught in semi-quantitative surveys, 2010-2014 (Source: DCAL)

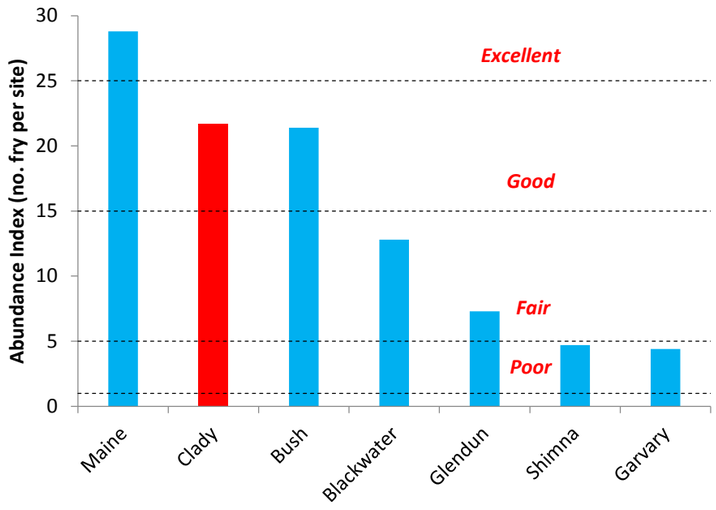
Site no.	River	Salmon fry (Age 0+)				
		2010	2011	2012	2013	2014
1	Knockoneill	0	0	1	0	0
2		0	0	0	0	8
3		0	0	0	0	0
4		0	0	0	0	0
5		0	0	3	0	0
6		0	1	0	0	6
7		-	0	-	0	3
8		0	0	0	4	26
9		5	9	4	18	25
10		-	6	11	3	29
11		-	0	-	-	23
12		5	2	5	0	17
13		0	0	4	7	-
14		0	1	0	33	17
15		0	4	2	3	2
16		-	0	16	0	30
17		-	14	37	12	25
18		18	8	20	25	44
19	Grillagh	0	1	-	-	0
20		11	17	0	-	0
21		3	2	4	-	3
22		12	14	0	0	0
23		0	1	4	-	-
24		10	19	3	42	2
25	Clady	1	0	7	10	1
26		6	0	11	17	2
27		-	0	-	8	-
28		0	1	-	1	0
29		-	0	-	2	-
30		7	5	13	11	7
31		-	0	6	17	8
32		6	1	0	24	0
33		0	0	6	18	2
34		5	14	23	52	22
35		4	3	20	40	20
36		14	15	3	41	13
37		5		11	39	11
38		1	4	5	28	0
39		8	0	2		1

Chart 9.2: Salmon fry Abundance Index for the Clady river system, 2009-2013 (Source: DCAL)



9.72 Salmon fry abundance across the seven Index Rivers in Northern Ireland is illustrated in **Chart 9.3** which indicates that the Clady was the second most productive river in 2013.

Chart 9.3: Salmon fry Abundance Index for seven Index Rivers, 2013 (Source: DCAL)



Brown Trout

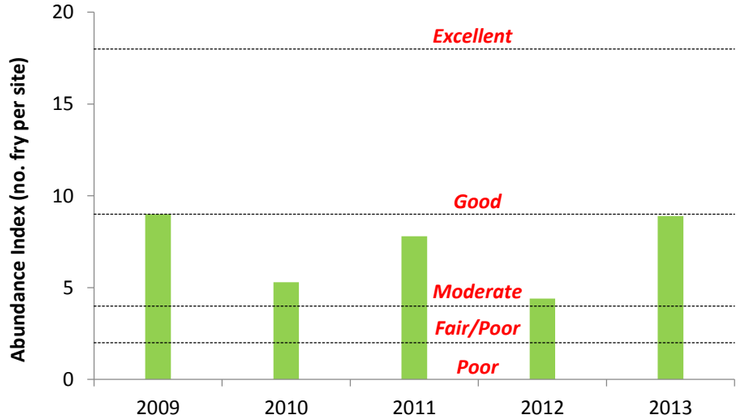
9.73 Juvenile trout are also recorded during annual electrofishing surveys at the same locations as for salmon **(Figure 9.3)** and the data for the Knockoneill is shown in **Table 9.11**. Trout are distributed over the full extent of the river with significant densities in upstream reaches at sites 3 and 4 within 2-3 km of the Site.

9.74 The Abundance Index for 2009-13 is illustrated in **Chart 9.4** with abundance categories *Poor* to *Excellent* as determined for trout fry by Kennedy (*unpublished data*). Average trout fry abundance across the full range of sites has been classified as *Moderate* in all five years.

Table 9.11: Numbers of trout fry caught in semi-quantitative surveys, 2010-2014 (Source: DCAL)

Site no.	River	Trout fry (Age 0+)				
		2010	2011	2012	2013	2014
1	Knockoneill	12	0	3	1	5
2		8	1	4	3	0
3		3	1	5	1	23
4		2	10	0	14	22
5		6	3	5	1	7
6		17	11	8	4	5
7		-	1	-	0	6
8		15	11	4	3	15
9		4	5	19	5	1
10		-	7	8	11	3
11		-	3	-	-	2
12		30	7	21	3	0
13		8	5	10	6	
14		4	4	3	6	4
15		6	7	12	6	46
16		-	4	8	4	4
17		-	3	9	1	4
18		2	12	6	5	4
Average		9.0	5.3	7.8	4.4	8.9

Chart 9.4: Average trout fry abundance in the Knockoneill River, 2009-2013 (Source: DCAL)



Angling

9.75 The Clady and District Angling Club was formed in 1966 and members fished throughout the Clady system although no official access to the waters had been secured. During the 1970s a leasing arrangement was agreed with The Honourable The Irish Society.

9.76 Good quality angling for salmon and brown trout is available on the Clady River with most fishing focussed on the main channel downstream of the Knockoneill-Grillagh confluence. As the salmon stock has consistently exceeded the calculated conservation limit, the DCAL conservation measures for the river were adapted in 2015 to allow the capture and retention of a limited number of salmon under an annual quota system.

9.77 This club has received EU funding initially for a fisheries survey of the catchment in 1996 and subsequently to implement the recommendations of the survey. A substantial clubhouse and disabled angling facility have been constructed at Clady, and the club also carries out a modest annual stock enhancement exercise.

Field Studies

Fish Habitat Survey

Stream Water Chemistry

9.78 Basic water quality parameters for the five streams draining the Site were recorded during low to medium flow conditions using portable meters on three occasions between April and August 2015; the sampling site locations are shown in **Fig 9.4** and the results are presented in **Table 9.12**.

Table 9.12: Selected Chemical Monitoring Data from Knockoneill River, 2009-10 (Source: NIEA)

Date	Site	Grid ref	Temp (°C)	pH	Diss. Oxygen (mg/l; % sat)	Conductivity (µS/cm)	Turbidity (NTU)
09/04/15	SW01		14.3	7.99	-	316	0.48
	SW02		13.4	7.89	-	156	1.76
	SW06		10.1	7.94	-	164	0.99
	SW07		10.7	7.82	-	180	3.72
	SW10		-	-	-	-	-
24/07/15	SW01		15.2	7.70	7.9 (78%)	264	1.09
	SW02		14.7	7.88	9.5 (93%)	148	1.18
	SW06		14.3	7.75	9.5 (92%)	147	1.00
	SW07		14.0	7.80	10.1 (97%)	149	5.54
	SW10		13.0	8.25	10.1 (94%)	147	6.92
14/08/15	SW01		-	-	-	-	-
	SW02		14.6	7.99	9.2 (90%)	198	1.41
	SW06		14.0	7.96	9.7 (93%)	192	1.11
	SW07		14.0	8.03	9.8 (94%)	179	5.58
	SW10		13.2	8.05	10.3 (97%)	178	9.57

9.79 These readings suggest satisfactory conditions for salmonid fish with regard to these parameters in the streams draining the Site. All of the streams are alkaline with moderate conductivity. They are also well oxygenated waters with low turbidity indicative of underlying low levels of suspended solids during normal flow conditions.

9.80 The low turbidity readings indicate low levels of suspended solids, well within the guidelines set by the former EU Freshwater Fish Directive and now listed on the Register of Protected Areas under the Water Framework Directive. However, sampling in spate conditions would have been likely to detect higher turbidity readings.

Fish Habitat

Local River Catchments

9.81 The Site encompasses an area of approximately 5 km^2 which is drained by a series of streams forming the headwaters of the Knockoneill River as described in some detail in Chapter 10, Geology & Water Environment. The fish habitat survey consisted of a walkover assessment of the main watercourses identified within the Site (Preliminary Site Boundary) **(Figure 9.5)**:

- Knockoneill River (including Central Tributary)
- Green Water
- Eastern Tributary
- Southern Tributary

Knockoneill River

9.82 The Knockoneill River rises on Carntogher Hill near the south-western corner of the Site and flows initially along the boundary line, then progressing through the Site in a north-easterly direction and then exiting the Site in the north-east approximately 350 m upstream of the confluence with the Green Water **(Figure 9.6)**.

9.83 Within the Site this is a very good quality stream in terms of nursery habitat for salmonids. Over most of its course within this area it varies in width 1-2 m with a relatively coarse substrate providing long riffles, occasional pools and gravel deposits **(Figure 9.6: Plates 9.1-9.7)**. There is little in the way of cover from bankside vegetation through most of its course within the Site and some reaches are deeply entrenched **(Figure 9.6: Plate 9.1)**.

9.84 During one site visit in April 2015 the water in the upper section appeared slightly turbid for no apparent reason and there was a brown deposit visible on the substrate. This may be due to raised levels of iron in the groundwater in this area. On contact with the air or by the action of iron-oxidising bacteria, the iron is converted from soluble ferrous to insoluble ferric compounds which settle on the riverbed.

9.85 Approximately 430 m from the Site the Knockoneill stream is joined by a tributary flowing north off the central area of the Site. This tributary is formed by a series of smaller streams rising in southern and south-western areas of the Site. It is slightly smaller than the Knockoneill with channel width in the range 0.5 – 3 m **(Figure 9.6: Plates 9.4 & 9.5)**. Habitat quality is good and fish were evident throughout much of the stream length during the walkover survey in April 2015.

9.86 Downstream of the confluence the average width of the main channel increases to 2.5 m and is up to 5 m at occasional points **(Figure 9.6: Plate 9.8)**. The bed slope has eased to some degree and there is a dense growth of trees on both banks over the subsequent 400 m reach to the point where the river exits the Site **(Figure 9.6: Plate 9.9)**. Throughout this reach fish habitat is reasonably good with continuing substrate of cobble, boulder and gravel giving rise to a riffle/glide sequence with occasional pools.

9.87 Downstream of the Preliminary Site Boundary the Knockoneill is an important spawning and nursery stream for salmon as indicated by the DCAL records reported in 9.73-9.75. Favourable habitat conditions were evident in the immediate downstream reach during the walkover survey **(Figure 9.7: Plate 9.10).**

Green Water

9.88 The Green Water rises on Pollangorm Hill to the west of the north-western corner of the Site **(Figure 9.7)**. It flows along the north boundary of the Site for approximately 1.2 km and the proceeds outwith the Site over a further course of 2 km before joining with the Knockoneill River as noted above.

9.89 Over the initial 500 m along the Site Boundary the Green Water is a relatively low gradient channel averaging 1 m wide with cobble bed materials providing adequate habitat for juvenile trout **(Figure 9.7: Plates 9.11 & 9.12)**. Over the next 500 m the bed slope increases significantly and there are regular outcrops of bedrock with occasional waterfalls **(Figure 9.7: Plates 9.13 & 9.16)**.

9.90 In this steep gradient reach the main channel is joined by two small tributaries draining the north-western area of the Site **(Figure 9.7: Plates 9.14 & 9.15)**. The first of these steams is very small (<1 m wide) with large areas of bedrock and significant ferric deposits due to iron-oxidising bacteria. The second tributary is larger and has reasonable qualities for fish habitation but it falls very steeply over a short 20 m section to join with the Green Water.

9.91 Over the last 200 m along the Preliminary Site Boundary the Green Water improves in terms of fish habitat characteristics. Channel width is generally in the range 1–2 m extending to 3 m in places. Bed materials consist of gravel, cobble and fines giving rise to a regular riffle/glide/pool sequence.

9.92 Downstream of the Site it develops into a significant nursery stream suitable for juvenile trout and salmon **(Figure 9.7: Plates 9.17 & 9.21)**

Eastern Tributary

9.93 This small stream rises in the south-eastern area of the Site near the Preliminary Site Boundary, initially flowing north through the Site before turning north-east and exiting the eastern boundary of the Site near the junction of Corlacky Road and Corlacky Hill **(Figure 9.8)**.

9.94 A considerable reach of this stream has reasonable fish habitat characteristics in terms of substrate materials, but it is very small and in normal conditions carries little water **(Figure 9.8: Plates 9.23 & 9.24)**.

9.95 Habitat quality is poor upstream of the existing culvert **(Figure 9.8: Plate 9.22)** and there is no fisheries interest in the area of the proposed stream crossing.

Southern Tributary

9.96 The Southern Tributary is formed by two small streams which drain a small area in the south-eastern corner of the Site **(Figure 9.8)**. One branch is a small incised ditch, less than 0.5 m wide **(Figure 9.8: Plate 9.25)** while the other is slightly larger with better quality substrate **(Figure 9.8: Plate 9.26)**. Fish are unlikely to be present in either stream within the area enclosed by the Preliminary Site Boundary.

Juvenile Fish Stocks

9.97 The juvenile fish stock survey of the watercourses draining the Site was carried out on 14 August 2015 at selected sampling sites (**Figure 9.4)**. Trout and salmon were the only fish species detected during the survey with trout present at all but one of the 15 sites surveyed.

Population Age Structure

9.98 The age structure of the trout and salmon populations in the stream network was verified by constructing separate length frequency distributions for each species (**Charts 9.5 and 9.6**).

Chart 9.5: Length frequency distribution of trout caught in the Knockoneill streams.

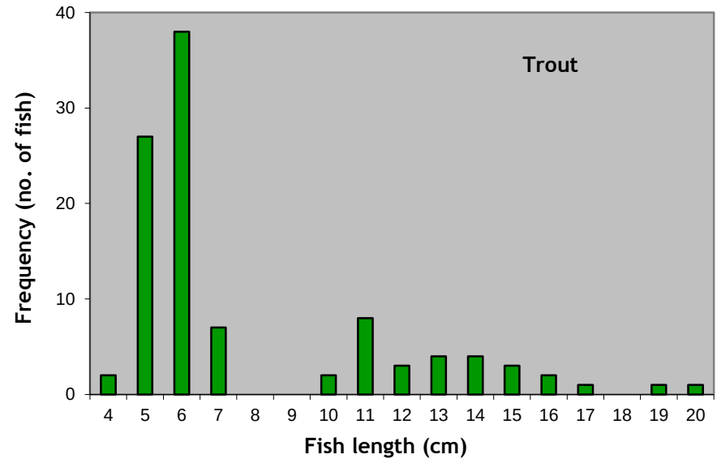
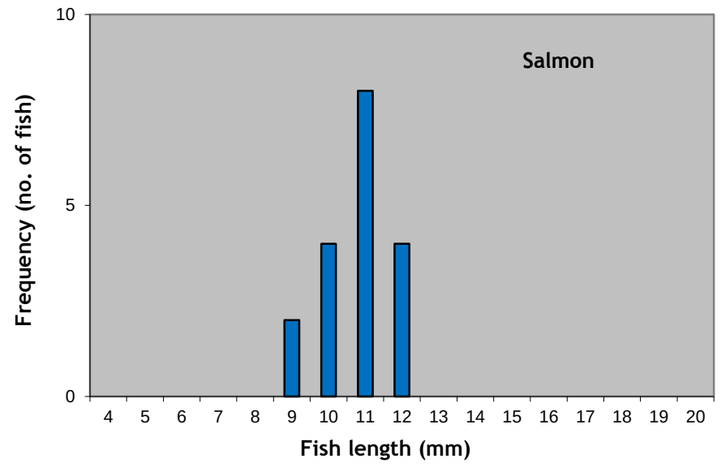


Chart 9.6: Length frequency distribution of salmon caught in the Knockoneill streams.



9.99 The trout length frequency shows a clear separation of Age 0 fry (4-8 cm) from 'older fish' (10-20 cm), made up of Age 1 and Age 2 fish. In contrast, the salmon length frequency consists of a single mode representing Age 1 fish, with no Age 0 fish present.

Distribution & Abundance

9.100 The results of the semi-quantitative survey are shown in **Table 9.13.** Juvenile trout, mostly in their first year (Age 0), were observed to have a widespread distribution within the Site in both the Knockoneill River and the Green Water but were absent from the Eastern tributary.

Table 9.13: Summary results of electrofishing survey indicating numbers of age 0 and older trout and salmon caught; trout fry abundance is also indicated.

Stream	Site	Grid Ref		Trout		Salmon		Trout Fry Abundance
		East	North	Age 0	Older	Age 0	Older	
Knockoneill River	1	280487	407629	7	3	0	0	Moderate
	2	280933	408105	15	2	0	0	Good
	3	281206	408143	14	2	0	2	Good
	4 (trib)	281231	407924	5	7	0	0	Moderate
	5 (trib)	281273	408125	3	2	0	4	Poor/Fair
	6	281255	408169	1	5	0	3	Poor
	7	281894	408481	3	1	0	9	Poor/Fair
Green Water	8	280267	408962	3	0	0	0	Poor/Fair
	9	280455	408931	5	0	0	0	Moderate
	10 (trib)	280517	408897	0	0	0	0	Absent
	11 (trib)	280535	408886	6	3	0	0	Moderate
	12	280697	408905	4	7	0	0	Moderate
	13	281065	408922	9	1	0	0	Good
	14	281883	408533	16	5	0	7	Good
Eastern trib	15	282351	408064	0	0	0	0	Absent

9.101 Applying the abundance index developed by Kennedy (*unpublished data*) to streams within the Site indicates trout densities ranging from *Poor* to *Good* in the Knockoneill and from *Poor/Fair* to *Good* in the Green Water (excluding one of the Green Water tributaries which was devoid of fish). This data indicates a significant level of spawning by adult trout in these streams.

9.102 The presence of salmon in specific reaches of the Knockoneill and the Green Water is noteworthy – all of these fish were in a narrow size range (9-12 cm) corresponding to Age 1 fish. DCAL surveys in this area would suggest little salmon spawning within 3 km of this reach, although salmon fry were detected in the area of Site 7 in 2014 **(Figure 9.4)**. This year class is equivalent to the Age 1 fish detected in this EIA survey in 2015. It is possible that there was some level of spawning in 2013 which could have given rise to this year class although this is considered unlikely as far upstream as sites 3 and 5 in the Knockoneill River **(Figure 9.4)**. Consultation with DCAL indicates that a salmon stocking exercise was carried out in 2014 by the local angling club and this is the origin of the fish detected in this EIA survey (J Hayes, *pers comm*).

Assessment of Effects

9.103 Potential effects were assessed for construction, operational and decommissioning phases of the Proposed Wind Farm Development. Construction impacts cover the discharge of suspended solids, release of other pollutants and interruption of fish passage. Post-construction (operational) impacts include habitat loss at watercourse crossings, obstruction of fish passage and surface water run-off.

9.104 Impact assessments are primarily based on their effect on salmonids either directly or upon their habitats. However, these assessments would be equally relevant to eels and lamprey if present in these waters.

Fisheries Significance / Sensitivity

9.105 Using the information assembled through the baseline assessment, the Fisheries Significance/Sensitivity for the main watercourses draining the area within the Preliminary Site Boundary and downstream of this area are shown respectively in **Tables 9.14 & 9.15**. Those waters containing Annexe II listed species such as Atlantic salmon or River/Brook/Sea lamprey are assessed as Very High in terms of environmental sensitivity. It should be noted that, although salmon were identified in two watercourses within the Site, the sensitivity of these waters is deemed to be *High* rather than *Very High* as they are likely to have been artificially stocked with salmon.

Table 9.14: Sensitivity of receiving watercourses within Preliminary Site Boundary and downstream to Knockoneill main channel.

River/Stream	Key Species	Sensitivity
Knockoneill River	Annexe II species: Atlantic salmon present. Brown trout also present.	High
Knockoneill Tributary	Annexe II species: Atlantic salmon present. Brown trout also present.	High
Green Water	Annexe II species: none. Brown trout present.	High
Green Water Tributary	Annexe II species: none. Brown trout present.	Medium
Eastern Tributary	Annexe II species: none. No fish present within Site but likely downstream.	Medium
Southern Tributary	Annexe II species: none. No fish present within Site but likely downstream.	Medium

Table 9.15: Sensitivity of receiving watercourses downstream of Preliminary Boundary

River/Stream	Key Species	Sensitivity
Green Water	Annexe II species: Atlantic salmon present. Brown trout also present.	High
Knockoneill River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High
Clady River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High
Lower Bann River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High

Construction Phase

Sediment Run-off

9.106 Salmonid fish are particularly sensitive to reductions in water quality and habitats can be damaged by siltation from settlement of Suspended Solids (SS) (Alabaster & Lloyd, 1980). This is recognised through the EC Freshwater Fish Directive which specifies a normal maximum SS concentration of 25 mg/l for salmonids, although the Directive has now been repealed by the WFD.

9.107 All waters designated under the EC Freshwater Fish Directive are included as or within water bodies under the WFD and water quality standards and monitoring requirements to ensure the protection of coarse and game fisheries are covered by the standards and procedures adopted in the WFD.

9.108 The impacts of SS on fish have been reviewed by Bilotta & Brazier (2008) who confirm that there are a range of potential impacts notably with regard to the deposition of sediments in salmonid spawning areas of rivers and its impact on development on eggs and fry. There can also be a direct effect on fish gills either through physical damage to the gill tissue or through clogging of the gills with waterborne particulate matter.

9.109 The settlement of sediments on the substrate can smother invertebrates and fish eggs, while the infiltration of coarse sediments (gravel and cobble) with fines can have longer term implications for the productivity of both groups. The characteristics of the riverbed are critical for fish spawning (Fluskey, 1989), and the tolerance of salmon eggs to sedimentation has been examined on the River Bush by O'Connor & Andrew (1998) who found that alevin survival was closely related to the level of fines with impacts detectable at a level of 10% fines.

9.110 Sediment run-off during construction could result from:

- Excavations associated with construction of access roads and turbine foundations;
- Engineering works associated with stream crossings;
- Surface peat disturbance and subsequent erosion of the underlying soils;
- Run-off from access roads;
- Peat slide resulting from slippage of access roads or excavated materials - a full Peat Slide Risk Assessment (PSRA) has been undertaken which concludes that the peat slide risk of the Proposed Wind Farm Development is *Very Low* to *Low* (see Chapter 10, Technical Appendix 10.4).

9.111 The survey has shown that watercourses within and along the Preliminary Site Boundary are populated by brown trout and Atlantic salmon, although the latter are likely to have been artificially stocked. Atlantic salmon and brown trout are also widely distributed at significant densities downstream of the Site throughout the Knockoneill and Clady rivers.

9.112 A significant sediment run-off could therefore have a localised impact on fish stocks and habitats both within the Site and in immediate downstream reaches. A major incident such as a peat slide event could have more serious impacts extending downstream into main channel stretches of the Knockoneill and Clady rivers with corresponding implications for fish stocks.

9.113 Much of the natural drainage at the Site will be by soakage rather than direct run-off. However, whenever the ground is saturated a high percentage of the rainfall will run off quickly to receiving watercourses. The main risk to these streams will therefore be during and following periods of heavy and sustained rainfall; such events are more likely during the autumn/winter period.

Release of other pollutants

9.114 As the Site drains into the headwaters of the Knockoneill River which connects to Clady River, there is some potential for spillage or release of diesel, oil or other polluting substances to reach these key waters with consequences for resident fish together with invertebrate organisms, including key Annexe II listed species.

9.115 During construction, with high usage of plant fuel and oil, there is an increased risk of accidental spillage and discharge to the Knockoneill River and thence to the Clady River. Similarly the application of ready-mix concrete in construction processes carries some risk of inadvertent discharge with the potential to impact on resident fish and invertebrate organisms in these watercourses.

Fish Passage: temporary obstruction

9.116 Improperly managed instream or bank works at crossing points can result in the obstruction of the stream channels during periods of upstream fish migration prior to spawning. A lack of spawning in the headwaters could reduce the overall productivity of juvenile fish in this area of the catchment during the construction phase.

9.117 The layout for the Proposed Wind Farm Development requires two significant watercourse crossings on potential fish migration routes in the Knockoneill River and its tributary:

- Main access track from the substation to T1 to T7;
- Access track branch to T1 to T5.

9.118 There are seven additional crossings on minor watercourses at which the field evidence indicates that fish passage will not be an issue i.e. the crossings are not on fish migration routes.

Operational Phase

9.119 The potential for any impacts will be significantly reduced during the operational phase with the construction process complete, site infrastructure in place, and a reduced requirement for any hazardous materials on-site.

Habitat loss at stream crossings

9.120 A watercourse crossing may result in significant loss of habitat if an extensive length of channel is enclosed in a culvert structure or significantly altered at a bridge structure, particularly where the original channel bed is lost and cannot be restored. Unnecessary removal of bed materials at stream crossing points can also result in long term loss of habitat and loss of channel diversity. Enclosure of the channel over significant lengths restricts light penetration which inhibits growth of benthic algae and aquatic plants, in turn leading to reduced potential for macroinvertebrates and fish. This effectively reduces productivity of the channel in the enclosed or shaded section.

9.121 The two watercourse crossings on the Knockoneill River and its tributary could each result in the loss of a small area of fish habitat. Proposed crossings on the other seven watercourses are located in reaches of little or no fisheries interest and are therefore not considered further.

Fish Passage: permanent obstruction/inhibition

9.122 The construction of stream crossings and installation of culverts can create permanent obstructions to fish passage if the movements of fish are not taken into account at the detailed design stage.

9.123 Obstructions usually result from the installation of inappropriate invert structures which may introduce either a steep slope to the channel with associated high water velocity, or an impassable vertical drop at the downstream edge.

9.124 There could be potential effects of this nature on fish passage at the two watercourse crossings on the Knockoneill River and its tributary.

Surface Water Run-off

9.125 Surface water run-off from an increased area of hard surface in the form of access tracks and hardstanding areas (crane hardstanding areas; onsite substation / control building compound) could lead to sediment-laden run-off to the receiving watercourses with potential effects on fish and other forms of aquatic life as outlined above.

9.126 Wash-out of areas of excavated peat during or following periods of heavy rainfall could also result in run-off of sediment to the receiving watercourses with potential increases in sediment load.

Decommissioning Phase

9.127 Decommissioning of the Proposed Wind Farm Development would have potential effects on fish stocks and aquatic habitats in the Knockoneill River. These impacts will be similar to those predicted for the construction phase but will ultimately depend on the level of reinstatement required.

9.128 In this case the decommissioning process will involve the removal of all above ground structures, removal of underground structures to one metre below ground level, and reinstatement of disturbed areas; access tracks are likely to remain for farm use. However, it is unlikely that any of the structures at or near to the main watercourses will be removed or modified in any way.

9.129 The effects of decommissioning on fish habitats and fish stocks are therefore likely to be similar to those of construction, although of lower magnitude.

Mitigation

Construction Phase

Sediment Run-off

9.130 Mitigation measures to control sediment run-off are described in detail in Chapter 10 (Geology & Water Environment) and summarised as follows:

Buffer Zones

9.131 It is important that sensitive watercourses should be avoided during the construction phase and 50m buffer zones for the development are outlined in Chapter 10. Turbine bases, access roads and associated infrastructure will be located outwith buffer zones with the exception of all new watercourse crossings.

9.132 This will minimise the risk of sediment run-off from site construction works reaching the headwaters of the Knockoneill River and more sensitive downstream reaches.

Construction Methods & Timing of Works

9.133 The Proposed Wind Farm Development will require new watercourse crossings at nine locations, two of which have been identified as sensitive. DCAL (2011) has developed guidance notes to assist in identifying potential effects on fisheries habitat in the course of construction and development work, and to outline practical measures for the avoidance and mitigation of damage.

9.134 Stream crossings at the two sensitive locations will be achieved using bottomless culverts to minimise disturbance of the river channel and the release of sediments – this is in line with DCAL guidance. The DCAL document also recommends that instream river works should be avoided during the salmonid spawning season and egg incubation phases, 1 October – 30 April. It has been agreed with DCAL that this restriction need not apply at these two

locations as the level of engineering required to install the bottomless culverts will be unlikely to have a significant impact on fish spawning (see Table 9.1 Consultee Responses).

9.135 The other seven watercourse crossings are relatively minor and will be completed using standard culvert structures which may be installed without any seasonal restriction.

9.136 All works at stream crossings will adhere to the measures outlined in the Good Practice Guidance notes PPG5: Works In, Near or Liable to Affect Watercourses (Environment Agency, 2014). It is also recommended that to minimise the risk of suspended sediment entrainment in surface water run-off, the site drainage system should only be constructed during periods of low rainfall and therefore low run-off rates.

Sustainable Drainage Systems (SuDS)

9.137 The potential for pollution of watercourses by silt-laden runoff has been addressed in detail in the SuDS Design Report and associated preliminary design included in Chapter 10: Geology & Water Environment. This approach adopts a temporary SuDS system for the drainage of the temporary works during the construction phase, with use of swales, check dams and settlement ponds to provide a surface water management system that will prevent any adverse effects on the ecology of the principal receiving watercourses during the construction phase of the project.

Release of other pollutants

Site Management

9.138 All precautions will be taken to avoid spillages of diesel, oil or other polluting substances during the construction phase. This will be achieved through good site practices as described in the Good Practice Guidance notes proposed by EA/SEPA/NIEA (Environment Agency, 2014), including:

- PPG1: General Guide to the Prevention of Water Pollution;
- PPG5: Works In, Near or Liable to Affect Watercourses;
- PPG10: Working at Construction and Demolition Sites.

9.139 A contingency plan will be prepared setting out the procedure to be followed in the event of a significant spillage occurring. Specific measures will be included in the Construction and Decommissioning Method Statement (CDMS), which will be agreed with DOE Planning prior to construction.

Sustainable Drainage Systems (SuDS)

9.140 The proposed SuDS system will also facilitate the interception of diesel, oil or other polluting substances during the construction phase.

Fish Passage: temporary obstruction

Construction Methods & Timing of Works

9.141 The installation of bottomless culverts to form new stream crossings at the two sensitive locations has been noted above. There will be no instream works required in the construction process and this ensure that there is no interruption of fish movements during the pre-spawning period for resident trout in these waters. For this reason it is also noted that there will be no seasonal restriction with regard to timing of construction at these locations.

Site Management

9.142 Appropriate site management during all works near watercourses will ensure that the channel remains passable for migratory fish at all times.

Operational Phase

Habitat loss at stream crossings

9.143 The use of bottomless culverts at the two sensitive watercourse crossings identified above will retain the natural stream bed and will therefore ensure that there will be no loss of fish habitat at these locations.

Fish Passage: permanent obstruction/inhibition

9.144 Long term free passage of fish at the two sensitive watercourse crossings will be assured through the installation of bottomless culverts which will have no significant morphological effect on the channel.

Surface Water Run-off

9.145 Site drainage will use the principles of SuDS, with installations to incorporate a “treatment train” of three stages of pollutant removal, including settlement and filtration features, to all surface water runoff during the operational phase, as with the construction and decommissioning phases.

- Additional measures to prevent the release of suspended solids will include:
- Preservation of natural run-off patterns;
- Reduction of flow rates from access tracks through use of attenuating check-dams;
- Use of shallow ponds to aid settlement;
- Linear track drainage swales with regular outflow points throughout the SuDS system to limit the potential for large flows at single outflow points;
- Avoidance of peat storage within denoted watercourse buffer zones or in areas of overland water flow;

9.146 Full details are provided in the SuDS Design Statement within Appendix 10.1).

Decommissioning Phase

9.147 Mitigation measures during decommissioning will be the same as during the construction phase with regard to addressing the potential for run-off of suspended solids and other polluting substances. However the level of mitigation will be determined by the level of reinstatement required. It is proposed that the surface water quality monitoring be extended into the decommissioning phase.

Residual Effects

9.148 The potential effects of the Proposed Wind Farm Development on fish stocks and their habitats in the Knockoneill River and the Clady River are measured against proposed mitigation measures, as a means of assessing the residual effects. It is the residual effects associated with the Proposed Wind Farm Development that most accurately reflect the overall predicted effects on fisheries and the aquatic environment during the construction, operational and decommissioning phases.

9.149 Of particular importance in this context are the effects on Atlantic salmon as a Habitats Directive Annex II species.

9.150 The magnitude of potential effects and their residual significance were assessed according to the procedure outlined in the Methodology section of this chapter. The aquatic receptors are considered in two groups:

- receiving watercourses within the Site and downstream to Knockoneill Bridge, 3.4 km from the Preliminary Site Boundary;
- receiving watercourses downstream of Knockoneill Bridge.

Knockoneill Bridge was selected as the boundary for local effects as the last of the Site drainage streams joins with the main channel in this area.

Construction Phase

9.151 Mitigation measures employed through the use of SuDS technology to control drainage and silt management on the Site will remove the potential for direct damage to fish or siltation of spawning and nursery habitats. These measures will also minimise the risk for release of other construction related polluting substances into the river network.

9.152 As there are no instream works scheduled in the two streams forming fish migration routes, there will be no effects on upstream trout migration or spawning activity.

9.153 The magnitude and significance of potential effects during the construction phase before mitigation are summarised for each watercourse in **Tables 9.16 & 9.17** along with the predicted residual effects after mitigation.

9.154 Without mitigation the effects during the construction phase are predicted to be at worst of Major Magnitude and of Very Large Significance, depending on specific effects and the sensitivity of individual watercourses e.g. sediment run-off to the Knockoneill River as a significant salmon spawning and nursery river. However, with mitigation the effects are reduced to Neutral.

Operational Phase

9.155 As there will be no instream works in the Knockoneill River there will be no loss of salmonid habitat or reduced productivity. Similarly there will be no long term obstruction or inhibition of fish passage as bottomless culverts will be deployed for stream crossings at sensitive sites.

9.156 Although there will be an increase in the area of hard surface due to the Proposed Wind Farm Development, the drainage design features for the control and attenuation of storm water run-off will protect receiving watercourses from excessive inputs of sediment.

9.157 The magnitude and significance of potential effects during the operational phase before mitigation are summarised for each watercourse in **Tables 9.18 & 9.19** along with the predicted residual effects after mitigation.

9.158 Without mitigation the effects during the operational phase are predicted to be at worst of Major Magnitude and of Very Large Significance, depending on specific effects and the sensitivity of individual watercourses. However, with mitigation the effects are reduced to Neutral.

Decommissioning Phase

9.159 The magnitude and significance of potential effects during the decommissioning phase before mitigation are summarised for each watercourse in **Tables 9.20 & 9.21** along with the predicted residual effects after mitigation.

9.160 Without mitigation the effects during the decommissioning phase are predicted to be at worst of Major Magnitude and of Very Large Significance, depending on specific effects and the sensitivity of individual watercourses. Mitigation measures will ensure that the effects remain as Neutral.

Table 9.16: Construction Phase – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses within Preliminary Site Boundary and downstream to Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Knockoneill River	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
			Obstruction of fish passage	Moderate	Moderate/Large	Neutral
Knockoneill Tributary	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
			Obstruction of fish passage	Moderate	Moderate/Large	Neutral
Green Water	Annexe II species: none. Brown trout present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
			Obstruction of fish passage	No impact	Neutral	n/a
Green Water Tributary	Annexe II species: none. Brown trout present.	Medium	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral
			Obstruction of fish passage	No impact	Neutral	n/a
Eastern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral
			Obstruction of fish passage	No impact	Neutral	n/a
Southern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral
			Obstruction of fish passage	No impact	Neutral	n/a

Table 9.17: Construction Phase – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses downstream of Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Green Water	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
Knockoneill River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Major	Very Large	Neutral
			Release of other pollutants	Major	Very Large	Neutral
Clady River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Moderate	Large/Very Large	Neutral
			Release of other pollutants	Moderate	Large/Very Large	Neutral
Lower Bann River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Minor	Moderate/Large	Neutral
			Release of other pollutants	Minor	Moderate/Large	Neutral

Table 9.18: Operational Phase – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses within Preliminary Site Boundary and downstream to Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Knockoneill River	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Habitat loss at stream crossings	Major	Large/Very Large	Neutral
			Fish Passage: permanent obstruction	Major	Large/Very Large	Neutral
			Surface water run-off	Moderate	Moderate/Large	Neutral
Knockoneill Tributary	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Habitat loss at stream crossings	Major	Large/Very Large	Neutral
			Fish Passage: permanent obstruction	Major	Large/Very Large	Neutral
			Surface water run-off	Moderate	Moderate/Large	Neutral
Green Water	Annexe II species: none. Brown trout present.	High	Habitat loss at stream crossings	No impact	Neutral	n/a
			Fish Passage: permanent obstruction	No impact	Neutral	n/a
			Surface water run-off	Moderate	Moderate/Large	Neutral
Green Water Tributary	Annexe II species: none. Brown trout present.	Medium	Habitat loss at stream crossings	No impact	Neutral	n/a
			Fish Passage: permanent obstruction	No impact	Neutral	n/a
			Surface water run-off	Moderate	Moderate	Neutral
Eastern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Habitat loss at stream crossings	No impact	Neutral	n/a
			Fish Passage: permanent obstruction	No impact	Neutral	n/a
			Surface water run-off	Moderate	Moderate	Neutral
Southern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Habitat loss at stream crossings	No impact	Neutral	n/a
			Fish Passage: permanent obstruction	No impact	Neutral	n/a
			Surface water run-off	Moderate	Moderate	Neutral

Table 9.19: Operational Phase – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses downstream of Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Green Water	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Surface water run-off	Major	Large/Very Large	Neutral
Knockoneill River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Surface water run-off	Major	Very Large	Neutral
Clady River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Surface water run-off	Moderate	Large/Very Large	Neutral
Lower Bann River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Surface water run-off	Minor	Moderate/Large	Neutral

Table 9.20: Decommissioning – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses within Preliminary Site Boundary and downstream to Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Knockoneill River	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
Knockoneill Tributary	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
Green Water	Annexe II species: none. Brown trout present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
Green Water Tributary	Annexe II species: none. Brown trout present.	Medium	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral
Eastern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral
Southern Tributary	Annexe II species: none. No fish present within Preliminary Boundary but likely downstream.	Medium (Low on-site)	Sediment Run-off	Moderate	Moderate	Neutral
			Release of other pollutants	Moderate	Moderate	Neutral

Table 9.21: Decommissioning – Magnitude and Significance of Potential Effects without Mitigation, and Residual Effects after Mitigation: receiving watercourses downstream of Knockoneill Bridge.

Receptor (River/ stream etc)	Location / Key Species	Sensitivity	Potential Effect	Magnitude of Effect	Significance without Mitigation	Residual Effect after Mitigation
Green Water	Annexe II species: Atlantic salmon present. Brown trout also present.	High	Sediment Run-off	Major	Large/Very Large	Neutral
			Release of other pollutants	Major	Large/Very Large	Neutral
Knockoneill River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Major	Very Large	Neutral
			Release of other pollutants	Major	Very Large	Neutral
Clady River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Moderate	Large/Very Large	Neutral
			Release of other pollutants	Moderate	Large/Very Large	Neutral
Lower Bann River	Annexe II species: Atlantic salmon present; River/Brook lamprey likely. Brown trout & European eel also present.	Very High	Sediment Run-off	Minor	Moderate/Large	Neutral
			Release of other pollutants	Minor	Moderate/Large	Neutral

Cumulative Effects

Additional Wind Farm Developments

9.161 This section considers other wind farm developments within a 20 km radius which have either been constructed or are at different stages of the planning process in Northern Ireland. Along with the Proposed Wind Farm Development, these developments/proposals could therefore give rise to the potential for cumulative effects on local rivers.

9.162 With regard to fisheries and the aquatic environment, the potential for cumulative effects is only relevant when proposed or existing developments are either hydrologically connected or which drain to the same receiving environment. It is therefore more important to consider additional developments in the context of river catchments, both locally and on a wider river basin scale.

9.163 A total of seven additional wind farm developments have been identified which are located within a 20 km radius of the Proposed Wind Farm Development and also within the Lower River Bann catchment **(Table 9.22)**. Two of these developments, Brockaghboy and Brockaghboy Extension, are partially located in the Knockoneill (Clady) catchment and could therefore give rise to the potential for cumulative effects on the Knockoneill River or the Clady catchment as a whole. Similarly, all seven developments could potentially have cumulative effects on the wider Lower Bann basin.

Table 9.22: Additional wind farm developments/proposals located within a 20 km radius of the Proposed Corlacky Hill Wind Farm and within the Lower Bann catchment

Wind Farm	Status	Approximate distance (km)	No. of Turbines	Location (River Catchment)
Brockaghboy	Consented	0.9	15	Knockoneill / Agivey
Brockaghboy Ext	Consented	1.4	4	Knockoneill / Agivey
Cam Burn	Consented	14	6	Agivey
Craiggore	Consented	9.1	10	Agivey
Upper Ballyrogan	Consented	8.9	5	Agivey
Evishagaran	Appeal	4.8	14	Agivey / Roe
Croaghan	Proposed	17.7	5	Macosquin

9.164 All of these schemes are yet to be constructed and will involve civil engineering works including land excavation to a greater or lesser extent and possibly including in-river works, each with the potential for similar effects on the aquatic environment including fisheries. As such there is the potential for the run-off of sediments to local watercourses with resultant damage to aquatic fauna and habitats.

9.165 Whilst there has been one noted problem relating to sediment run-off at Bin Mountain Wind Farm in the Fairy Water catchment, there do not appear to have been any problems relating to other sites in Northern Ireland or specifically within other areas of the Lower Bann catchment.

9.166 ES reports for the Brockaghboy and Brockaghboy Extension projects indicate that buffer strips at watercourses will be equivalent to the Proposed Wind Farm Development (i.e. 50 m and 10 m respectively at significant and minor watercourses). Moreover a Fisheries Assessment undertaken for the Brockaghboy development indicated that there would be no impacts on the Knockoneill River and its fish stocks.

Assessment

9.167 The potential for any cumulative effects in the immediate Knockoneill/Clady catchment is very low as there are only two consented or proposed developments within the same catchment, both of which are only partially located within the Knockoneill area.

9.168 The likelihood of significant cumulative impacts on the aquatic environment is increased if two or more wind farms are to be constructed or decommissioned at the same time. Brockaghboy and Brockaghboy Extension have both been consented and construction is likely to proceed within the next three years. In contrast Corlacky Hill is highly unlikely to commence building within this timeframe – simultaneous construction is therefore unlikely and this will further reduce the potential for any cumulative effects.

9.169 In terms of the wider Lower Bann basin the nearest potential wind farm developments are in the Agivey River catchment. The potential for any cumulative effects in combination with developments in the Agivey catchment is extremely low as the Proposed Wind Farm Development is hydrologically separated from the Agivey by 45 km of river channel (22 km of the Knockoneill/Clady and 23 km of the Lower Bann).

Summary

9.170 This chapter outlines the potential effects of the Proposed Wind Farm Development on the fish stocks and fish habitats of the receiving watercourses in the Knockoneill/Clady catchment. It provides relevant baseline information on fisheries enabling the potential effects to be identified and evaluated.

9.171 It has been determined that potential impacts are primarily related to the sediment run-off to the receiving watercourses with related effects on fish stocks and their habitats. Without mitigation it is considered that these impacts have the potential to be of Major Magnitude and of Very Large Significance depending of the sensitivity of individual watercourses

9.172 A series of specific mitigation measures have been designed to avoid adverse effects on fisheries with regard to both construction and operational phases of the project.

9.173 Hydrology and site drainage issues have been considered in detail in Chapter 10 which outlines a surface water management system and drainage (SuDS) designed to control drainage and silt management on the Site.

9.174 It is concluded that, provided the mitigation measures are implemented as specified, construction and operation of the Proposed Wind Farm Development will have a neutral impact on the fish stocks and aquatic biology of the Knockoneill and Clady rivers.

List of References and Figures

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Figures

- Figure 9.1: Location of proposed wind farm site in Knockoneill/Clady and Lower Bann river catchments indicating boundary of Neagh Bann International River Basin District.
- Figure 9.2: Location of Corlacky site in the Knockoneill River catchment and associated river waterbodies connecting to the Lower River Bann.
- Figure 9.3: Location of DCAL juvenile fish monitoring sites in Clady catchment, and NIEA chemical & biological monitoring sites on Knockoneill River.
- Figure 9.4: Location of fish survey sites and water chemistry sampling sites on site drainage streams.
- Figure 9.5: Surface water catchments and principal watercourses draining the Corlacky site.
- Figure 9.6: Outline habitat assessment of Knockoneill River within and adjacent to Preliminary Site Boundary – photo images.
- Figure 9.7: Outline habitat assessment of Green Water within and adjacent to Preliminary Site Boundary – photo images.
- Figure 9.8: Outline habitat assessment of Eastern & Southern tributaries within and adjacent to Preliminary Site Boundary – photo images.