APPENDIX D-2

Aquatic Ecology and Fish Report

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Malachy Walsh and Partners
Engineering and Environmental Consultants

Aquatic Ecology and Fish Report
Drumnahough Wind Farm

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1 INTRODUCTION

Malachy Walsh and Partners (MWP) have been commissioned by SSE Airtricity to prepare an Environmental Impact Assessment Report (EIAR) to accompany a planning application to Donegal County Council for the Drumnahough Wind Farm in Co. Donegal. As part of the EIAR preparation a suite of aquatic ecology and fish surveys were undertaken.

This report outlines the methods of obtaining survey information and data in relation to aquatic ecology at the proposed development site and waterbodies considered in the receiving environment of the project. Survey results of fish, macroinvertebrates and water quality assessments are presented. Information collated from desk studies has also been included in this report and has informed the surveys.

1.1 SITE LOCATION

The proposed wind farm is located in south-mid Donegal, approximately 13km west of Letterkenny and 10km north of Ballyboffey. The development site encompasses the townlands of Cark, Meenadaura, Treankeel and Carrickalangan. The site comprises predominantly non-native conifer forestry which is surrounded by blanket bog and marginal agricultural grassland. The land under conifer is predominantly under Coillte ownership and management.

The study area is located in the Finn/Derg/Foyle Water Management Unit (WMU) in Foyle Water Framework Directive (WFD) catchment which is part of Hydrometric Area 01, within the North-Western River Basin District (NWRBD). This report is based primarily on field studies of watercourses within this WMU potentially affected by the proposed development.

1.2 WATERCOURSES IN THE STUDY AREA

The proposed wind energy development site is drained largely by the Elatagh River and some small streams within Hydrometric Area 01 (Foyle). A map of the watercourses in the study area is provided in **Figure 2**. The Foyle catchment includes the area drained by the River Foyle and by all streams entering tidal water between Culmore Point, Co. Derry and Coolkeeragh, Co. Derry. This is a cross border catchment with a surface area of 2,919km², 914km² of which is located within the Republic of Ireland (RoI). The largest urban centres in the catchment are Ballybofey and Stranorlar. The part of the catchment located in Donegal is largely mountainous and is underlain by granites and metamorphic rocks of various types that are relatively poor aquifers[1].

The upper catchment of this Elatagh River an elevated area of peat overburden, much which has been planted with commercial coniferous forestry. The undying geology of the proposed development consists of schist, Termon Formation and river alluvium in areas along parts of the rivers course[2]. The Elatagh River is one of the upper tributaries of the River Finn. Impacts arising from peat cutting and forestry activities and chemical pollution from sheep dip are all pressures impacting both the Elatagh River and the River Finn according to WFD Cycle 2 (Catchment Foyle)[3].

[1] https://www.catchments.ie/data/#/catchment/01?_k=ch0j61

[2] https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

[3] https://www.catchments.ie/wp-content/files/subcatchmentassessments/01_8%20Finn[Donegal]_SC_010%20Subcatchment%20Assessment%20WFD%20Cycle%202.pdf

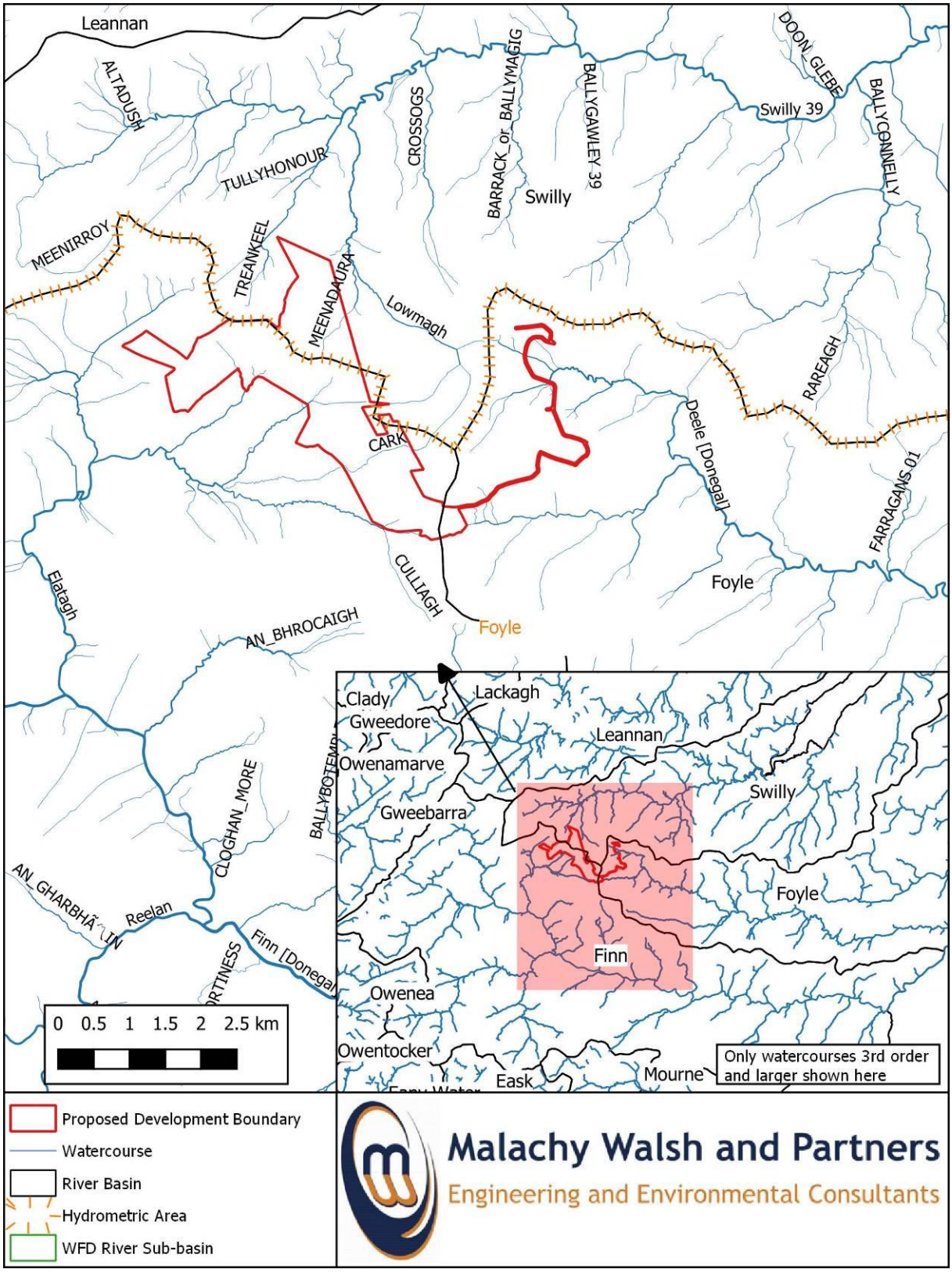

Figure 1. Watercourses in the study area.

Most watecourses within the proposed development drain in to the Elatagh River (See **Plate 1**). The Elatagh River rises to the south of the proposed site and flows north-west. Less than fed by a 1st order km from source, it is fed by the Culliagh stream from the south and an unnamed 1st order stream from the north. The 2nd order Elatagh River continues north-west and then west for ca. 1.8km before being fed by the 1st order Tullytrasna stream from the south. The Elatagh River continues north-west for ca. for less than 1km to meet the Cark Stream, a 1st order watercourse

which flows through the proposed development site. An un-named second order stream joins the Elatagh River ca. 50m downstream of the Cark Stream confluence. This unnamed stream is formed by two 1st order streams that rise within the proposed development site. For the next ca. 1.1km the 3rd order Elatagh River flows north-west and is fed by two unnamed 2nd order streams from the south before meeting the 2nd order stream Carraig An Langáin Stream. The Carraig An Langáin Stream rises within the proposed development and drains the north-west of the site. After its confluences with Carraig An Langáin stream, the Elatagh River flows south-west for ca. 2.7km. Along this reach it is fed by a 1st order, 2nd order and 3rd order unnamed streams from the north, three unnamed 1st order streams from the west and the 1st order An Ailt Leathan stream from the east. For the next ca. 0.6km the 4th order Elatagh River flows south and is fed by one unnamed 1st order stream from the east before finally meeting the 5th order River Finn (See **Plate 1**).

Plate 1. Stretch of the Elatagh River at bridge south-west of the proposed development (left) and stretch of the River Finn at the R252 to the south of the proposed development July 2019.

The River Finn is classed as a Special Area of Conservation (SAC) for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive; Oligotrophic Waters containing very few minerals [3110], Northern Atlantic wet heaths with *Erica tetralix* [4010], Blanket bogs (* if active bog) [7130], Transition mires and quaking bogs [7140], Salmon (*Salmo salar*) [1106] and Otter (*Lutra lutra*) [1355][4]. The main stem of the Elatagh River and associated riparian areas are part of this designated site.

The River Finn SAC Site Synopsis states: The Finn system is one of Ireland's premier salmon waters. Although the Atlantic Salmon is still fished commercially in Ireland, it is considered to be endangered or locally threatened elsewhere in Europe and is listed on Annex II of the E.U. Habitats Directive. Commercial netting on the Foyle does not begin until June and this gives spring fish a good opportunity to get into the Finn. The Finn is important in an international context in that its populations of spring salmon appear to be stable, while they are declining in many areas of Ireland and Europe. Agriculture, with particular emphasis on grazing, is the main land use along the Finn and its tributaries. Much of the grassland is unimproved but improved grassland and silage are also present, particularly east of Ballybofey. The spreading of slurry and fertiliser poses a threat to the water quality of this salmonid river, particularly in this region as the river is subject to extensive flooding. Fishing is a main tourist attraction on the Finn and there are a large number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. The River Finn is a designated Salmonid Water under the E.U. Freshwater Fish Directive. Other

[4] https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002301.pdf

aspects of tourism such as boating are concentrated around Lough Finn. Afforestation is ongoing, particularly along the western sections of the site adjacent to the headwaters and around the shores of Lough Derg. Recent planting has been carried out along the Cronamuck River. Forestry poses a threat in that sedimentation and acidification occurs. Sedimentation can cover the gravel beds resulting in a loss of suitable spawning grounds[4].

1.3 GUIDANCE AND LEGISLATION

The assessment has regard to the following legislation:

- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. 272 of 2009) and (Amendment) Regulations 2012 and 2015
- Birds and Natural Habitats Regulations 2011 (S.I. No. 477/2011), and (Amendment) Regulations 2013 and 2015
- Wildlife Act 1976 as amended

The European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. 272 of 2009) and (Amendment) Regulations 2012 and 2015 establish legally binding quality objectives for all surface waters and environmental quality standards for pollutants for purposes of implementing provisions of E.U. legislation on protection of surface waters. These regulations clarify the role of public authorities in the protection of surface waters also concern the protection of designated habitats.

The Water Framework Directive (WFD), (2000/60/EC) is EU legislation and a major driver for achieving sustainable management of water in Ireland and across the EU. The objective of this directive is to prevent any further deterioration in status of all inland and coastal waters and to restore polluted waterbodies to at least 'Good' ecological status. 'Good ecological status' means achieving satisfactory quality water, suitable for local communities' drinking, bathing, agricultural, industrial and recreational needs, while maintaining ecosystems that can support all the species of plants, birds, fish and animals that live in these aquatic habitats.

The European Communities Birds and Natural Habitats Regulations 2011 transpose the Habitats Directive and the Birds Directive. The Habitats Directive contributes to ensuring biodiversity in the European Union by conserving natural habitats and wild fauna and flora species. It sets up the 'Natura 2000' network, the largest ecological network in the world. Natura 2000 comprises special areas of conservation designated by EU countries under this directive and special protection areas classified under the Birds Directive (Directive 2009/147/EC).

The Wildlife Act, 1976 provided a good legislative base for nature conservation. The species protection provisions, including those regulating hunting, are quite comprehensive, to the extent, for example, that they largely foresaw similar aspects of the EU Birds and Habitats Directives.

Relevant guidance published by the National Roads Authority (NRA, now TII), and applicable to assessing watercourses in Ireland were also followed, including 'Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes' (NRA, 2005). IFI (2016) 'Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters' was also consulted in relation to necessary mitigation.

Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter is defined as not only as any substance that is liable to injure fish but is also liable to damage their spawning grounds or the food of any fish or to injure fish in their value as human food or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish. It is necessary to get written permission from Inland Fisheries Ireland to proceed with works in any areas where disturbance to the spawning and nursery areas of both salmonids and lampreys occur. Salmon, all lamprey species and their habitats are further protected under the EU Habitats Directive.

Under Section 3 of the Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act) it is an offence to cause or permit any polluting matter to enter waters. Suspended solids would be a key parameter here. Likewise, any visual evidence of oil/fuel in the river would constitute an offence.

2 METHODOLOGY

2.1 DESK STUDY

A desktop review was carried out to collate information on fish and to identify features of aquatic ecological importance within the study area. Records of protected aquatic species in the environs of the proposed development were identified. This information was obtained by accessing the website of the National Parks & Wildlife Service (NPWS)[5] and Inland Fisheries Ireland (IFI)[6]. The database of the National Biodiversity Data Centre (NBDC)[7] was consulted to assess the presence of aquatic faunal species and records of protected species from records of the study area. The document '*Quantification of the freshwater salmon habitat asset in Ireland*' by McGinnity *et al.* (2003) was also reviewed to classify the salmonid habitats in the study area.

2.2 FIELD SURVEYS

The field surveys comprised an evaluation of aquatic habitats, fish assessments, biotic assessment using aquatic macroinvertebrates and water sampling for analysis of physico-chemical water quality parameters. A Freshwater Pearl Mussel (FPM) survey was carried out on selected watercourses. Representative accessible locations on watercourses draining the proposed development were surveyed (see **Figure 2**). A total of eleven sites were surveyed. These sites were selected at/near roads and/or tracks, given that these sites may require monitoring. Site 1 on the Elatagh River was chosen with considerations for its relatively large size, location as a receptor on the river draining most the proposed development, supporting habitats for salmonids and that it corresponds to EPA water quality monitoring station RS01E020100. The list of survey sites is given **Table 1**.

Water quality affects the viability and quality of salmonid habitat so is useful in assessing habitats for aquatic organisms, including trout and salmon. To this end biological sampling and water quality indices, as well as macroinvertebrate functional feeding group analysis were used to evaluate watercourses at selected locations. Field work pertaining to aquatic habitats and macroinvertebrates was carried out on the 3rd, 4th and 5th of July 2019.

[5] https://www.npws.ie/maps-and-data
[6] https://www.fisheriesireland.ie/
[7] http://www.biodiversityireland.ie/

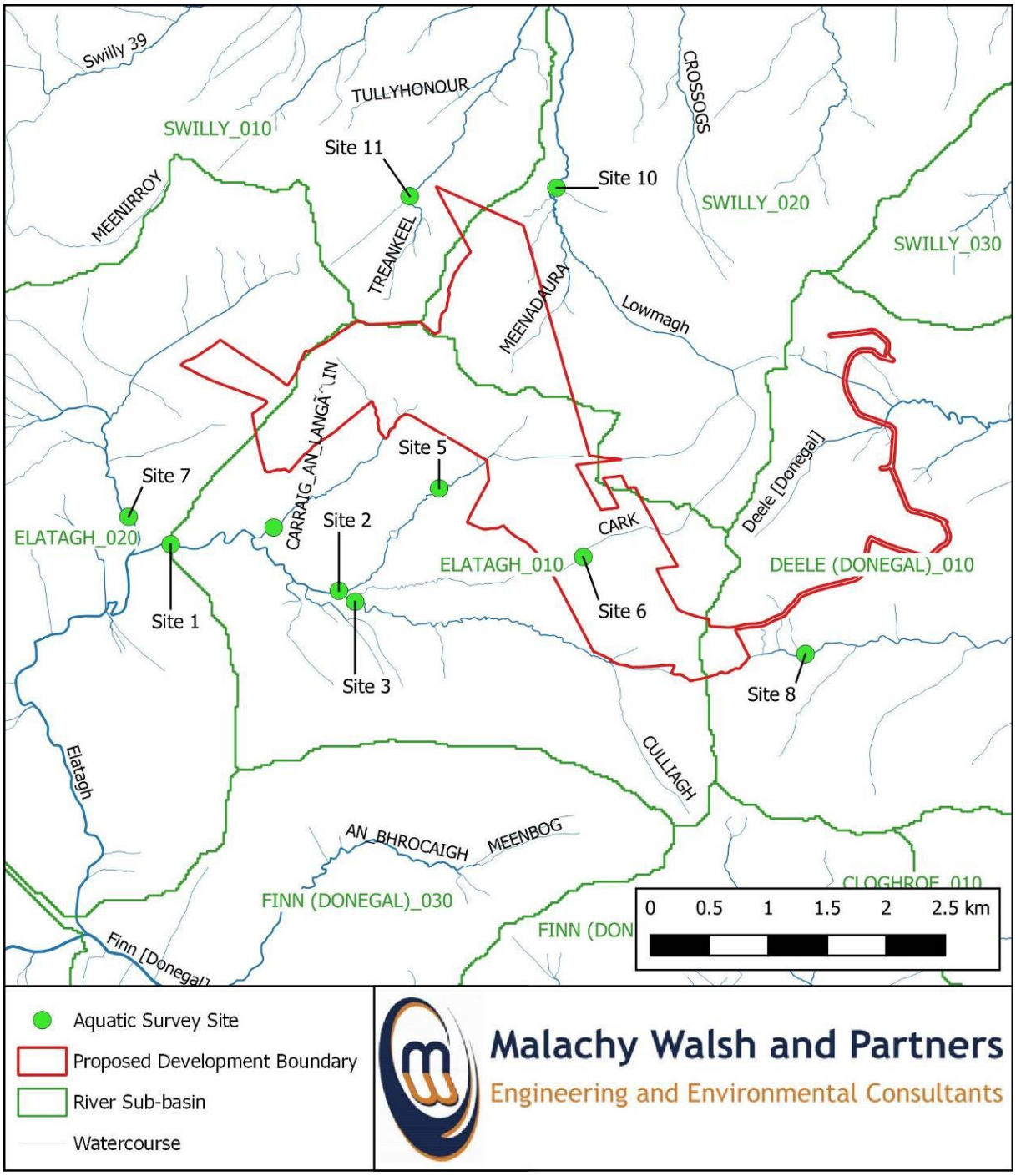

Figure 2. Watercourses and survey sites examined as part of the aquatic ecology studies for the proposed Drumnahough Wind Farm.

Table 1. Aquatic ecology and fish survey locations on watercourses draining the proposed Drumnahough Wind Farm.

Hydrometric Area/River Basin	River Catchment	Waterbody / EPA Code	Site No.	Tributary - Sub-tributary / EPA Code	Order	Location	EPA River Segment code	Co-ordinate (ITM)		Survey			
								X	Y	Fish habitat	Fish survey	Biological	Physico-chemical
01 / North Western	Foyle	Finn / 01F01	1	Elatagh / 01E02	3	Bridge N of Stranabrack Lower (corresponds to EPA station RS01E020100)	01-906	602405.2	904619.7	✓	✓	✓	✓
			2	Elatagh / 01E02	3	Carrickalangan, ca. 200m upstream of Elatagh River	01-889	602763	904384.9	✓	✓	✓	✓
			3	Elatagh / 01E02	2	Tullytrasna/Cark, ca. 100m upstream of Cark Stream confluence	01-251	604189.8	903986	✓	✓	✓	✓
			4	Elatagh - Carraig An Langáin / 01C14	2	Carrickalangan, ca. 200m upstream of Elatagh River	01-1733	604327	903892.4	✓	✓	✓	✓
			5	Elatagh - Unnamed	2	Carrickalangan / Cark, ca. 1.3km upstream of Elatagh River	01-897	603636	904528.1	✓	✓	✓	✓
			6	Elatagh - Cark / 01C11	1	Cark, ca. 2.2km upstream of Elatagh River	01-628	605039.9	904864.3	✓		✓	✓
			7	Elatagh - Unnamed	3	Carrickalangan / Arbatt, ca. 400m upstream of Elatagh River	01-1502	606262.8	904276.9	✓	✓	✓	✓
			8	Cloghroe / 01C05	2		01_618	604791.1	907370.3	✓		✓	
			9	Deele / 01D01	3	Cark / Kirkneedy	01_493	606035.9	907442.2	✓		✓	✓
39 / Lough Swilly	Swilly	Swilly / 39S02	10	Lowmagh / 39L04	3	Ballygallan / Treankeel, just upstream of Ballygallan Stream confluence	39_717	608147.6	903443.5	✓		✓	
			11	Treankeel / 39T14	2	Tullyhonour / Treankeel	39_2437	610344.8	905266.5	✓		✓	

2.2.1 Aquatic Habitats

The study area was defined as fluvial habitats (watercourses) potentially affected by the proposed development, including within the proposed development site, and those downstream, within the receiving environment. While survey locations down-gradient of the proposed development area are influenced by factors outside of the site boundary, downstream biota are nonetheless receptors with regard to potential effects of the proposed development, and acquisition of baseline information at these locations is deemed important in a complete understanding of aquatic sensitivities in the receiving environment. Indeed, the larger size of watercourses downstream of the proposed development provide more habitat and are considered more suitable for aquatic biota than reaches inside the proposed development site boundary.

Habitat assessment was carried out at these sites using the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). Watercourses were photographed at survey site locations and at various locations throughout the study area. Anthropogenic and livestock influences on fluvial and riparian habitats were noted along the surveyed stretches. Aquatic survey sites were assessed in terms of:

- Stream width and depth and other physical characteristics;
- Substrate type, listing substrate fractions in order of dominance, i.e. large rocks, cobble, gravel, sand, mud etc.;
- Flow type, listing percentage of riffle[8], glide[9] and pool[10] in the sampling area;
- Instream vegetation, listing plant species occurring and their percentage coverage of the stream bottom at the sampling site (as applicable) and on the bankside; and
- Estimated cover by bankside vegetation, giving percentage shade of the sampling site.

2.2.1.1 Macroinvertebrate Habitat Evaluation

Habitat has a key influence on the macroinvertebrate communities, which occur in rivers and streams. The physical habitats of study sites were assessed in relation to macroinvertebrates using a method given by Barbour and Stribling (1991). This method assesses habitat parameters and rates each parameter as optimal, sub-optimal, marginal or poor (scores 5, 10, 15 and 20 respectively). The scores for each parameter are then added up to give an overall habitat score. **Appendix 1** shows how habitats are assessed using this method.

2.2.1.2 Fish Habitat Evaluation

The results of the aquatic habitat survey were used in conjunction with the document 'Ecology of the Atlantic Salmon' (Hendry and Cragg-Hine, 2003) to assess habitat suitability for salmonids at selected representative sites. An evaluation of lamprey nursery habitat was also carried out based on the habitat requirements of juvenile lampreys as outlined in Maitland (2003). Searches for juvenile lampreys were carried out using agitation sampling where suitable nursery habitat occurred.

[8] Described in EA (2003) as shallow, fast-flowing, water with a distinctly disturbed surface over unconsolidated gravel-pebble, or cobble, substrate

[9] Laminar flow where water movement did not produce a disturbed surface

[10] Little/no observable flow

The results of the stream habitat surveys were used in conjunction with the leaflet '*The Evaluation of habitat for Salmon and Trout*' (DANI, 1995) to assess habitat suitability for salmonids at selected representative sites. This leaflet (Advisory leaflet No. 1) was produced by the Department of Agriculture for Northern Ireland Fisheries Division and was designed for use in the EU salmonid enhancement programme.

2.2.2 Macroinvertebrates

2.2.2.1 Benthic Macroinvertebrate Sampling

Semi-quantitative sampling of benthic macroinvertebrates, or aquatic insects, was undertaken at all river sites using kick-sampling (Toner *et al*., 2005). Benthic (bottom dwelling) macroinvertebrates are small stream-inhabiting creatures that are large enough to be seen with the naked eye and spend all or part of their life cycle in or on the stream bottom. Three replicate, 3-minute, multi-habitat kick samples were taken within a 50m stretch using a 1mm mesh kick net (see **Plate 2**). All samples of invertebrates were combined for each site and live sorted on location, fixed in ethanol and labelled for subsequent laboratory identification. The relative abundance and numbers of macroinvertebrates was recorded on-site at each site. Macroinvertebrate sampling was carried out in accordance with ISO 5667-3:2004: Water Quality – Sampling – Part 3: Guidance on the Preservation and Handling of Water Samples and ISO 7828: 'Water Quality – Methods of biological sampling – Guidance on Hand net sampling of aquatic benthic macro-invertebrates'. Macroinvertebrates were identified using keys listed in the references section. Biological water quality assessments and Functional Feeding Group (FFG) analysis was carried out for each site using biotic indices, based on the range and abundances of macroinvertebrates recorded. Details of biotic indices and FFG are provided in **Appendix 2**.

Plate 2. Biological sampling was undertaken at selected representative watercourses in the study area (left). Macroinvertebrates captured during kick sampling were live sorted for 20 minutes at each site using a forceps and a white background. Biological water quality sampling apparatus employed during the on-site investigations (right).

2.2.2.2 Freshwater Pearl Mussel Survey

MWP applied for and were issued a licence (No. C71/2019) from NPWS to carry out freshwater pearl mussel (FPM) *Margaritifera margaritifera* survey work in the study area. The survey was carried out from the 2nd – 4th July 2019 in the Finn catchment. Surveying in the Swilly catchment was carried out on the 2nd and 3rd November 2019. At these times, water levels were low, sunshine dominated, and underwater visibility was suitable for FPM detection.

The Finn catchment is within a catchment listed in the NPWS *Margaritifera* Sensitive Areas Map[a] and is the only such catchment potentially impacted by the proposed development. This catchment is identified having 'Previous records of *Margaritifera*, but current status unknown'. Stream reaches within the Swilly catchment to the north of the proposed development were also surveyed. The river reaches listed in **Table 2** and illustrated in **Figure 3** were surveyed. The areas surveyed were selected on the basis of accessibility (incl. safety), proximity to site, watercourse size and coverage within the receiving environment.

Surveying for FPM was carried out following the NPWS guidance '*Margaritifera margaritifera* Stage 1 and Stage 2 survey guidelines, Irish Wildlife Manuals, No. 12' (Anon, 2004). The watercourse reaches examined were subject to a presence/absence survey which involved wading in the river while viewing the substrate and looking for FPM with the aid of a bathyscope (see **Plate 3**) and with polarised sunglasses. Instream movements were from downstream to upstream. The survey also involved checked for the presence of dead shells, particularly in depositing areas. Transect surveys were carried out on the main channel of the River Finn. Entire river reaches were surveyed in the Elatagh River.

The river condition and habitat features at each survey stretch were noted. The potential for FPM to occur along each stretch was assessed with reference to the following publication: Conserving Natura 2000 Rivers Ecology Series No. 2 *'Ecology of the Freshwater Pearl Mussel*' (Skinner *et al.*, 2003). The habitat was evaluated with reference to Environmental Quality Objectives (EQOs) as specified in Schedule 4 of the '*European Communities Environmental Objectives (Freshwater Pearl*

Mussel) Regulations', S.I. 296 of 2009 (See

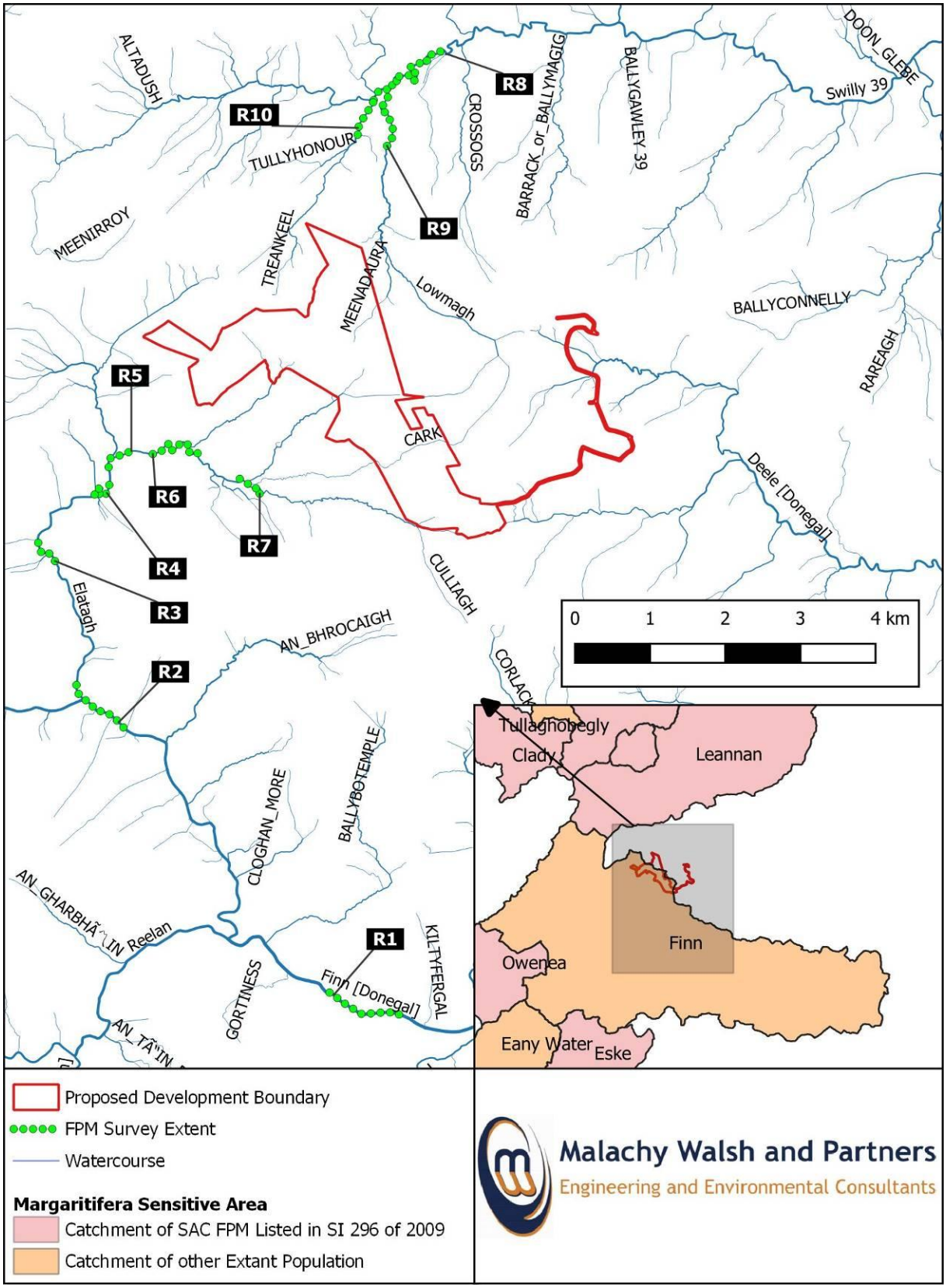

Figure 3. **River reaches surveyed for FPM downslope of the proposed Drumnahough wind farm in 2019.**

Plate 3. Electrical fishing at Site 4 (left). Surveying for FPM with a bathyscope in the Elatagh River (right).
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Results for each survey reach were compared with the ecological quality objective set for macroalgae in the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations, S.I. 296 of 2009. The following evaluation ranges for population densities, siltation and filamentous algae were employed in the current survey, based on the monitoring methods set out in the Freshwater Pearl Mussel Sub-basin Plans (North South 2, 2009) and employed by the NPWS during Freshwater Pearl Mussel monitoring:

Population densities:

- Abundant (>250 per 100m of channel)
- Frequent to Common (20 – 250 per 100m)
- Occasional (less than 20 per 100m)
- Absent

Siltation:

- no visible silt plume
- some visible silt
- a lot of visible silt

Algae

- *Rare:* just visible in the field, covers < 1 % of the riverbed
- *Occasional*: covers 1 % to < 5 % of the riverbed
- *Frequent*: covers 5 % to < 25 % of the riverbed
- *Abundant*: covers 25 % to < 50 % of the riverbed
- *Dominant*: covers > 50 % of the riverbed

Table 2. Watercourses reaches surveyed for FPM during 2019.

Watercourse	Survey reach code	Location / townland	Survey stretch (ITM)		Approx. length of channel surveyed (m)
			Start	Finish	
River Finn	R1	Main channel of Finn at Kiltyfergal/Ballybobaneen/Altnapaste	605340, 897095	605278, 897108	1km
Elatagh River/ River Finn	R2	Reach of the River Finn downstream of the Etalgh confluence and reach of Etalgh upstream of Finn confluence at Altlahan/Meenalig/Letterbrick	602585, 900665	601968, 901278	950m
Elatagh River	R3	Reach of the Elatagh River at Arbatt/Altlahan/Letterbrick	601674, 902904	601456, 903251	490m
Elatagh River	R4	Reach of the Elatagh River at Arbatt/Altlahan	602199, 903794	602396, 903929	500m
Elatagh River	R5	Reach of the Elatagh River at Altlahan	602389, 904168	602765, 904386	500m
Elatagh River	R6	Reach of the Elatagh River at Altlahan near the Carraig an Langáin Stream confluence	602977, 904346	603610, 904252	1.4km
Elatagh River	R7	Reach of the Elatagh River at Tullytrasna/Cark	604084, 903965	604398, 903812	400m
River Swilly	R8	Reach downstream of the Treankeel River confluence	606881, 909734	605917, 909112	1.5km
Lowmagh River	R9	Reach upstream of the River Swilly confluence	605917, 909112	606096, 908501	850m
Treankeel River	R10	Reach upstream of the River Swilly confluence	605917, 909112	605703, 908644	540m

Table 3. Ecological Quality Objectives for Freshwater pearl mussel habitat.

Element	Objective	Notes
Filamentous algae (Macroalgae)	Absent or Trace (<5%)	Any filamentous algae should be wispy and ephemeral and never form mats
Phytobenthos (Diatoms)	*EQR 0.93*	*High status*
Macrophytes - Rooted higher plants	Absent or Trace (<5%)	Rooted macrophytes should be absent or rare within the mussel habitat
Siltation	No artificially elevated levels of siltation	No plumes of silt when substratum is disturbed

from S.I. No. 296 of 2009

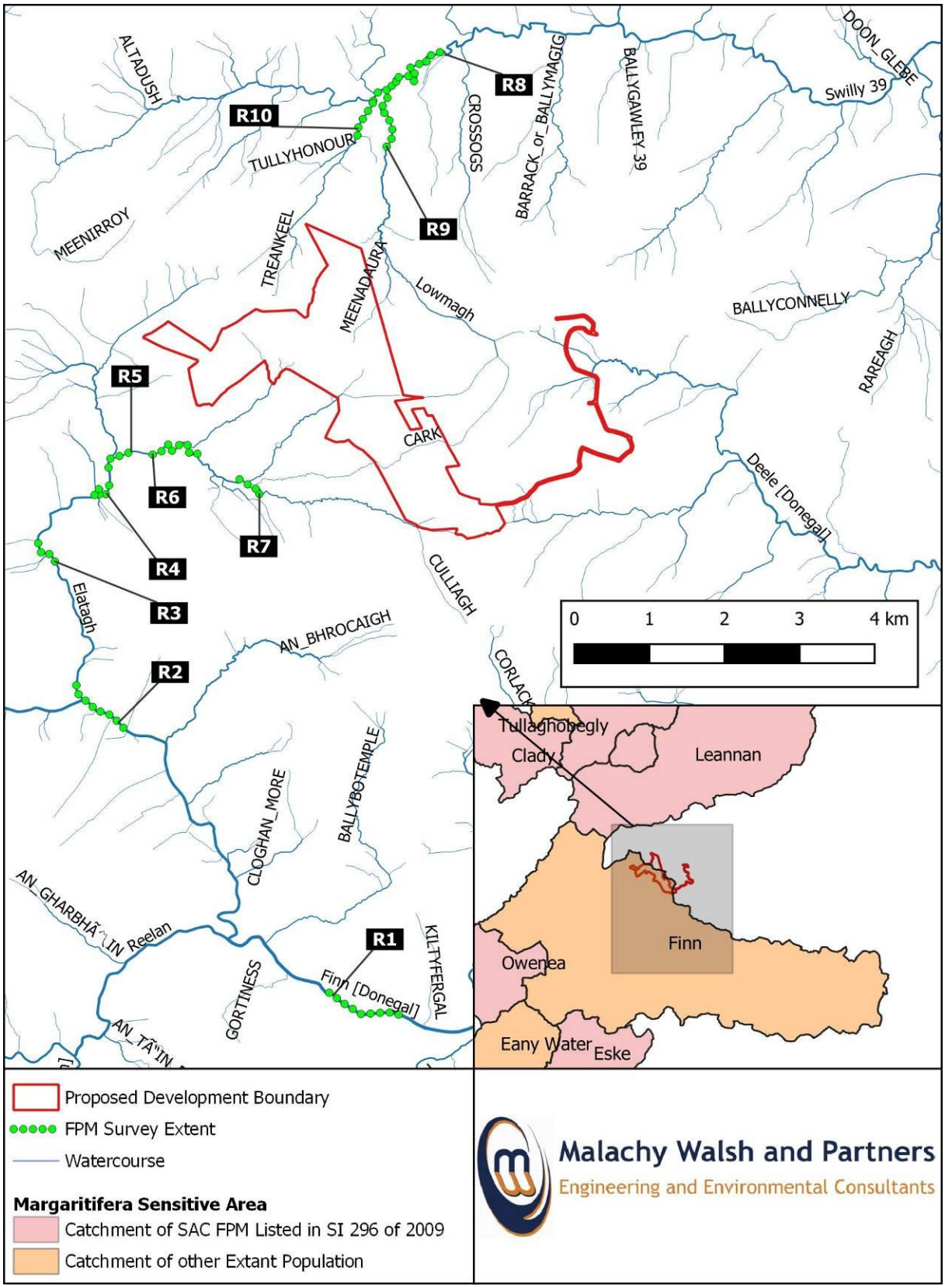

Figure 3. River reaches surveyed for FPM downslope of the proposed Drumnahough wind farm in 2019.

Plate 3. Electrical fishing at Site 4 (left). Surveying for FPM with a bathyscope in the Elatagh River (right).

2.2.3 Biological Water Quality

Benthic macroinvertebrates, or aquatic insects were used as an indicator of water quality at each sampling site. The Quality Rating (Q) System and other biotic indices described below were used to classify biological water quality at all aquatic survey sites (See **Table 1** and **Figure 2**).

2.2.3.1 Biotic Indices

Biotic indices used to assess water quality are described here and further detail is provided in **Appendix 2.**

2.2.3.1.1 Quality Rating (Q) System

The Quality Rating (Q) System devised by Toner *et al.* (2005) was used to obtain a water quality rating, or Q-value. As per S.I. No. 258 of 1998, 'biological quality rating' means a rating of water quality for any part of a river based principally on the composition of macroinvertebrate communities/faunal groups present and their general sensitivity to organic pollution. This method categorises invertebrates into one of five groups (A-E), depending on their sensitivity to pollution. Q values range from Q1-Q5 with Q1 being of the poorest quality and Q5 representing pristine/unpolluted conditions. The Q index system is used by the Environment Protection Agency (EPA) and is currently the standard biological assessment technique used in surveying rivers in Ireland under the Water Framework Directive (WFD).

Biological quality elements are classified into five WFD ecological status classes – High, Good, Moderate, Poor, and Bad. These and have been intercalibrated with the EPA Q-rating system as shown in

Table **2**. These tables also provide a description of each of the ecological status classes based on the definitions in the WFD and the typical ecological responses associated with each class.

2.2.3.1.2 Biological Monitoring Working Party (BMWP)

The other main biotic index used was the BMWP score. In the revised BMWP scheme (Walley and Hawkes, 1997), each family recorded in the sample is assigned a habitat specific score. This score depends on the pollution sensitivity of the invertebrate family together with the characteristics of the site where the invertebrates were found. A site is classed as one of the following depending on substrate type: riffle (>= 70% boulders and pebbles), pool (>= 70% sand and silt) or riffle/pool (the remainder). The BMWP score is the sum of the individual scores of the families recorded at each site - a family scores if present. A higher BMWP score is considered to reflect a better water quality and a score over 100 is indicative of very good water quality. **Appendix 2** shows revised BMWP scores for riffled locations and the BMWP scoring system. Each site was assigned a biological status on a scale of High-Good-Moderate-Poor-Bad.

The Habitat Specific Scores are based on the following substrate compositions:

- Riffles: >= 70% boulders and pebbles
- Pool: >= 70% sand and silt
- Riffle/Pool: the remainder

2.2.3.1.3 Average Score Per Taxa

Each site was allocated an Average Score Per Taxa (ASPT). A weakness of the BMWP system, in common with many other score systems, is the effect of sampling effort. A prolonged sampling period can be expected, under most circumstance, to produce a higher final score than a sample taken quickly. To overcome this inherent weakness of the BMWP system, it became common practice to calculate the ASPT. The ASPT index calculation is based on the average value of each taxa (families) sampled is calculated by summing up the indicator values and their division by numbers of taxa (families) sampled and ranges from 0 to 10. A high ASPT index values indicates thus high ecological status and low values indicate bad/degraded ecological status. In general, the higher the number of taxa present, the better the biological quality of the reach, especially where the ASPT values are high (greater than 5.5).

2.2.3.1.4 EPT Index

Biological water quality was also assessed using the EPT (**E**phemeroptera **P**lecoptera **T**richoptera) index. The EPT index (Lenat, 1988) uses three orders of aquatic insects that are easily sorted and identified: mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera), and is commonly used as an indicator of water quality. The EPT index is calculated by summing the number of taxa represented by these 3 insect orders. The EPT Index is based on the premise that high-quality streams usually have the greatest species richness. Many aquatic insect species are intolerant of pollutants and will not be found in polluted waters. The greater the pollution, the lower the species richness expected.

2.2.3.2 Physico-Chemical Water Quality

Water samples were taken from the 7 river sites in the Finn catchment on the 30th September 2019. See **Table 1** and **Figure 3** for locations. Samples were taken from each site using aseptic techniques and were then stored in a cooler box. The samples were then delivered to BHP Laboratories the

following morning. The following physico-chemical parameters were assessed: Ammonium, Total Ammonia, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate, Nitrite, Orthophosphate, Suspended Solids, Total Phosphorus, Total Hardness, Total Dissolved Solids, and Total Organic Carbon (TOC). Water levels and conditions were noted at the time of the survey.

Each site was assigned a chemical status on a scale of High-Good-Moderate-Poor-Bad based on water quality standards given in Surface Water Regulations (DoEHLG, 2009), the Freshwater Fish Directive (78/659/EEC) and the Salmonid Water Regulations (1998).

Table 4 gives chemical parameter thresholds for achievement of Water Framework Directive 'High' and 'Good' Status.

Table 4. Chemical parameter thresholds for achievement of Water Framework Directive 'High' and 'Good' Status. From the Surface Water Regulations (SWR, 2009 and as emended)

Parameter	High Status	Good Status
BOD	≤1.3 (mean(1)) or ≤2.2 (95%ile)	≤1.5 (mean(1)) or ≤2.6 95%ile
Total Ammonia	≤0.040 (mean) or ≤0.090 (95%ile)	≤0.065 (mean) or ≤0.140 (95%ile)
Orthophosphate	≤0.025 (mean) or ≤0.045 (95%ile)	≤0.035 (mean) or ≤0.075 (95%ile)

2.2.4 Functional Feeding Group (FFG) Analysis

Functional Feeding Group (FFG) analysis was undertaken to gain further insight into the aquatic ecology of the receiving environment. FFG analysis was carried out on the macroinvertebrates recorded at each site. FFG is a classification technique for stream macroinvertebrates which involves the functional analysis of invertebrate feeding, based on morpho-behavioural mechanisms of food acquisition. Several functional feeding groups of invertebrates occur in streams. These are Shredders, Collectors (or filterers), Scrapers (or grazers), and Predators. Changes in functional groups reflect changes in food sources, nutrient processing and energy flow in the river system. Human influences on a river can dramatically alter food sources and in turn affect the trophic groups. This method of analyses was used as it provides a greater insight into the ecology of a river and can detect more subtle changes in community structure than would be apparent from biotic indices.

The juvenile P/R ratio and salmonid index were calculated based on the relative abundances of macroinvertebrates. The P/R ratio is a measure of the trophic status of a system: the ratio of gross primary production to community respiration (ratio of scrapers to collectors and shredders). If P/R ratio is >1, the system is autotrophic. Heterotrophy vs autotrophy is based on a P/R threshold of > 0.75 = autotrophic (Rabenil *et al*. 2005).

The juvenile salmonid index is the ratio of behavioral drifters (filtering and gathering collectors) to accidental drifters (scrapers, shredders and predators). A predictable juvenile salmonid food supply is based on a threshold of >0.50 (Rabenil *et al*. 2005).

2.2.5 Fish

An electric fishing survey was carried out at Site 1 to Site 7 in the River Finn catchment under authorisation from the Department of Communication, Energy and Natural Resources under Section 14 of the Fisheries Act (1980). See **Table 1** and **Figure 2** for locations. **Table 5** presents the upstream

and downstream limits of the electrical fishing surveys. The purpose of this survey was to assess fish populations present at selected sites on watercourses draining the proposed development. Sites were surveyed following the methodology outlined in the CFB guidance 'Methods for the Water Framework Directive - Electric Fishing in Wadable Reaches' (CFB, 2008). A 'Smith Root' portable electrical fishing unit was used during the assessment (see **Plate 3**). Electric fishing focussed on sites in the Finn catchment as all most infrastructure is in this area (i.e. all proposed turbines).

Fishing was carried out continuously for 10 minutes at each site. Captured fish were collected into a container of river water using dip nets. On completion of the survey, fish were then anaesthetised using a solution of clove oil, identified, and measured to the nearest mm using a measuring board. Subsequent to this the fish were allowed to recover in a container of river water and were the released alive and spread evenly over the sampling area. Quantitative/depletion electrical fishing was carried out at Site 1. This area was fished a total of five times (five passes). Records were taken of fish captured from each pass immediately after each pass.

Table 5. Downstream and upstream limits of the electrical fishing surveys undertaken on watercourses draining the proposed development.

Site No.	Tributary - Sub-tributary / EPA Code	Order	Survey extent (ITM)				Area fished (m^2)
			Downstream		Upstream		
			X	Y	X	Y	
1	Elatagh / 01E02	3	602709	904394	602759	904392	400
2	Elatagh / 01E02	3	604230	903956	604160	903997	175
3	Elatagh / 01E02	2	604252	903934	604302	903902	165
4	Elatagh - Carraig An Langáin / 01C14	2	603585	904494	603619	904527	150
5	Elatagh - Unnamed	2	604978	904835	605040	904865	105
6	Elatagh - Cark / 01C11	1	606168	904228	606249	904313	64
7	Elatagh - Unnamed	3	602458	904583	602415	904618	225

Following completion of the fishing, the dimensions and physical habitat characteristics of each site were recorded, including area and flow characteristics. The surveys were carried out on the 20th September under ideal environmental conditions, low water levels and a bright day. Any fish captured during biological sampling and electrical fishing were recorded and identified with reference to the Freshwater Biological Association's publication *'Key to British Freshwater Fish with notes on their ecology and distribution*' (Maitland, 2004) and other referenced sources.

Catch Per Unit Effort (CPUE) indices were derived for each site surveyed based on numbers of fish captured and time fished. Length - % frequency distribution graphs were derived for all salmon and all trout captured during the surveys, and at locations where statistically significant numbers of fish were recorded.

2.2.6 Aquatic Biosecurity

In cognisance of the risk of spread of non-native invasive alien species, the Inland Fisheries Ireland (IFI) document 'Biosecurity Protocol for Field Survey Work' (IFI, 2010) was followed at all stages of field work. All equipment (including waders etc.) was disinfected with spray bleach disinfectant after use, washed, dried out and put in storage.

3 RESULTS

This section provides a description of the aquatic habitats, macroinvertebrates (incl. FPM) and fish in the study area, based on the 11 survey sites examined.

3.1 AQUATIC HABITATS

The physical attributes of watercourses draining the proposed development are the basis of the aquatic ecosystems supported therein. The habitat quality for macroinvertebrates (**Section 3.1.1**) and fish (**Section 3.1.2**) is a function of watercourse characteristics in the receiving riverine environment. Habitat for FPM is discussed separately in **Section 3.3.1**. The physical characteristics of survey sites are listed in **Table 6**. The watercourses within the boundary of the proposed development site are high gradient streams no greater than 1m wide, with limited lotic[11] carrying capacity.

The watercourses in the study area are generally fast flowing and of a spate nature i.e. they are rainwater fed from overland flow and thus exhibit fast repsonse to rainfall. They are categorised as eroding/upland rivers with reference to Fossitt (2000). The watercourses draining the proposed development are typically medium-high gradient channels over siliceous geology. The watercourses within the site boundary are small 1st or 2nd order streams, elevated and drain predominantly peaty soils.

Drainage associated with afforestation and commercial forestry in the catchments may be affecting the flow regime of the receiving watercourses. For example, low flows during the summer could have been exacerbated by drainage of peat habitats, where potential water reserves in peat are released faster than natural processes by lowering the water table. The development of large areas of commercial forestry can also limit precipitation reaching the soil and therefore reduce surface water flow.

The stream substrates comprise mainly of cobble and gravel with little to no silt deposits. Bedrock is the main component of the streambed along some high gradient reaches. The subject watercourses are generally characterised by riffle-glide-pool sequences. They are generally shallow with a mean summer depth of 15cm-20cm.

[11] of organisms or habitats inhabiting or situated in rapidly moving fresh water

Table 6. Physical characteristics of the aquatic study sites.

Site	Watercourse	Site																
		Wetted Width (m)	Mean Depth (cm)	Max Depth (cm)	Rock (%)	Cobble (%)	Gravel (%)	Fine (%)	Riffle (%)	Glide (%)	Pool (%)	Instream vegetation* (%)	Bank Height (cm)	Bank slope (°)	Bank cover (%)	Shade (%)	Silt	Algae
1	Elatagh River	3.5	10	40	50	25	20	5	70	20	10	0	1.5	80	85	50	Considerable	Occasional
2	Elatagh River	3.6	5	25	40	30	20	10	40	30	30	0	0.5	90	60	20	Light	Occasional
3	Elatagh River	3	5	30	30	30	30	10	50	20	30	0	1	55	85	15	Light	Occasional
4	Carraig An Langáin	1.5	10	35	75	15	10	0	50	30	20	0	1.7	60	90	40	None	Abundant
5	Unnamed	0.9	5	30	75	15	5	5	50	20	30	0	0.7	75	95	5	Considerable	Rare
6	Cark	0.8	5	20	15	70	15	0	30	30	40	0	1.1	85	80	5	Moderate	Occasional
7	Unnamed	2.5	15	55	30	40	20	10	15	15	70	5	1	90	80	40	Considerable	Occasional
8	Cloghroe	0.8	5	15	5	60	35	0	25	25	50	0	45	90	85	0	Light	Occasional
9	Deele	2.2	10	40	30	30	30	10	70	20	10	0	40	70	100	10	Light	Occasional
10	Lowmagh	1.5	10	35	10	55	25	10	10	15	75	5	45	50	85	0	Light	Occasional
11	Treankeel	0.8	5	20	25	55	15	5	20	25	65	0	35	90	100	0	Light	Frequent

**instream vegetation related primarily to bryophytes*

[1]*when examined in August, not excessive in September*

3.1.1 Macroinvertebrate Habitats

The physical habitat suitability assessment of the survey sites for macroinvertebrate production is provided in **Table 7.** Based on the physical attributes of the surveyed sites and assessment criteria, the sites are generally rated between marginal and suboptimal. This rating was applied to all the sites mainly due to the domination of substrates by one size class (rock/cobble), owing to their high gradient, suboptimal habitat complexity, coupled with mainly marginal pool quality (<1m deep), bank stability (eroding in some instances) and canopy conditions (limited shaded). Habitats of this classification can limit taxa richness as there are fewer ecological niches available e.g. high gradient streams more suitable for macroinvertebrates with morphology evolved for fast flows such as Heptagenid mayflies. Habitat suitability also depends on water quality, and impacted conditions (e.g. below 'good' status) will also result in fewer taxa. The synergistic effect of river morphological character (including physical habitat) and stressors (e.g. silt) along with and other water quality influences (e.g. nutrient loading) could explain the variation in results at the study sites (See **Section 3.2.2**).

Table 7. Physical habitat assessment of the survey sites regards suitability for macroinvertebrate production (adapted from Barbour and Stribling, 1991)

Catchment	Site	Watercourse	Bottom substrate	Habitat complexity	Pool quality	Bank stability	Bank protection	Canopy	Score	Overall Assessment[1]
Finn	1	Elatagh	10	15	10	15	15	15	80	Suboptimal
	2	Elatagh	15	15	10	5	10	5	60	Marginal/suboptimal
	3	Elatagh	20	15	10	15	15	10	85	Suboptimal
	4	Carraig an Langáin	15	15	5	15	15	5	70	Suboptimal
	5	Unnamed	10	10	5	15	15	5	60	Marginal/suboptimal
	6	Cark	15	15	5	15	15	10	75	Suboptimal
	7	Unnamed	10	15	5	15	10	15	70	Suboptimal
Deele	8	Cloghroe	10	10	5	10	10	5	50	Marginal
	9	Deele	15	15	10	15	15	10	80	Suboptimal
Swilly	10	Lowmagh	10	10	10	10	15	5	60	Marginal/suboptimal
	11	Treankeel	10	10	5	10	10	5	50	Marginal

[1] *scale: poor - marginal – suboptimal – optimal*

3.1.2 Fish Habitats

It is considered that the importance of streams draining the proposed development site generally increase with distance until their gradient eases, or merge with other streams to become larger watercourses. This is a universal concept related to stream size and water quantities in parts of catchments near watershed boundaries.

Within the streams surveyed, a relatively small proportion of the fluvial habitat was classified as suitable for salmonid spawning. Such habitats are the transitional areas between pool and riffle where flow accelerates and depth decrease over gravel beds, due to a marked change in hydraulic head over the gravel. Based on the physical character of the sites surveyed, the watercourses draining the site are considered optimal for the early life stages of salmonids and suitable for

spawning adult salmonids. The gravel substrates at the end of pools provide spawning areas. It is noted by Crisp (2000) that small trout may spawn in quite small gravel patches between large stones. Such features may be of more importance to spawning trout in the upper reaches of the Elatagh River and in the smaller (1st and 2nd order) streams draining the proposed development site.

The abundance of riffle (broken water), instream rocks, irregularities in the stream bed and overhanging banks and dappled shade, or combinations thereof, generally provide good salmonid nursery habitat in the subject watercourses. There are some obvious water quality problems associated with siltation and enrichment however which reduce the quality of salmonid spawning and nursery habitat however. The small size of the watercourses near the proposed development are unsuitable for holding large salmonids: the small/shallow pools are not considered sufficiently large for large trout and adult salmon througout the year.

Based on the assemblages of instream macroinvertebrate life, generally good juvenile salmonid food supply exists in the headwaters of the streams draining the proposed development site (See **Section 3.5**). Site 2 to Site 6 inclusive, in the Elatagh catchment had strongly 'Predictable' macroinvertebrate food supply. The reduced values at Site 8 – Site 11 could be attributed to sampling during the winter. Salmonids, especially at early life stage require good water quality, and generally unsatisfactory water quality conditions at the survey sites (Q3-4, See **Section 3.4.1.2**) are considered to limit reproductive success (decreasing oxygen supply to ova buried in gravels) and early life stage opportunities for salmon and trout. A study by Kelly *et al.* (2007) established that there is a relationship between fish-community composition and Q-values – the abundance of 1+ and older salmon was significantly different between moderate (Q3–4) and good-quality (Q4) sites. **Table 8** gives the habitat rating of the watercourses examined with reference to salmonid habitats.

Table 8. Habitat rating at the sites examined on watercourses potentially affected by the proposed development.

Catchment	Site	Watercourse	Spawning		Nursery		Holding	
			Habitat grade[1]	fluvial cover[2] (≈%)	Habitat grade[1]	fluvial cover[2] (≈%)	Habitat grade[1]	fluvial cover[2] (≈%)
Finn	1	Elatagh	2-3	10	1	55	4	20
	2	Elatagh	2	15	1	65	3	15
	3	Elatagh	2-3	15	1	70	3-4	15
	4	Carraig an Langáin	3	10	1-2	80	4	10
	5	Unnamed	3	10	2-3	50	4	5
	6	Cark	3-4	10	3	55	4	5
	7	Unnamed	3	15	2	60	3	20
Deele	8	Cloghroe	3	5	2-3	35	4	10
	9	Deele	2-3	15	1	60	4	20
Swilly	10	Lowmagh	3	5	2-3	35	3-4	30
	11	Treankeel	3	10	2	65	3-4	25

Following DCAL's advisory leaflet '*The Evaluation of habitat for Salmon and Trout*'

[1] *Grade 1 is optimal habitat and habitat quality reduces with increases in Grade (Grade 4 = poor)*

[2] *Fluvial cover relates to river substrate under water and available to fish*

Lampreys have similar habitat requirements for spawning to small trout. There is adequate lamprey spawning habitat in the watercourses draining the proposed development, particularly for smaller lamprey species (brook lamprey), but there is a general lack of sand/silt deposits, a requirement for lamprey larvae. A search for juvenile lamprey was undertaken in a sandy deposit in the Elatagh River ca. 3.5km southwest of the proposed development. This was deemed the most suitable refuge encountered for juvenile lampreys during the current surveys. Lampreys were not recorded in this area however. Lamprey may occur in low densities in the middle reaches of the rivers assessed, where flows are sufficiently slow to allow accumulation of fine substrates. Any lamprey (if they occur) within the receiving environment of the proposed are considered Brook Lamprey *L. planeri*. This assertion takes account of the poor swimming ability of lampreys (Reinhardt *et al.* 2009) and high river gradients.

The following is an account of the fluvial habitats with respect to fish. Survey site photographs can be seen in **Plate 4** to **Plate 12.**

3.1.2.1 Site 1

The channel was a good nursery area for salmonids with good numbers recorded during electro-fishing. Potential salmonid spawning value was regarded as moderate. The holding value was moderate to good given the presence of localised deeper glide and pool. The high energy of the area would not make the channel suitable for juvenile lampreys (larvae, also known as ammocoetes) due to lack of fine sediment.

3.1.2.2 Site 2

The salmonid nursery value of the river was very good given the presence of boulder and cobble refugia, glide and riffle sequences. The spawning value was good as pockets of course and medium gravels existed between boulders providing ample spawning opportunities. These areas were more extensive in the slack areas of slower moving pools. The holding value was also good locally for trout but would also support larger salmonids in winter should conditions for downstream fish passage be suitable. This reach had no lamprey value given higher gradient and spate nature of channel.

3.1.2.3 Site 3

The nursery value of the river was very good given the presence of boulder and cobble refugia, glide and riffle sequences. The spawning value was good as pockets of coarse and medium gravels existed between boulders providing ample spawning. These areas were more extensive in the slack areas of slower moving peaty pools. The holding value was also good locally for trout but not for larger salmonids (i.e. Atlantic salmon or sea trout) that were absent. This reach had no lamprey nursery value given higher gradient and spate nature of channel.

3.1.2.4 Site 4

This reach provided good nursery areas for trout. The salmonid habitat was diminished somewhat by adjoining afforested areas of semi-mature Sitka spruce and improved grazing areas for sheep. The channel could nonetheless be considered a moderate to good nursery given riffle, glide and pool areas, and ample flows. This was supported by the fair numbers of trout captured. The high energy environment would reduce the spawning value. Holding areas were considered suboptimal for brown trout but not suitable for other larger salmonid species (i.e. sea trout or Atlantic salmon) or lamprey.

3.1.2.5 Site 5

The fish habitat value of this reach was reduced both by the size of the stream (narrow and shallow), adjoining peat soils, coniferous plantations and clear-felled forestry. It was rated suboptimal as a salmonid nursery and spawning area given the presence of limited spawning areas and small size of channel, peat soils and bordering land uses. This observation was confirmed by the small numbers of juvenile trout captured. It is considered that stream improves as a salmonid habitat with increasing distance downstream where greater flows and the absence of coniferous plantations would benefit salmonid populations. This reach had no lamprey value given the unsuitable gradient and likely spate nature of channel.

3.1.2.6 Site 6

The fish habitat value of this reach was diminished both by the size of the stream (narrow and shallow), peat base and adjoining coniferous plantations. This reach is of marginal value as a salmonid nursery, spawning and or holding area for these reasons. No lamprey value is attributed to this reach given the unsuitable gradient and likely spate nature during winter.

3.1.2.7 Site 7

The channel was a good nursery area for salmonids with good numbers recorded during electro-fishing. Spawning habitat was regarded as suboptimal but possibly improving upstream. The holding value was deemed moderate/good given the presence of deeper glide and pool habitat. The number of fish at this site was deemed high despite the substratum siltation. The high energy of the area would not make the channel suitable for lamprey.

3.1.2.8 Site 8

This site on the Cloghroe Stream was characterised by long shallow pools connected by short riffles. The bed of the stream had a significant amount of deposited iron residue which clogged the substratum. Nursery and potential salmonid spawning habitat were deemed moderate and marginal respectively. This stream likely supports a small population of small trout but is considered too small for salmon. The erosive nature of this stream makes it unsuitable for lampreys.

3.1.2.9 Site 9

This stream had good substratum heterogeneity and was deemed an optimal nursery area. Salmonid spawning potential along this reach was regarded as moderate and best suited to the spawning requirements of trout. Pool quality was poor in terms of holding adult fish. This reach likely supports brown trout (adults and juvenile) and salmon (juvenile). This stream does not have suitable lamprey nursery habitat, thereby precluding the presence of this group.

3.1.2.10 Site 10

The Lowmagh Stream at Site 10 is a medium gradient channel, characterised by long shallow pools connected by short riffles. The bed of the stream had a significant amount of deposited iron residue which clogged the substratum. Nursery and potential salmonid spawning habitat were deemed moderate and marginal respectively. This stream likely supports a small population of small trout. A series of falls over a high gradient reach downstream, in combination with small stream size probably occludes salmon penetration this far upstream. The stream is considered unsuitable for lampreys.

3.1.2.11 Site 11

The fish habitat value of this reach was diminished by its size (narrow and shallow). This reach is of marginal value as a salmonid nursery, spawning and or holding area for these reasons. This stream likely supports a small population of brown trout but not salmon. The high energy of the area would not make the channel suitable for lamprey.

Plate 4. Site 1, 3rd order Elatagh River on the (left and right). This site is located west of the proposed development.

Plate 5. Site 2, 3rd order Elatagh River on the left and right (located upstream of Site 1).

Plate 6. Site 3, 2nd order Elatagh stream on left and right (located upstream of Site 1 and Site 2).

Plate 7. Site 4, 2nd order Carraig An Langáin stream on left and right. This stream drains north-west of the proposed development before joining the Elatagh River to the west.

Plate 8. Site 5, 2nd order unnamed stream on left and right which drains across the northern part of the proposed development. This site was located to the west of the proposed development.

Plate 9. Site 6, 1st order Cark Stream which drains the southern part of the site. This site was located within the boundary and in the southern region of the proposed development.

Plate 10. Site 7, 3rd order tributary of the Elatagh River.

Plate 11. Site 8 on an un-named tributary of the River Deele (left) Site 9 on the River Deele (right).

Plate 12. Site 10 on the Lowmagh Stream (left) and Site 11 on the Treankeel Stream (right).

3.2 MACROINVERTEBRATES

This section provides information on aquatic macro-invertebrates other than freshwater pearl mussel (FPM). FPM is discussed in **Section 3.3** below.

3.2.1 Existing information

The proposed development and the watercourses examined during the current assessment occur in the 10km grid square C00. National Biodiversity Data Centre (NBDC) records indicate the presence of numerous groups of aquatic insects in this area. Water beetles (Coeloptera) previously recorded include *Elmis aenea, Haliplus lineatocollis, Helophorus (Helophorus) flavipes, Hydraena gracilis, Hydroporus pubescens, Limnius volckmari*, *Oreodytes septentrionalis*, *Oulimnius tuberculatus and Stictotarsus duodecimpustulatus*. Aquatic Molluscan records in the study area were minimal with just one species: *Ancylus fluviatilis*. Dragonflies known to occur comprise species such as *Aeshna juncea* and *Pyrrhosoma nymphula.* The habitats of these Odonates are slow flowing waterbodies and lakes.

There are a variety of Stoneflies (Plecoptera) in the study area, as indicated by NBDC records. These include *Amphinemura sulcicollis, Brachyptera risi*, *Capnia bifrons, Isoperla grammatica, Perla bipunctata, Leuctra hippopus, L. Fusca*, *L. inermis*, L. *nigra, Nemoura cinerea, Protonemura meyeri and Siphonoperla torrentium.* Mayflies known to occur comprise of species such as *Alainites muticus, Baetis rhodani, Caenis rivulorum, Ecdyonurus dispar and Serratella ignita.* True fly (Diptera) diversity within the 10km square of C00 appears to be low with only one species recorded; *Paratrichocladius rufiventris* or *Chironomus rufiventris* and no previous records of Aquatic Bugs (Heteroptera) or Crustaceans exist.

3.2.2 Macroinvertebrate Diversity and Abundance

The results of the macroinvertebrate surveys are presented in **Appendix 3**, where a species list of macroinvertebrates recorded at each survey location has been provided. The bulk of macroinvertebrates recorded belong to pollution sensitivity group C across the survey sites (pollution tolerant) as per Toner *et al,* (2005). Some of the most commonly recorded macroinvertebrates in the study area are shown in Plate 14 and **Plate 14.**

Pollution tolerant mayfly larvae of *Baetis rhodani* were dominant within the survey sites. The only other Ephemeropterans (mayflies) recorded in the Finn catchment survey sites during the current survey were larval 'Group C' *Seratella ignita* (Sites 1, 2, 3, 4 and 7), and pollution sensitive 'Group A' (Family) Siphlonuridae (Site 6) and Leptophlebiidae (Site 5). Pollution sensitive mayfly larvae of *Ecdyonurus* sp. were recorded in the survey sites in the Deele and Swilly catchments, with *Heptagenia sulphurea* and *Rhithrogena semicolorata* also recorded at Site 9.

Order Plecoptera (stoneflies) had varied distribution. Larvae of less sensitive stonefly *Leuctra* sp. were the most widespread and abundant stonefly larvae and were generally found in fair numbers throughout the study area. Pollution sensitive larvae of the *Chloroperla torrentium*, *Isoperla grammatica, Nemoura sp.* and *Amphinemura* sp. had scattered occurrence and abundance ranged from 'present' to 'fair numbers' where encountered.

The Trichopterans were well a represented group with three cased (Group B) taxa and five caseless (Group C) taxa recorded. Cased Caddisfly larvae in families Limnephilidae, Glossosomatidae and Goeridae were present within the survey sites. Limnephilidae was the most frequently recorded in all sites except Site 7. Glossosomatidae and Goeridae were only present at Site 7 in few numbers. Caseless caddisfly larvae of Hydropsyche sp. were present at Site 1 and 3. Trumpet-net caddisflies (Polycentopodidae) and *Rhyacophila dorsalis* were well distributed within the surveyed sites but generally scarce. Hydroptilidae were present at Site 7.

Dipteran larvae accounted for a significant proportion of the macroinvertebrate community in the survey sites. The most common true fly larvae were pollution tolerant Simulidae and green chironomids (fair numbers). Other true fly larvae recorded in small numbers were; *Dicranota sp*., *Tipula sp., Limnophora sp.,* and families Ceratopogonidae, Pediciidae, Limoniidae and Stratiomyidae.

Beetles in two different families were recorded: Elmidae and Hydraenidae 'Group C'. Beetle abundance was found to be low (present or scarce). Bugs (Hemiptera) were represented in two family groups; Veliidae and Mesoveliidae, both of which are pollution tolerant. Each family only occurred at two out of seven sites in few numbers. The only mollusc species recorded were River limpet *Ancylus fluviatilis* and *Potamopyrgus antipodarum* which were present at Site 4 and Site 7 in few numbers. The crustacean *Gammarus deubeni* was the sole member of Order Crustacea recorded during the current study and appeared in three sites in few numbers.

Plate 13 Pollution sensitive mayfly larvae of *Ecdyonurus* sp. and caseless caddisfly larvae of *Rhyacophila* sp. recorded during the current survey (left). The molluscs *Potamopyrgus antipodarum* and *Ancylus fluviatilis* recorded at Site 7 (right).

Plate 14 The most common macroinvertebrate encountered was mayfly larvae of *Baetis rhodani* (left). Larvae of the caseless caddisfly (Polycentropodidae) was restricted to the uppermost sites in the study area (right).

3.3 FRESHWATER PEARL MUSSEL

3.3.1 Freshwater Pearl Mussel Habitat

The FPM life cycle involves an adult stage, living as a filter feeder, a juvenile stage living interstitially in sediment, and a larval (glochidial) stage living attached to the gills of trout or salmon. All life stages therefore need consideration, as does the viability of the host species of fish. Adults are more tolerant of a wider range of in-river conditions than juveniles (Hastie *et al.,* 2000 in Skinner *et al.,* 2003).

'Ecological status' is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with the normative definitions of ecological status described in the WFD. 'Ecological Quality Ratio' (EQR) is an expression of the relationship between the values of the biological parameters observed for a given body of surface water and the values for those parameters in the reference conditions applicable to that body. The ratio is expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero. For intercalibration of river ecological classification systems across the European Union as required by the Water Framework Directive (WFD), Ireland has used the Q-rating system[12]. For example, the EQR for macroinvertebrates is given as ≥0.85 to meet the high status/good status boundary in the Surface Water Regulations (SWR) (2009). The Freshwater Pearl Mussel Objectives (2009) requirement for an EQR ≥0.90 relates to 'high status' watercourses i.e. Q4-5 & Q5, as per the EPA Q-rating system. Regarding the ecological quality objectives for FPM habitat, the watercourses within and adjacent to the proposed development site channel generally fail on criteria for macroinvertebrates, macroalgae and siltation (DoEHLG, 2009).

It is noted in Moorkens *et al.* (1992) that alteration in a river's flow regime, such as that caused by drainage for forestry or agriculture, may result in summer flows being insufficient to support FPM. Some reaches of the main stem of the Elatagh River have been subjected to drainage in the past. For example, the morphology of a reach of the river ca. 1.5km downstream of Site 1 has likely been altered by excavation, as indicated by the presence of a berm along the bank of the river. Such an activity is a known pressure on FPM (Moorkens, 1999). **Table 9** presents the findings of the survey in terms of habitat quality and survey extents.

Using criteria in Anon (2004), the Elatagh River is classified as a low priority river i.e. river with either igneous or sandstone bedrock for less than one third of its length. The Elatagh is mainly underlain by 'banded semi-pelitic & psammitic schist', 'feldspathic psammite; quartzite and marble'. Rivers which fall into category 'C' such as the Elatagh are probably unsuitable for FPM (Anon, 2004).

[12] See **Table A2.1** for more EQR values and intercalibration information

Table 9. Findings of the surveys carried out on selected watercourses reaches draining the proposed development.

Watercourse	Survey reach code	Location / townland	Length of channel surveyed (m)	Environmental Quality Objectives (EQO)[13]			FPM population	Notes
				Filamentous algae	Macro-phytes	Siltation		
River Finn	R1		1km	Rare, < 1 % of the river bed	Absent	No visible silt plume	Absent	A total of 20 transect surveys were completed along the 1km length of channel examined. The reach of the River Finn downstream of the Elatagh River confluence is highly erosive, with largely mobile substrates. This high energy fluvial environment is considered a marginal/unsuitable habitat for FPM, despite favourable qualities regarding the EQO's. Numerous juvenile salmon along the surveyed reach. Dead sheep observed in the river.
Elatagh River/ River Finn	R2	Reach of the River Finn downstream of the Elatagh confluence and reach of Elatagh upstream of Finn confluence at Altlahan/ Meenalig/ Letterbrick	950m	Frequent	Absent	Some visible silt	Absent	A total of 15 transect surveys completed on the River Finn. The reach on the River Finn featured some glide/pool habitat, with potentially suitable FPM habitat in sand deposits downstream of boulders/rocks. This reach does not pass on two EQO's for FPM habitat: algae and silt. Adult Salmon recorded in the River Finn in the pool downstream of the Elatagh confluence. Entire bed of Elatagh surveyed. Gradient of the lower reach of the Elatagh deemed too high to support FPM.
Elatagh River	R3	Reach of the Elatagh River at Arbatt/ Altlahan/Letterbrick	490m	Abundant	Absent	A lot of visible silt	Absent	Entire riverbed survey carried out. The upper reach of this section has been drained as evident from a berm along the left bank, a recognised pressure in FPM catchments. This reach does not pass on two EQO's for FPM habitat: algae and silt. Siltation level

[13] EQO = Ecological Quality Objectives for FPM habitat

Watercourse	Survey reach code	Location / townland	Length of channel surveyed (m)	Environmental Quality Objectives (EQO)[13]			FPM population	Notes
				Filamentous algae	Macro-phytes	Siltation		
								exacerbated by bank slippage upstream.
Elatagh River	R4	Reach of the Elatagh River at Arbatt/ Altlahan	500m	Abundant	Absent	A lot of visible silt	Absent	Entire riverbed survey carried out. Reach exhibited good physical heterogeneity, but mass wastage of banks observed due to lack of cover, and substratum subsequently silted. Evidence of eutrophication noted. This reach does not pass on two EQO's for FPM habitat: algae and silt. Luxuriant strands of algal cover present.
Elatagh River	R5	Reach of the Elatagh River at Altlahan	500m	Abundant	Absent	A lot of visible silt	Absent	Entire riverbed survey carried out. Siltation and algal conditions improved slightly upstream of the confluence with the unnamed stream that joins the river from the north. This indicates an impact from this watercourse. Some low intensity drainage likely to have taken place in the Elatagh River upstream of the confluence.
Elatagh River	R6	Reach of the Elatagh River at Altlahan near the Carraig an Langáin Stream confluence	1.4km	some visible silt	Absent	Frequent	Absent	Entire riverbed survey carried out. Reach exhibiting good physical heterogeneity, resulting in good habitat/substrate conditions for FPM. The upper extent of the reach appeared to have been lightly drained and silt was light. This reach does not pass on one EQO for FPM habitat: silt.
Elatagh River	R7	Reach of the Elatagh River at Tullytrasna/ Cark	400m	some visible silt	Absent	Frequent	Absent	Entire riverbed survey carried out. Generally very shallow reach with riffle dominant. Substrate with abundant moss cover. Considerable bank erosion at eroding bends and dense filamentous algae in slower flowing areas. This reach does not pass on two EQO's for FPM habitat: algae and silt.

Watercourse	Survey reach code	Location / townland	Length of channel surveyed (m)	Environmental Quality Objectives (EQO)[13]			FPM population	Notes
				Filamentous algae	Macro-phytes	Siltation		
River Swilly	R8	Reach downstream of the Treankeel River confluence	1.5km	Frequent	Absent	Some visible silt	Absent	Entire riverbed survey carried out. Deeply drained channel - the morphology of the river has been dramatically altered. Substrates were considered highly mobile in some areas and the river is likely to transport a significant bed load during spate. This reach does not pass on two EQO's for FPM habitat: algae and silt.
Lowmagh River	R9	Reach upstream of the River Swilly confluence	850m	Rare	Absent	No visible silt plume	Absent	Entire riverbed survey carried out. The reach of the Lowmagh River upstream of the River Swilly is a high gradient watercourse. This reach does not pass on two EQO's for FPM habitat: algae and silt.
Treankeel River	R10	Reach upstream of the River Swilly confluence	540m	Abundant	Absent	A lot of visible silt	Absent	Entire riverbed survey carried out. Medium gradient reach with a mix of substrate sizes. Luxuriant algal growth when surveyed in the month of August. This reach does not pass on one EQO for FPM habitat: silt.

3.3.2 Existing Information

The Freshwater Pearl Mussel (FPM) is a large, long-lived, bivalve mollusc found in clean, fast-flowing rivers. The FPM has an unusual lifecycle and produces very tiny young that burrow into river gravels to prevent being washed to sea. The species requires very clean and well oxygenated rivers. In recent decades, when experts began searching for the young they discovered that most Irish populations have not recruited since the 1970s or 80s. Riverbeds had become clogged with silt, algae and rooted-plants so that the young mussels can no longer survive. In some rivers, pollution is sufficiently severe that adult mussels are also dying. FPM have a complex life cycle. Mussels mature between seven and 15 years of age, and have a prolonged fertile period lasting into old age. The species produces glochidial larvae that use a temporary salmonid host, typically Atlantic salmon and sea trout in Ireland, but also brown trout. Juvenile mussels occupy interstitial habitats in the riverbed for five years or more. (NPWS, 2019).

Mussels are long-lived filter feeders and consequently are sensitive to pollution. In a pearl mussel river, the effects of pollution can range from loss of the salmonid fish which are essential to the mussel's life cycle, to long term stress and death of adult and young mussels from oxygen deprivation, to immediate death of the entire mussel population from toxic poisoning (Moorkens, 1999). Freshwater pearl mussels are flagship, indicator, keystone and umbrella[14] species (Geist, 2005). The pearl mussel is a key indicator species of river ecosystem quality i.e. protecting the pearl mussel has a positive impact on the entire river ecosystem.

This species is under increasing pressure from a number of sources and are continuing to decline and classified as Endangered on the IUCN Red List of Endangered Species and are listed under Annex II of the EU Habitats Directive.

The proposed development is located primarily in the Finn catchment, an area identified as a Freshwater Pearl Mussel (FPM) sensitive area and classified as a '*Catchment of other extant populations'*. In an inspectors report on a waste water discharge licence application for the Castlefinn agglomeration (Reg. No. D05414-01)[15], located >12km downstream of Ballybofey, an account of FPM in the River Finn is provided. This report notes a 1993/94 record of FPM by Colin Beasley (PhD study) in the River Finn downstream of Castlefinn, but here were no other FPM found anywhere in the river despite extensive searches. This FPM record is more than 35km downstream of the proposed development site i.e. via surface water linkage. This record corresponds with the FPM record returned by NPWS following a data request for the species in the Finn catchment. Nonetheless, using criteria in Anon (2004), the River Finn is categorised as a high priority river i.e. a river with prior mussel records.

Drainage from a portion of the proposed development is to the Swilly and Deele Rivers. These catchments are not indicated in the *Margaritifera* sensitive areas map produced by NPWS[16]. FPM records supplied following a data request from NPWS do not indicate the presence of the species in these catchments.

[14] Protecting the pearl mussel has a positive impact on the entire river ecosystem. The most important features of an effective umbrella species are a large range size and complex habitat requirements (Caro, 2010).
[15] http://www.epa.ie/licences/lic_eDMS/090151b2804c22b7.pdf
[16] https://www.npws.ie/maps-and-data/habitat-and-species-data

3.3.3 Survey Results

FPM were not detected during the surveys carried out on the Finn, Elatagh, Swilly, Treankeel and Lowmagh Rivers. In general, macroalgal coverage within the survey reaches was frequent, abundant or dominant, and these conditions are considered unfavourable in terms of the species' habitat. Likewise, the sedimentation levels recorded were generally indicative of artificially induced siltation. Representative photos of FPM survey reaches can be seen from **Plate 15** to **Plate 23**, in order from downstream to upstream.

No live FPM or evidence of FPM in the form of shells were recorded during the field investigations. The surveys included various reaches of the Finn, Elatagh and Swilly Rivers. The stretches examined were deemed representative of these rivers and a variety of microhabitats were surveyed (e.g. clean substrates in riffle, glide and pool under partial and full shade). Approximately 3.3km of the Elatagh River was surveyed, a significant proportion of this watercourse, the primary river receptor for the proposed development site.

The main channel of the River Swilly has been drained, with major implications for FPM. Any drainage of a river likely has a direct catastrophic effect on FPM (injury and mortality), and a permanent impact on supporting habitats. Substrates were considered highly mobile in some areas, thereby rendering substrate conditions unsuitable for FPM. The substratum lacked the combination of rock-cobble-gravel typical of a river in Co. Donegal, with a greater proportion of finer material present. These impacts also affect the habitats and therefore abundance of FPM host fish.

The 2009 Irish Red list of non-marine molluscs identified the following as major threats to FPM: reduction in water quality; increases in siltation and physical interference with habitat (Byrne *et al.* 2009). These threats decrease macroinvertebrate and fish habitat quality in general and were noted at several locations as outlined above. An entire survey of the Elatagh and Finn Rivers (the only suitable habitats in the receiving environment within a FPM sensitive area) was not undertaken as this would be beyond the scope of this assessment. The likelihood of FPM occurring in the either the River Elatagh, or the River Finn from the Elatagh confluence to R1 is deemed very low considering the habitats present.

The presence of FPM in the Zone of Influence (ZOI) of the proposed development is therefore considered unlikely. The river reaches surveyed were considered to have overlapped with the ZOI of the proposed development regarding FPM. It is considered likely that the previous FPM record from the River Finn is beyond the ZOI of the proposed development, taking account of hydrological separation in excess of 35km, dilution provided by other watercourses flowing into the River Finn and recovery from pollution which takes place in rivers with distance downstream from sources. Given the apparent absence of FPM and weak source-receptor pathways, with reference to a FPM record downstream of Castlefinn, it is highly unlikely this species would be affected by the proposed development. According to Moorkens (1999) however, this species may be affected by impacts occurring at considerable distances upstream from their populations, and taking into account its conservation status, impacts on this species cannot be ruled out.

Plate 15. Main channel of the River Finn at R1 (left) and typical substrate (right).

Plate 16. Reach of the River Finn at the Elatagh River confluence (left) and view of substrate (right)**.** Survey reach R2.

Plate 17. Surveyed reaches of the Elatagh River upstream of the River Finn confluence (R2). Reach at R3 has been drained (right).

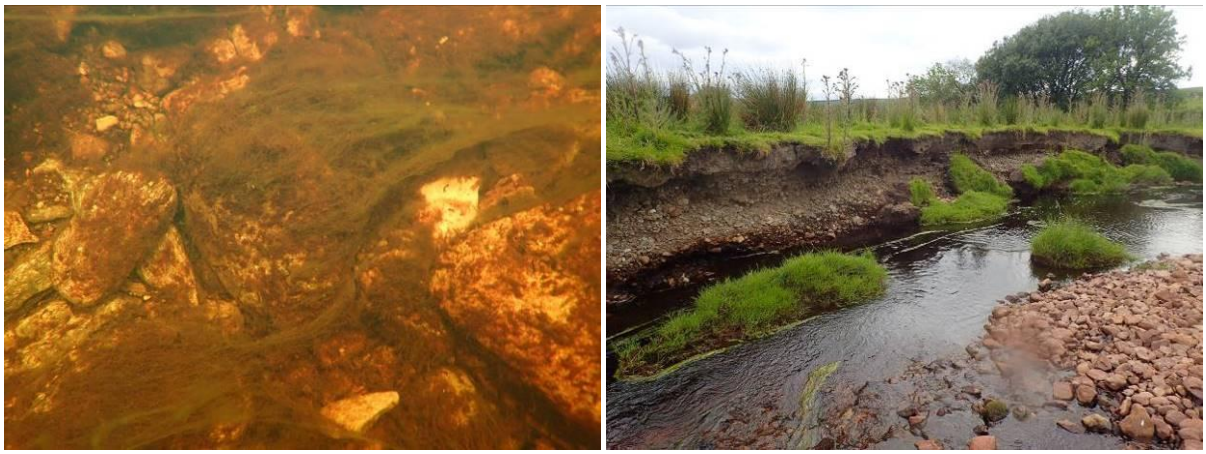

Plate 18. Underwater view of substrate showing siltation and algal growth typical of the mid reaches of the Elatagh River (left). Stretch of Elatagh River prone to bank erosion at R4 (right).

Plate 19. Elatagh River between R4 and R5 (left) had signs of drainage in the past (left) e.g. low embankments along river. Elatagh River at R5 at the confluence of an unnamed 3rd order stream (right).

Plate 20. Elatagh River at lower reach of R6 (left). Elatagh River at R7 at the Carraig an Langáin Stream confluence (right).

Plate 21. Reach of the Elatagh River at R7 (left) and view of substrate (right).

Plate 22. Typical character of the River Swilly along the reach surveyed at R8 (left). Underwater view of substrate (right).

Plate 23. The Lowmagh River at R9 (left). Stretch of the Treankeel River near the upper extent of R10 (right).

3.4 WATER QUALITY

3.4.1 Biological Water Quality

3.4.1.1 Existing information

The EPA carries out biological monitoring at stations at various locations along the River Elatagh which drains the propose development. The most recent EPA biological water quality results at the closest EPA biological monitoring stations can been seen in **Figure 4** and **Table 10**.

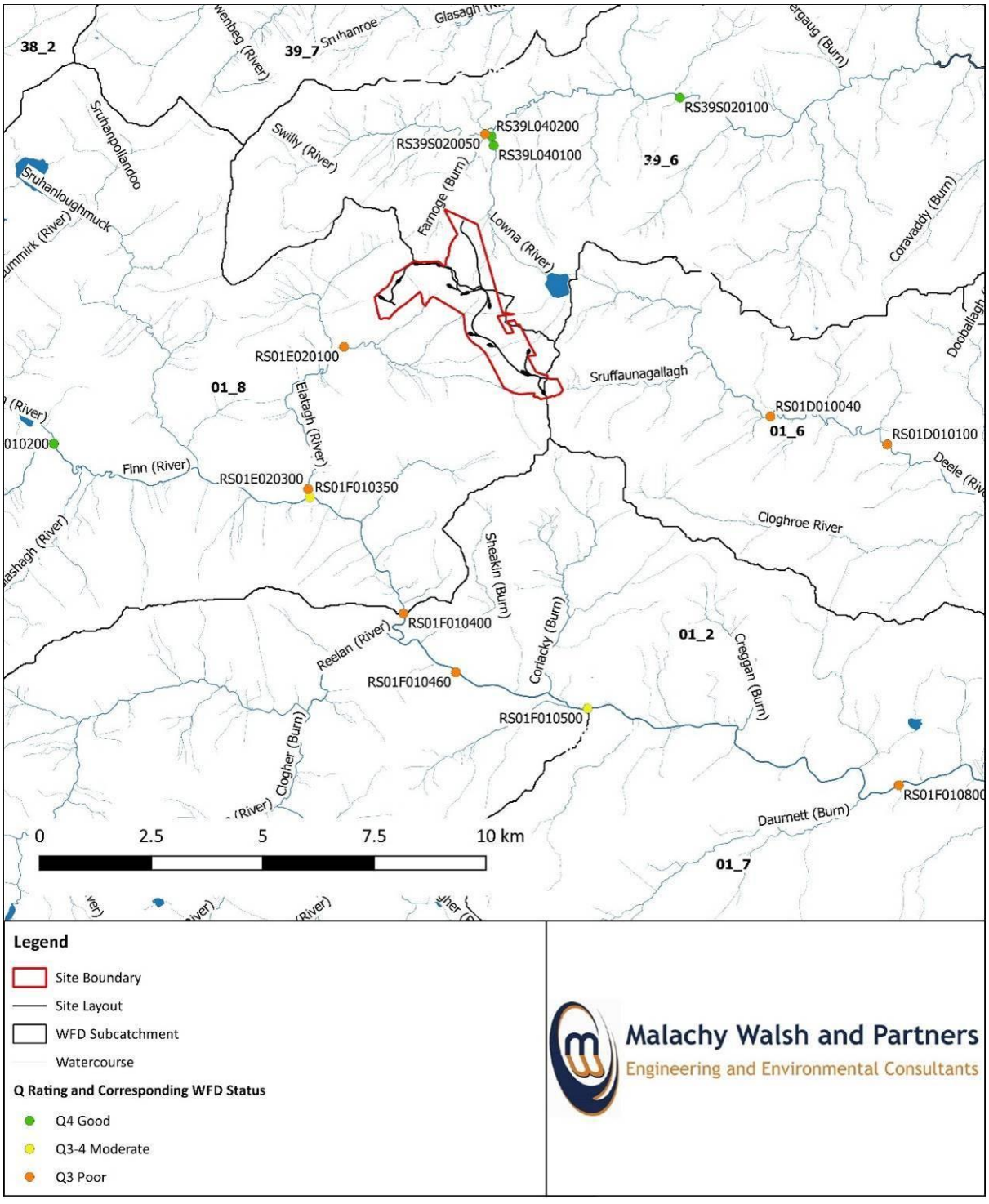

Figure 4. Most recent EPA biological water quality ratings at monitoring stations on watercourses draining the proposed development.

Inspecting historical biological water quality in watercourses downslope of the proposed development (refer to **Table 10**), it is clear that water quality in the study area has significantly deteriorated in the past few decades. Ratings of Q5, Q4-5 and Q4 were typical up to the year 2001, the only exception being the River Finn at stations at Ballybofey/Stranorlar (RS01F010800/RS01F010600). Q5 and Q4-5 biological water quality ratings signify pristine and almost pristine conditions respectively, indicative of a normal community structure, the presence of sensitive macroinvertebrate species intolerant of pollution, and ecological processes functioning normally. Q4 ratings reflect slight difference from these Q5 reference conditions and slight changes in community structure. Under these conditions, fewer sensitive species are present, but there is an increase in species richness and productivity, with ecological processes functioning normally.

Since 2004, biological water quality has declined to Q3-4 (WFD 'Moderate Status') or lower. This reduction in water quality has been severe in the River Finn and it tributary the Elatagh River, which drain most of the proposed development site. Biological water quality of Q3-4 status signifies a change in community structure and loss of some niche species. Some ecological processes have been altered, and there is reduced resilience and ability to absorb external shocks (i.e. reduced assimilation capacity). During the most recent EPA (2016) assessment, poor quality (Q3/0) was recorded at both sites in the Elatagh River. Where a toxic effect is apparent or suspected the suffix '0' is added to the biotic index[17]. At Elatagh Bridge (EPA station 0300) located just upstream of the River Finn confluence, biological water quality improved from 2011-2013 (Q3 to Q3-4), but dropped to Q3/0 corresponding to WFD 'Poor status' in 2016. Q3 ratings are consistent with significant changes in community structure from pristine conditions. There represents a significant loss of niche species, while food chains and biogeochemical pathways are significantly altered since the previous sampling period.

The bridge north of Stranabrack Lower (EPA station RS01E020100), corresponding to aquatic survey Site 1, has been consistently rated Q3 since 2004 i.e. 4 occasions, with a toxic effect probable during the most recent 2016 assessment. In 2016, the only station on the main channel of the River Finn upstream of the Elatagh River confluence to Ballybofey achieving Q4 (WFD 'Good Status') was at the Bridge south of Bellanamore (EPA station RS01F010200), ca. 8km upstream of the Elatagh River confluence (no other stations were monitored along this reach in 2016). It appears that there are some polluting activities in the Elatagh catchment that are having a serious impact on biological water quality, with such impacts also possibly adversely affecting, or at least contributing to pollution in the main channel of the River Finn. Chemical pollution is a suspected cause of this ongoing issue in the upper Finn catchment[17]. It is noted that Site 1 was rated Q3-4 during EPA field investigations in 2017 (see next section).

The following is the most recent EPA assessments[17] for the watercourses draining the proposed development:

- The Elatagh is one of the upper tributaries of the River Finn. There was a small improvement noted on the Elatagh in 2019 with both sites improving to moderate condition. The number of taxa at site 0100 remains very low with only ten taxa recorded. It is unclear exactly what is causing unsatisfactory water quality in this river but multiple sources are being investigated.

[17] http://www.epa.ie/QValue/webusers/PDFS/HA1.pdf?Submit=Get+Results

- The Finn (Donegal) continues to have unsatisfactory water quality throughout most of its sites. The only site on the Finn to achieve good ecological quality was site 0200 in the upper reaches. No change was recorded at five of the nine sites surveyed. The tributaries Reelan and Elatagh flow into the upper reaches of the Finn and are also impacted which may add to the multiple pressures on the river Finn. The Castlefin which is the lowermost site on the Finn deteriorated from good ecological quality in 2016 to moderate in 2019 with no pollution sensitive macroinvertebrate taxa recorded.
- The upper Swilly (0050) showed a definite improvement in July 2019. The middle stretch sampled at Station 0100 maintained its previous good quality while a return from high to good quality conditions was noted at Newmills (0200).
- The Lownagh declined to moderate ecological condition in 2019 with the lack of sensitive taxa such as *Ecdyonurus* which has been recorded in all seven surveys undertaken since 1996.
- There was a welcome return to good ecological quality throughout much of the River Deele with the exception of two sites (0200) and (0500) which were at moderate quality. It appears likely that the improvements observed in the river were related to the upgrade of the Convoy STW. The site 0412 increased from Q2-3 in 2016 to Q4 in 2019 with good numbers of *Rhithrogena* and *Ecdyonurus* recorded here.
- Cloghroe: a welcome return to good ecological quality was observed at the upper site (0200) with three pollution sensitive macroinvertebrate taxa observed here. Site 0400 showed no change remaining at moderate quality.

Table 10. EPA biological quality ratings (Q-values) for stations on watercourses draining the proposed development.

Catchment	River	Station code	Station name	2019	2016	2013	2011	2007	2004	2001	1998	1997	1994	1990	1984	1980	1977	1973	1971
Finn	Elatagh	RS01E020100	Br N of Stranabrack Lr	3-4	3/0	3	3	-	3	4	3-4	4-5	3	-	-	-	-	-	-
		RS01E020300	Elatagh Bridge	3-4	3/0	3-4	3	3	3	4-5	4-5	4	4	5	-				
	Finn	RS01F010200	Bridge S. of Bellanamore	4	4	3-4	4	4	4-5	4-5	4-5	4	4	4-5	4-5	5	-	5	-
		RS01F010350	Br 100 m u/s Elatagh R confl	3-4	3-4	3-4	4	4	4	4-5	4-5	4-5	-	-	-	-	-	-	-
		RS01F010400	Bridge due S. of Cloghan	3-4	3/0	3-4	3-4	3-4	4	4-5	4-5	4-5	4-5	5	5	5	5	5	5
		RS01F010500	Bridge near Glenmore Railway Sta	3-4	3-4	3-4	4	4	3-4	4	4-5	4-5	4	4-5	5	5	4-5	5	5
		RS01F010600	Bridge 2.5 km u/s Ballybofey	3-4	3	3-4	3-4	-	3	3	5	4-5	4-5	4-5	4-5	4	4-5	5	5
		RS01F010800	Br S of Stranorlar	3	3	3-4	3-4	3	3-4	4	2	3	3	3	3-4	4	3	4	-
				‘19	‘16	‘13	‘11	‘07	‘04	‘01	1998	1996	1991	1987	1985	1980	1977	1973	1971
Swilly	Swilly	RS39S020050	Swilly Br (near Breenagh)	4-5	3-4	4	4	4	4	4-5	4	4-5	4-5	5	4-5	5	5	5	-
		RS39S020100	Br at Rashedoge (Fox Hall)	4	4	4	4	-	4-5	4-5	4-5	4	4-5	4	5	5	-	-	-
	Lownagh	RS39L040100	Second Br u/s Swilly River	-	-	-	-	-	-	-	-	-	4	5	-	-	-	-	-
		RS39L040200	Br u/s Swilly R confl	3-4	4	4	4	4	4	4	4-5	4-5	-	-	-	-	-	-	-
					‘18	‘16	‘13	‘11	‘07	‘04	‘02	‘01	1998	1997	1994	1990	1985	1980	1977
Deele	Deele	RS01D010040	Bridge N. of Aughkeely	4	3/0	3/0	4	4	4-5	5	-	4-5	4	4-5	4-5	5	-	-	-
		RS01D010200	2nd Br d/s Br near Newtown	3-4	-	3/0	4	4	4	4-5	-	4	4-5	-	-	4	5	4-5	-
	Cloghroe	RS01C050200	CLOGHROE - Cloghroe Bridge	4	-	3-4	4	4	-	4	4	4	4	4	4	4	-	-	-
		RS01C050400	Br d/s Callan Br	3-4	-	3-4	4	4	3	4	4	4-5	4-5	5	-	-	-	-	-

The Q-rating scheme mainly reflects the effects of organic pollution (i.e. de-oxygenation and eutrophication) but where a toxic effect is apparent or suspected the suffix '0' is added to the biotic index.

3.4.1.2 Survey results

The watercourses provide water of a quality adequate to support some of pollution sensitive mayfly and stonefly larvae, as well as salmonids, but water quality is largely compromised in the study area. Q-ratings and EPT indices derived from the diversity and relative abundance of the macroinvertebrates at the study sites are given in **Table 11.**

Biological water quality at Site 4 and Site 5 was rated 'Moderately polluted (Q3)', equivalent to Water Framework Directive (WFD) 'Poor status' due the absence of pollution sensitive taxa. The remaining five sites in the Finn catchment were rated as 'Slightly polluted Q3-4' equivalent to WFD 'moderate status'. Thus, none of these sites met the quality WFD requirements of at least good ecological status. Site 9, Site 10 and Site 11 in the Deele/Swilly catchments were rated Q4, corresponding to WFD 'good status'.

Based on BMWP scores, biological water quality was rated as good to moderate. All feeding groups of macroinvertebrates were represented at all of the surveyed sites. This suggests that watercourses in the study area are reasonably healthy, as serious stream impairment may be indicated when one or more feeding groups are missing from a stream. ASPT scores ranged from 5.7 to 7.7. These values are indicative of good water quality, where a value of > 5.5 is deemed to signify same.

The EPT (Ephemeroptera, Plecoptera, Trichoptera) index of water quality varied between 2 (Site 4) to 8 (Site 3, Site 7, Site 9). Based on the EPT index therefore, macroinvertebrate richness is highly variable. This is suggestive of an unbalanced/unstable ecosystem in the upper Elatagh catchment.

The effects of increased drainage on water quality, such as land drainage of grassland as depicted in **Plate 24** are multiple. For example, iron-oxidizing bacteria have direct and indirect effects on river ecosystems. Iron precipitates on both biological and other surfaces, indirectly affects organisms by disturbing the normal metabolism and osmoregulation and by changing the structure and quality of benthic habitats and food resources. The combined direct and indirect effects of iron contamination decreases the species diversity and abundance of periphyton (organisms attached to submerged surfaces), benthic invertebrate and fish (Vuori, 1995).

Too many nutrients, especially phosphorus, can result in excessive plant and algae growth which severely impacts the normal functioning of aquatic environments (e.g. **Plate 25** and **Plate 26**). This results in changes in the natural biological communities and an undesirable disturbance to the overall ecology (EPA, 2018). Indeed, the issues related to farming in the Foyle catchment are mainly loss of phosphorus to surface waters from, for example, direct discharges; or runoff from yards, roadways or other compacted surfaces, or runoff from poorly draining soils[18].

[18] https://www.catchments.ie/wp-content/files/catchmentassessments/01%20Foyle%20Catchment%20Summary%20WFD%20Cycle%202.pdf

Table 11. Biological water quality results and interpretations at study sites on watercourses potentially affected by the proposed Drumnahough Wind Farm.

Site	Watercourse	Q-rating	Quality Status	Corresponding WFD Status	BMWP Score	BMWP Category	BMWP Interpretation	ASPT	EPT
1	Elatagh	3-4	Slightly polluted	Moderate	83	Good	Clean but slightly impacted	6.9	7
2	Elatagh	3-4	Slightly polluted	Moderate	76.9	Good	Clean but slightly impacted	7.0	6
3	Elatagh	3-4	Slightly polluted	Moderate	79.8	Good	Clean but slightly impacted	7.3	8
4	Carraig an Langáin	3	Moderately Polluted	Poor	50.9	Moderate	Moderately impacted	5.7	2
5	Unnamed	3	Moderately Polluted	Poor	38.6	Poor	Polluted or impacted	7.0	5
6	Cark	3-4	Slightly polluted	Poor	76.6	Good	Clean but slightly impacted	7.7	7
7	Unnamed	3-4	Slightly polluted	Moderate	84.2	Good	Clean but slightly impacted	6.5	8
8	Cloghroe / 01C05	3-4	Slightly polluted	Moderate	62.6	Moderate	Moderately impacted	7.0	6
9	Deele / 01D01	4	Unpolluted	Good	81.6	Moderate	Moderately impacted	7.4	8
10	Lowmagh / 39L04	4	Unpolluted	Good	63.7	Moderate	Moderately impacted	7.1	6
11	Treankeel / 39T14	4	Unpolluted	Good	68	Moderate	Moderately impacted	7.6	7

Plate 24. Land drainage outfall to the Elatagh River showing excessive iron-oxidizing bacteria.

Plate 25. Substrate on the Lowmagh Stream at Site 10, with excessive algae (left). Treankeel Stream at Site 11 with evidence of some siltation (right).

Plate 26. Upper Deele near the proposed Option B crossing point (left). The substrate of the River Deele at Site 9 had signs of eutrophication and was silted (right).

3.4.2 Physico-chemical Water Quality

3.4.2.1 Existing information

Nutrient enrichment (excessive inputs of phosphorus and nitrogen) is the main cause of water pollution in Ireland. The Environmental Quality Standards (EQS) for individual chemical parameters, define the threshold for achieving 'Good' chemical status. The compliance of river and lake monitoring stations against the physico-chemical EQSs, in particular ortho-phosphate, but also nitrate and ammonia, is usually complimentary to biological assessments at the same monitoring point. Catchment scale nutrient concentrations and in-stream loads are given for River Finn in EPA (2018). The average orthophosphate and total oxidised nitrogen (TON) concentrations were below detection limits from FINN_010 (upper river) to FINN_070 (FINN (DONEGAL)_080, concentrations of 0.015mg/l and 0.019mg/l were measured for orthophosphate and TON, respectively. The (EQS) for orthophosphate (0.035mg/l) and threshold for TON (2.6mg/l) were not exceeded at any of the main channel water bodies. Ammonia concentrations ranged from 0.040 to 0.093mg/l along the river. The EQS (0.065mg/l) ammonia was exceeded in the part of the catchment at Ballybofey (FINN (DONEGAL)_060).

3.4.2.2 Survey results

Results of the on-site physico-chemical measurements at survey sites are presented in **Table 12.** **Appendix 4** gives the laboratory test report. The results are discussed by parameter below.

Table 12. Physico-chemical water quality analysis results for sites in the River Finn catchment.

Parameter	Unit	Site						
		1	2	3	4	5	6	7
Ammonium	mg/L NH_4	0.15	0.16	0.14	0.13	0.129	0.14	0.14
B.O.D	mg/L	1.9	1.2	1.1	2.0	1.6	1.0	1.2
C.O.D	mg/L	91	76	45	84	83	48	41
Ortho-Phosphate (as P)	mg/L P	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065	<0.065
Total Ammonia	mg/L N	0.11	0.12	0.11	0.1	<0.1	0.11	0.11
Total Hardness	mg/L $CaCO_3$	23	<20	<20	21	22	<20	21
Total Organic Carbon	mg/L	35	35	31	38	45	33	20
Total Phosphorous (as P)	mg/L P	0.090	0.11	<0.075	0.1	<0.075	0.13	<0.075
Total Suspended Solids	mg/L	<10	<10	<5	<10	<5	<10	<10
Total Dissolved Solids	mg/L	104	<100	<100	<100	124	112	<100
Nitrate (as NO_3)	mg/L NO_3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrite (as NO_2)	mg/L NO_2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

3.4.2.2.1 Total Ammonia/Ammonium

Ammonia occurs naturally in rivers arising from the microbiological decomposition of nitrogenous compounds in organic matter. Fish and other aquatic organisms also excrete ammonia (EPA, 2001). Ammonia is naturally present in unpolluted waters in small amounts usually <0.02mg/L as N. Animal slurry, domestic sewage and industrial processes can all contribute to ammonia levels in water bodies. Ammonia may also be discharged directly into water bodies by some industrial processes or

as a component of domestic sewage or animal slurry. The decay of organic waste is another factor leading to the addition of ammonia in waters (EPA, 2001).

Total Ammonia concentrations sampled were between 0.1mg/l and 0.12mg/l across all sites. In relation to the 'Quality of Salmonid Waters Regulations 1988' this parameter has an EQS of ≤1mg/L NH_4, subject to conforming to the standard for non-ionized ammonia (Flynn, 1988). All sites meet this objective based on the sample taken, however this parameter should be measured for its quality of salmonid waters by using 95% of the results collected over a 12 month period for it to be considered an appropriate reading (Flynn, 1988). The result in the table above is single reading only in this regard.

The results for Ammonium was <0.129 for every site is well below the mandatory values of the 'Freshwater Fish Directive (78/659 EEC) of <1mg/L NH_4^+.

3.4.2.2.2 Biochemical Oxygen Demand (BOD)

BOD serves as an indicator of the presence of organic matter in a watercourse (eutrophication) and is a useful measure of water quality. BOD results were within the range 1mg/l (Site 6) – 2mg/l (Site 4). The results at Site 2, Site 3, Site 6 and Site 7 were consistent with WFD high status with respect to this parameter. These results are within the recommended tolerance of 5mg/L O_2 for salmonid species which are vital for FPM establishment. The results also achieve adherence to the 'Freshwater Fish Directive (78/659/EEC)' guidance of 3mg/L O_2 for salmonid waters and 6mg/L O_2 for cyprinid (fish from carp family) waters (EPA, 2001). During times of heavy rainfall and high river flows the BOD value often increases due to organic matter being washed from land and farmyards (EPA, 2011). In relation to the sites compatibility for FPM, **Site 1** and **Site 9** were too high for BOD as the required level is <1.3mg/L according to Oliver (2000) and 1.4mg/L according to Bauer (1988).

3.4.2.2.3 Orthophosphate/Total Phosphorus

This chemical parameter does occur naturally in water bodies from geological sources. Orthophosphate is the most readily available form of the nutrient Phosphorous for plant uptake for uptake during photosynthesis and is generally considered to be the limiting nutrient for plant growth in freshwater. Elevated levels of this chemical can have a detrimental effect on aquatic life. The results for orthophosphate across all 5 sites was <0.065mg/l. The orthophosphate levels for the surveyed sites met the 'good' quality status requirements for the 95%ile value though the results for the sites was from a single reading. The main cause for elevated levels is from agricultural runoff from land and farmyards which can contain organic and artificial fertilisers and other effluents (EPA, 2001).

In the Freshwater Fish Directive [78/659/EEC], a Total Phosphorus concentration of 0.2mg/l for salmonids is regarded as indicative in order to reduce eutrophication (Planning, 1990). The total phosphorus count for each site was <0.075mg/l. These results are well below the 0.2mg/l target.

3.4.2.2.4 Nitrate/Nitrite

There are no environmental quality standards for nitrate but average nitrate concentration values less than 4 mg/l NO_3 (0.9mg/l N) and less than 8 mg/l NO_3 (1.8mg/l N) are considered by the EPA to be indicative of high and good quality respectively (EPA, 2017). The results for all sites were below

0.5mg/l which means these sites are considered to be of good quality, in accordance with EPA (2001) guidance.

3.4.2.2.5 Suspended Solids/Total Dissolved Solids/Total Hardness

All sites had a result for suspended solids of <10 mg/L which is much less than the mandatory value of ≤25mg/L which is stated in the 'Salmonid Water Regulations (1988)' EPA, 2001).

Total dissolved solids (TDS) were >100mg/l at Site 1 (104mg/l), Site 5 (124mg/l) and Site 6 (112mg/l). All other sites recorded values less than the L.O.D. of 100mg/l. There are no specified parametric limits for TDS but these results would not be considered elevated.

Total Hardness values of <20mg/L $CaCO_3$ were obtained for Site 2, Site 3 and Site 6. The maximum value of this parameter was 23mg/L $CaCO_3$, at Site 1. According to the EPA's classification table for water hardness (EPA, 2019), water in the study area is classified as soft. Harder water can reduce the effect of toxicity of some metals including zinc, copper and lead (EPA, 2019).

3.4.2.2.6 Chemical Oxygen Demand (COD)

The COD results for the sites ranged from 41mg/L (Site 7) to 91mg/L (Site 1). There are no given specified target values for this parameter for freshwaters.

3.4.2.2.7 Total Organic Carbon (TOC)

The majority of organic carbon in water is made up of humic substances as well as partially degraded plant and animal materials. Organic carbon is resistant to microbial degradation (EPA, 2019). TOC values varied from 20mg/L at Site 7 to 45mg/l at Site 5. This parameter has no limit target specified in the legislation.

3.5 FUNCTIONAL FEEDING GROUP ANALYSIS

Table 13 shows the functional feeding group characteristics of the aquatic study sites. All study sites except for Site 8 and Site 10 were considered suitable to the rearing of juvenile salmoinds with respect to macroinvertebrates, as all had a predictable juvenile salmonid index.The juvenile salmonid index is the ratio of behavioral drifters (filtering and gathering collectors) to accidental drifters (scrapers, shredders and predators). A predictable juvenile salmonid food supply is based on a threshold of >0.50 (Rabenil *et al*. 2005).

All survey sites had a P/R ratio of less than 0.5, well below the threshold of 0.75 (>0.75 = autotrophic). This signifies that the watercourses in the study area require an external supply of organic matter (allochthonous organic matter) for biological sustenance i.e. energy sources for aquatic ecosystems in the study area are derived from outside the watercourses. All watercourses in the study area drain soils overlaying schist geology, where nutrient peaty soils are predominant. The naturally low nutrient concentrations of surface waters in the study area, coupled in some instances with their peaty nature mean that benthic life and therefore higher organisms are highly dependent on terrestrial energy sources for survival. For example, leaf litter and aerial insects are likely important food sources for macroinvertebrates and fish, respectively.

Table 13. Functional Feeding Group characteristics of the study sites

FFG	Site										
	1	2	3	4	5	6	7	8	9	10	11
Filtering collector	40	52	77	52	48	27	24	7	15	6	22
Gathering collector	8	26.5	62	43	35	55	63.5	47	60.5	33.5	46.5
Scraper	10	2	9	12	5	26	38	44	62.5	34.5	46.5
Predator	3	19.5	44	40	33	35	76.5	0	11	0	3
Shredder	66	38	33	19	5	24	29	66	52	47	32
Total	127	138	225	166	126	167	231	164	201	121	150
P/R ratio[1]	0.09	0.02	0.05	0.11	0.06	0.25	0.33	0.37	0.49	0.4	0.46
Heterotrophic (H) vs Autotrophic (A)	H	H	H	H	H	H	H	H	H	H	H
Juvenile salmonid index	0.61	1.32	1.62	1.34	1.93	0.96	0.61	0.49	0.6	0.48	0.84
Predictable (P) vs Unpredictable (U)[2]	P	P	P	P	P	P	P	U	P	U	P

[1] *Heterotrophy vs autotrophy based on a P/R threshold of > 0.75 = autotrophic*

[2] *Predictable juvenile salmonid food supply based on a threshold of >0.50*

3.6 FISH

3.6.1 Existing Information

The proposed development is primarily in the River Finn catchment. The Loughs Agency is the competent authority for fishery issues in the Finn catchment. The aim of the Loughs Agency is to provide effective management, conservation, promotion and development of the fisheries and marine resources of the Foyle and Carlingford areas. The River Deele is also under the jurisdiction of the Loughs Agency. Inland Fisheries Ireland is the competent authority for fishery issues in the Swilly catchment.

Populations of the Atlantic salmon, European Eel (*Anguilla anguilla*), Stickleback (*Gasterosteus aculeatus*), River/Brook (*Lampetra* sp.) and Sea Lamprey (*Petromyzon marinus*) form an important part of the native fisheries biodiversity of the Finn catchment. Maintaining high standards of water quality and appropriate habitat for these species is essential for the overall health of the aquatic ecosystem[19]. During surveys undertaken by the Loughs Agency in the River Finn catchment in 2010, Atlantic salmon, Brown Trout (*Salmo trutta*), European Eel, Stickleback, Minnow *Phoxinus phoxinus* and Stone Loach (*Barbatula barbatula*) were recorded along the main channel of the river.

The European eel is subject to European Council Regulation 1100/2007 'Establishing measures for the recovery of the stock of European eel'. Recruitment of glass eels is 5% of the pre-1980's levels[20]. European eel is listed as 'Critically endangered' and is now 'Red Listed' according to 'Red List No. 5: Amphibians, Reptiles & Freshwater Fish' (King *et al*., 2011). All three Irish lamprey species are listed under Annex II of the European Union Habitats Directive (92/43/EEC); included in Schedule Four of the European Communities (Birds and Natural Habitats) Regulations (S.I. No. 477/2011) and also

[19] https://www.loughs-agency.org/wp-content/uploads/2015/05/river-finn-and-tributaries-catchment-status-report-2010.pdf

[20] https://www.fisheriesireland.ie/fish-species/eel.html

protected by the following legal instruments: Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) Appendix III, Fisheries Acts 1959 to 2006, Fisheries Act (Northern Ireland) 1966, Foyle Fisheries Act (NI) 1952, Foyle and Carlingford Fisheries Act 2007.

Brown trout are the most widespread fish in Ireland and are found in practically every river, stream and lake in the country. Brown trout are not specifically listed for protection by EU directives. In Ireland, brown trout fisheries are regulated by national legislation and bye laws governing closed seasons, angling methods, size limits, bag limits, etc. Angling clubs may also have their own regulations. Sea trout are the migratory form of Brown trout. Sea trout > 40 cm fork-length are classified as salmon in terms of legislation and are covered under salmon regulations; commercial and rod harvest of salmon is permitted where stocks are in surplus (exceeding a system-specific Conservation Limit) and the fisheries are very strictly controlled[21].

The red list status of every species is assigned by the International Union for Conservation of Nature (IUCN). The red list status of stone loach, three-spined stickleback and Minnow is 'Least concern'. Stone loach and three-spined stickleback are protected by Coarse Fish bye-law No. 806, 2006 but have are not protected under EU legislation.

In McGinnity *et al* (2003), the River Swilly was recognised as a producer of Salmon and Sea Trout.

The Atlantic salmon is listed under Annexes II and V of the EU Habitats Directive and Appendix III of the Bern Convention. The Atlantic salmon is an anadromous species. The overall assessment of the Conservation Status for Atlantic salmon populations in Ireland has been recently assessed as being 'inadequate' NPWS (2019). Within river systems, variation in individual stock abundance can be influenced by a variety of factors, notably, alterations in physical habitat, water quality, environmental factors, predation, and angling and commercial fisheries exploitation.

The Salmon Conservation Limit (CL) in any river is the number of spawning salmon required to maintain a sustainable population and is used to indicate the number of salmon in a river system above which a harvestable surplus can be considered. The Loughs Agency reported in 2017 that the electronic fish counters in the River Finn recorded 1,985 returning Atlantic salmon with a 5-year average of 2,818. These figures are much lower than the management target counts of 5,410 and the conservation limit of 4,328[22].

The River Finn salmon fishing season is from the 1st March to the 15th September. Fishing for spring salmon is best east of Stranolar while the grilse run through to the upper reaches. The grilse run peaks here, depending on water, usually in mid June. The estimated rod catch from the Finn is approximately 500-800 spring salmon and 4,000 grilse annually, producing about 40% of the total Foyle count. The Loughs Agency has a management regime in place called the 'control of fishing regulations'. If enough salmon are not past the counter at Killygordon at a certain key date then both the angling and commercial fishing can be closed for set periods[23].

[21] https://www.fisheriesireland.ie/fish-species/brown-trout.html
[22] http://www.loughs-agency.org/wp-content/uploads/2018/10/2017-Foyle-Area-Status-Report.pdf
[23] https://www.npws.ie/protected-sites/sac/002301

One site was electric fished on the River Swilly as part of the Water Framework Directive (WFD) surveillance monitoring programme in rivers in 2011 (Kelly *et al*, 2012). The survey site was located at the R250 Bridge ca. 200m upstream of the Treankeel Stream confluence. Four fish species were recorded. Brown trout was the most abundant species, followed by salmon, lamprey and eels. During a previous fish survey in 2008, the same species composition was recorded.

3.6.2 Fish Survey Results

3.6.2.1.1 Field investigations

Atlantic salmon, brown trout and European eel were recorded during the survey of watercourses draining the proposed Drumnahough Wind Farm site in 2019. **Table 14** gives length descriptive statistics for all fish species captured. **Table 15** gives Catch Per Unit Effort (CPUE) indices for the salmonids captured. All electrical fishing data is presented in **Appendix 5**. Photographs of selected fish captured/seen during the survey are presented in **Plate 27** to **Plate 29**.

Table 14. Length descriptive statistics for fish species captured during the 2019 electrofishing survey of watercourses draining the proposed Drumnahough Wind Farm.

Site	Watercourse	Fish Species	Scientific Name	N	Length (cm)			
					Mean	Min	Max	St. Dev.
1	Elatagh	Brown trout	*Salmo trutta*	22	10.8	5.3	17.7	3.7
		Salmon	*Salmo salar*	10	7.9	46	11.3	2.3
2	Elatagh	Brown trout	*Salmo trutta*	25	10.9	5.8	18.3	3.5
		Atlantic salmon	*Salmo salar*	6	10.8	10.1	10.2	0.7
		European Eel	*Anguilla anguilla*	1	36.1	36.1	36.1	n/a
3	Elatagh	Brown trout	*Salmo trutta*	26	10.2	6.1	11.7	3.1
		European Eel	*Anguilla anguilla*	1	32.15	32.1	32.1	n/a
4	Carraig an Langáin	Brown trout	*Salmo trutta*	21	9.7	7.1	17.2	2.9
		European Eel	*Anguilla anguilla*	1	30.5	30.5	30.6	0.07
5	Unnamed	Brown trout	*Salmo trutta*	5	7.5	6.7	8	0.5
6	Cark	No fish	-	-	-	-	-	-
7	Unnamed	Brown trout	*Salmo trutta*	30	10.1	6	17.2	3.2
		Atlantic salmon	*Salmo salar*	2	7.15	7.1	7.2	0.07
		European Eel	*Anguilla anguilla*	0	-	-	-	n/a

Table 15. Catch Per Unit Effort (CPUE) indices for salmonids captured during the 2019 electrofishing surveys of watercourses draining the proposed Drumnahough Wind Farm.

Site	Tributary - Sub-tributary / EPA Code	Area fished (m^2)	Time fished (mins)	Brown trout			Atlantic salmon CPUE		
				N	CPUE		N	CPUE	
					Fish/m^2	Fish/min		Fish/m^2	Fish/min
1	Elatagh	400	n/a	22	0.06	n/a	10	0.03	n/a
2	Elatagh	175	10	25	0.14	2.5	6	0.03	0.6
3	Elatagh	165	10	26	0.16	2.6	0	0.00	0
4	Carraig An Langáin	150	10	21	0.14	2.1	0	0.00	0
5	Unnamed	105	10	5	0.05	0.5	0	0.00	0
6	Cark	64	10	0	0.00	0	0	0.00	0
7	Unnamed	225	10	30	0.13	2.9	2	0.01	0.2

Salmon were recorded only at Site 1, Site 2 and Site 7, all 3rd order reaches. This is related to habitat suitability. Atlantic Salmon can be expected to occur in all the larger (3rd order and larger) streams draining the proposed development, with the exception perhaps of the reach of the Lowmagh River in the environs of Site 10. A high gradient reach of this river less than 1km upstream of the Swilly confluence may prevent upstream migration of this species. Trout of smaller adult proportion are able to penetrate further into the headwaters and take advantage of spawning and nursery areas in 1st and 2nd order streams such as the Carraig an Langáin (Site 4) and Cark (Site 6) Streams, avoiding competition with salmon in these areas.

European eel was recorded at Site 2 (n=1), 3 (n=1), 4 (n=2) and 7 (n=1). These fish ranged in length from 30.5cm to 38.6cm. The watercourses in the study area contain plentiful rocks which provide optimal habitat for this species.

Figure 5 and **Figure 6** presents the length - % frequency distribution (LFD) for trout and salmon captured during the entire survey of watercourses in the upper River Elatagh catchment. It can be seen from LFDs that the age structure is generally dominated by fish in younger cohorts (age groups) for both the salmon and trout population. The LFD for all salmon clearly illustrates two cohorts: 0+ and 1+ salmon. The 0+ cohort ranged from ca. 5cm long to 7cm long, the 1+ cohort ranged from ca. 8.5cm long to 12cm long. There is no such distinction between trout cohorts for all sites. Separation of various trout age groups is uncertain, but it appears that at least three cohorts were captured.

The LFD of fish for individual survey sites are presented in **Appendix 6.** The LDF for salmon at Site 1 is a reflection of the overall result, with two cohorts apparent. Comparing trout LFDs at Site 1 with Sites 2 and 3, it can be seen that the smaller watercourses are relatively more important for younger class fish. This can be attributed to stream size, with the larger Elatgh at Site 1 able to support a greater array of fish cohorts.

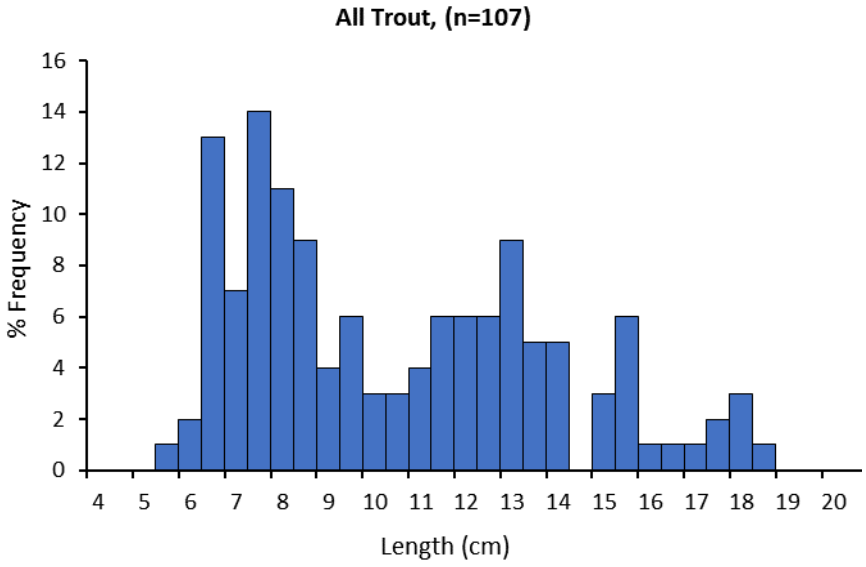

Figure 5 Length - % Frequency distribution of Trout captured during the entire survey.

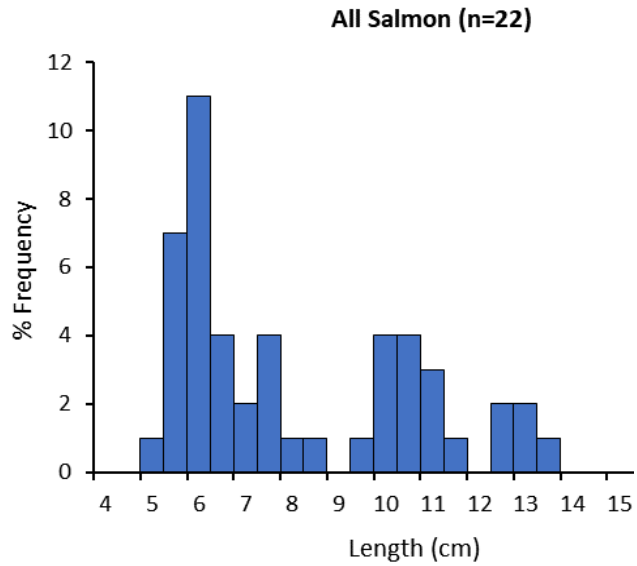

Figure 6 Length - % Frequency distribution of Atlantic Salmon captured during the entire survey.

Plate 27 Juvenile salmon and trout captured at Site 1 on the Elatagh River (left). Salmon considered to be in the 2+ cohort recorded at Site 1 (right).

Plate 28 Juvenile Brown trout (0+) at Site 3 on the Elatagh River (left). Sample of salmonids from the electrical fishing survey at Site 2 on the Elatagh River (right). Juvenile salmon (right) can normally be distinguished from young Brown trout by the more streamlined shape, deeply forked tail, longer pectoral fin, lack of orange on adipose fin, smaller mouth, sharper snout, only 1-4 spots on gill cover (often one large spot), well defined parr marks[24].

[24] http://www.atlanticsalmontrust.org/salmon-and-trout-recognition/


Plate 29 European eel was recorded at Site 2, 3, 4 and 7. Deposited sand in the Elatagh River, a potential habitat for juvenile lamprey (right).

4 CONCLUSIONS

The upper reaches of the watercourses in the part of the catchments affected by the proposed development are small medium-high gradient 1st and 2nd order streams. Within the proposed development site, the streams are high gradient and highly erosive with stream beds comprised mainly of rock/cobble.

These streams are generally shallow, have some problems associated with erosion and are shaded to varying degrees. With regard to habitat for aquatic macroinvertebrates, they were rated marginal-suboptimal. Macroinvertebrates communities usually associated with the fluvial conditions at the subject streams showed reduced diversity with reference to habitat suitability (e.g. Feeley *et al.*, 2020, Kelly-Quinn and Regan, 2012) especially in the Elatagh catchment, with a lack of pollution sensitive taxa. For example, two families of stonefly (Perlodidae and Nemouridae) were absent from the sites surveyed on the River Elatagh and its tributaries. Based on a desk study and field survey, it is concluded that FPM are highly unlikely to occur in the ZOI of the proposed development, acknowledging that the Finn catchment is FPM sensitive area.

Water quality issues are an ongoing problem the Finn catchment as documented by EPA monitoring across the catchment, and particularly in the Elatagh sub-catchment. The EPA carries out biological monitoring on the River Elatagh at two locations, the uppermost (station 0100) corresponding to survey Site 1. The 2016 EPA assessment of the River Elatagh note that *"both sites had an impoverished fauna and while this river once recorded up to 19 taxa, a mere 8 and 11 taxa were recorded at sites (0100 and 0300) during 2016, respectively. None of the most pollution-sensitive invertebrates were observed and chemical pollution is a suspected cause of this ongoing issue in the upper Finn catchment".* The EPA noted a small improvement on the Elatagh in 2019, but the number of taxa at station 0100 remained very low (10). The EPA result of Q3-4 based on sampling on 25/07/2019 corresponded with the result obtained by MWP on 4/07/2019. During MWP surveys of the River Elatagh, siltation and excessive algal growth was evident, signifying loss of soil in the catchment to fluvial habitats and eutrophication. Water quality deterioration was noted also in Swilly and Deele catchments but to a lesser degree.

In a detailed study carried out by Davis *et al.* (2018), sediment, phosphorus and nitrogen were manipulated simultaneously. Davis *et al.* (2018) concluded that sediment was the most pervasive stressor particularly at high cover levels. Substrate siltation could explain reduced biological diversity in the Elatagh catchment. Problems in watercourses arise from smothering of coarse patches of sediment with fine particles that ingress into the coarse sediment and deplete oxygen levels by reducing through-flow within the sediment (Walsh *et al.,* 2012)[25]. The negative impacts of high and persistent sediment loads affect invertebrate assemblages and abundances, with Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa exhibiting the greatest negative response to increased sediment[26]. Suspended solids levels in samples taken during September 2019 were all below 25mg/l (no evidence of harm from concentrations < 25mg/l) but samples were taken when the river was at normal flow. The degree of silt at some locations indicate that suspended solids is clearly a problem in the river however, probably being transferred to watercourses from adjacent lands during periods of intense rainfall on areas where vegetation cover is low, or absent. As pointed out by Crisp (2000), inert suspended solids can have a variety of effects upon salmonid fishes. They may have indirect effects through reduction of light input and, when they settle out in slower flows, they may occlude gravel interstices and reduce the amount of hiding places for small fish and/or their invertebrate prey. More directly, they may abrade or clog delicate membranes (e.g. fish gills) and they may cause skin irritation and abrasions, which may facilitate various secondary infections (Crisp, 2000). The most likely sources of pollution are considered related to commercial forestry and agriculture. In their 2019 assessment of the River Elatagh, the EPA indicate "*it is unclear exactly what is causing unsatisfactory water quality in this river, but multiple sources are being investigated"*.

The watercourses draining the site are considered good habitats for the early life stages of salmonids, but water quality problems reduce their value. Salmonid spawning and nursery areas are of variable quality across the sites surveyed. Salmonid juveniles and smolts have similar general requirements to those of sexually mature fish, and as they grow, the juveniles of both species of *Salmo* tend to move into deeper water (Crisp, 2000). The streams draining the site therefore increase in value for salmonids with distance from source, due to their greater fluvial area and presence of larger pools with associated increasing size. This was exemplified by the current results where salmon were detected at only two of the seven locations surveyed (Site 1 and Site 2). Both of these sites were on the 3rd order Elatagh River, downstream of the proposed development.

[25] https://www.epa.ie/pubs/reports/water/rivers/EPA_River_Sediment_Studies.pdf

[26] https://www.salmon-trout.org/wp-content/uploads/2017/09/STC-The-impact-of-excess-fine-sediment-on-invertebrates-and-fish-in-riverine-systems.pdf

5 RECOMMENDATIONS

It is imperative that any development in the River Elatagh catchment does not cause further surface water quality deterioration or inhibits restoration of surface waters to at least WFD 'good status'. A conclusion of the Davis *et al.* (2018) study was that improving river ecological quality requires improved management of sediment inputs.

Incorrect practices in land use, and improper management during construction projects can lead to excessive runoff of silt, nutrients and organic matter in times of heavy rainfall. A Surface Water Management Plan (SWMP) should therefore be produced for the proposed development in advance of any works taking place. The SWMP should detail method statement(s) for protecting water quality in the watercourses affected. The SWMP should be distributed and discussed with all parties involved in construction (including any sub-contractors) to protect aquatic conservation interests within the study area. The SWMP should set out measures to avoid siltation, erosion, surface water run-off and accidental pollution events which all have the potential to adversely affect water quality within the site during the construction phase. Any new development at watercourse crossings (upgrading/new tracks) should consider fish passage. Any works involving stream crossings should maintain or improve faunal connectivity upstream and downstream of works. The proposed development will be constructed in cognisance of the following guidelines:

- '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes'* (NRA, 2008)
- '*River Crossings and Migratory Fish: Design Guidance'* (Scottish Executive, 2000)
- '*Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters'* (IFI, 2016)
- '*Control of water pollution from construction sites – Guidance for consultants and contractors*' (Masters-Williams *et al*. 2001)
- '*Control of water pollution from linear construction projects*' (Murnane *et al.* 2006).

Silt control will be a primary concern during construction stage, as peat silt has been identified a sediment source for downstream areas. The use of conifer brash should be considered in designing erosion control and silt control measures. This is a plentiful resource at the site. It could be used to check flows, feature as an attenuation component in silt traps and protect denuded areas by laying compacted brash on soils prone to erosion.

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Appendix 1 Macroinvertebrate Physical Habitat Suitability

Table A1.1. Physical habitat assessment of streams for their suitability for macroinvertebrate production (adapted from Barbour and Stribling, 1991).

	Optimal	Suboptimal	Marginal	Poor
Score	**20**	**15**	**10**	**5**
Bottom substrate	More than 60% of bottom is gravel, cobble, and boulders. Even mix of substratum size classes.	30-60% of bottom is cobble or boulder substrata. Substrate may be dominated by one size class.	10-30% of substrata consists of large materials. Silt or sand accounts for 70-90% of bottom.	Substrate dominated by silt and sand. Gravel, cobble and larger substrate sizes <10%.
Habitat complexity	A variety of types and sizes of material form a diverse habitat.	Structural types or sizes of material are less than optimum but adequate cover still provided.	Habitat dominated by only one or two structural components. Amount of cover is limited.	Monotonous habitat with little diversity. Silt and sand dominate and reduce habitat diversity and complexity.
Pool quality	25% of the pools are as wide or wider than the mean stream width and area >1m deep.	<5% of the pools are >1m deep and wider than the mean stream width.	<1% of the pools are >1m deep and wider than the mean stream width. Pools present may be very deep or very shallow. Variety of pools or quality is fair.	Majority of pools are small and shallow. Pools may be absent.
Bank stability	Little evidence of past bank failure and little potential for future mass wasting into channel.	Infrequent or very small slides. Low future potential of slides.	Mass wasting moderate in frequency and size. Raw spots eroded during high floods.	Frequent or large slides. Banks unstable and contributing sediment to the stream.
Bank protection	Over 80% of streambank surfaces are covered by vegetation, boulders, bedrock, or other stable materials.	50-80% of the streambanks covered with vegetation, cobble, or larger material.	25-50% of the streambank is covered by vegetation.	<25% of the streambank is covered by vegetation or stable materials.
Canopy	Vegetation of various heights provides a mix of shade and filtering light to water surface.	Discontinuous vegetation provides areas of shade alternating with areas of full exposure. Or filtering shade occurs <6h/day.	Shading is complete and dense. Or filtering shade occurs <3h/day.	Water surface is exposed to full sun nearly all day long.

Appendix 2 Biotic Indices

Table A2.1. Intercalibration of EPA Q-rating system with Water Framework Directive status based on macroinvertebrates.

Q Value*	WFD Status	WFD Intercalibration Common Metric Value[27]	Pollution Status	Condition**	Ecological description
Q5, Q4-5	High	0.92	Unpolluted	Satisfactory	No or only minor difference from reference condition. Normal community structure, sensitive species present. Ecological processes functioning normally.
Q4	Good	0.853	Unpolluted	Satisfactory	Slight difference from reference condition. Slight change in community structure. Fewer sensitive species present, but increase in species richness and productivity. Ecological processes functioning normally.
Q3-4	Moderate	0.764	Slightly polluted	Unsatisfactory	Moderate difference from reference condition. Moderate change in community structure and loss of some niche species. Some ecological processes altered. Reduced resilience and ability to absorb external shocks.
Q3, Q2-3	Poor	0.627	Moderately polluted	Unsatisfactory	Major difference from reference condition. Significant change in community structure. Significant loss of niche species. Food chains and biogeochemical pathways significantly altered. Limited ability to absorb external shocks
Q2, Q1-2, Q1	Bad	0.42	Seriously polluted	Unsatisfactory	Severe difference from reference condition. Severe change in community structure. Severe loss of niche species and ecological functioning. Food chains collapse and biogeochemical pathways breakdown. Water body incapable of supporting most aquatic life.

** These Values are based primarily on the relative proportions of pollution sensitive to tolerant macroinvertebrates (the young stages of insects primarily but also snails, worms, shrimps etc.) resident at a river site.*

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

[27] From: https://www.epa.ie/pubs/reports/water/other/wfd/EPA_water_WFD_monitoring_programme_main_report.pdf

Table A2.2. BMWP Scores, categories and interpretation

BMWP score	Category	Interpretation
0-10	Very poor	Heavily polluted
11-40	Poor	Polluted or impacted
41-70	Moderate	Moderately impacted
71-100	Good	Clean but slightly impacted
>100	Very good	Unpolluted, unimpacted

Table A2.4. Revised BMWP scoring system

Name	Family	Original BMWP Score	Revised BMWP Score	Habitat Specific Scores		
				Riffles	Riffle/Pools	Pools
Flatworms	Planariidae	5	4.2	4.5	4.1	3.7
	Dendrocoelidae	5	3.1	2.3	4.1	3.1
Snails	Neritidae	6	7.5	6.7	8.1	9.3
	Viviparidae	6	6.3	2.1	4.7	7.1
	Valvatidae	3	2.8	2.5	2.5	3.2
	Hydrobiidae	3	3.9	4.1	3.9	3.7
	Lymnaeidae	3	3	3.2	3.1	2.8
	Physidae	3	1.8	0.9	1.5	2.8
	Planorbidae	3	2.9	2.6	2.9	3.1
Limpets and	Ancylidae	6	5.6	5.5	5.5	6.2
Mussels	Unionidae	6	5.2	4.7	4.8	5.5
	Sphaeriidae	3	3.6	3.7	3.7	3.4
Worms	Oligochaeta	1	3.5	3.9	3.2	2.5
Leeches	Piscicolidae	4	5	4.5	5.4	5.2
	Glossiphoniidae	3	3.1	3	3.3	2.9
	Hirudididae	3	0	0.3	-0.3	
	Erpobdellidae	3	2.8	2.8	2.8	2.6
Crustaceans	Asellidae	3	2.1	1.5	2.4	2.7
	Corophiidae	6	6.1	5.4	5.1	6.5
	Gammaridae	6	4.5	4.7	4.3	4.3
	Astacidae	8	9	8.8	9	11.2
Mayflies	Siphlonuridae	10	11	11		
	Baetidae	4	5.3	5.5	4.8	5.1
	Heptageniidae	10	9.8	9.7	10.7	13
	Leptophlebiidae	10	8.9	8.7	8.9	9.9
	Ephemerellidae	10	7.7	7.6	8.1	9.3
	Potamanthidae	10	7.6	7.6		
	Ephemeridae	10	9.3	9	9.2	11
	Caenidae	7	7.1	7.2	7.3	6.4
Stoneflies	Taeniopterygidae	10	10.8	10.7	12.1	
	Nemouridae	7	9.1	9.2	8.5	8.8
	Leuctridae	10	9.9	9.8	10.4	11.2
	Capniidae	10	10	10.1		
	Perlodidae	10	10.7	10.8	10.7	10.9
	Perlidae	10	12.5	12.5	12.2	
	Chloroperlidae	10	12.4	12.5	12.1	
Damselflies	Platycnemidae	6	5.1	3.6	5.4	5.7
	Coenagriidae	6	3.5	2.6	3.3	3.8
	Lestidae	8	5.4			5.4
	Calopterygidae	8	6.4	6	6.1	7.6
Dragonflies	Gomphidae	8				
	Cordulegasteridae	8	8.6	9.5	6.5	7.6
	Aeshnidae	8	6.1	7	6.9	5.7

Name	Family	Original BMWP Score	Revised BMWP Score	Habitat Specific Scores		
				Riffles	Riffle/Pools	Pools
	Corduliidae	8				
	Libellulidae	8	5			5
Bugs	Mesoveliidae *	5	4.7	4.9	4	5.1
	Hydrometridae	5	5.3	5	6.2	4.9
	Gerridae	5	4.7	4.5	5	4.7
	Nepidae	5	4.3	4.1	4.2	4.5
	Naucoridae	5	4.3			4.3
	Aphelocheiridae	10	8.9	8.4	9.5	11.7
	Notonectidae	5	3.8	1.8	3.4	4.4
	Pleidae	5	3.9			3.9
	Corixidae	5	3.7	3.6	3.5	3.9
Beetles	Haliplidae	5	4	3.7	4.2	4.3
	Hygrobiidae	5	2.6	5.6	-0.8	2.6
	Dytiscidae	5	4.8	5.2	4.3	4.2
	Gyrinidae	5	7.8	8.1	7.4	6.8
	Hydrophilidae	5	5.1	5.5	4.5	3.9
	Clambidae	5				
	Scirtidae	5	6.5	6.9	6.2	5.8
	Dryopidae	5	6.5	6.5		
	Elmidae	5	6.4	6.5	6.1	6.5
	Chrysomelidae *	5	4.2	4.9	1.1	4.1
	Curculionidae *	5	4	4.7	3.1	2.9
Alderflies	Sialidae	4	4.5	4.7	4.7	4.3
Caddisflies	Rhyacophilidae	7	8.3	8.2	8.6	9.6
	Philopotamidae	8	10.6	10.7	9.8	
	Polycentropidae	7	8.6	8.6	8.4	8.7
	Psychomyiidae	8	6.9	6.4	7.4	8
	Hydropsychidae	5	6.6	6.6	6.5	7.2
	Hydroptilidae	6	6.7	6.7	6.8	6.5
	Phryganeidae	10	7	6.6	5.4	8
	Limnephilidae	7	6.9	7.1	6.5	6.6
	Molannidae	10	8.9	7.8	8.1	10
	Beraeidae	10	9	8.3	7.8	10
	Odontoceridae	10	10.9	10.8	11.4	11.7
	Leptoceridae	10	7.8	7.8	7.7	8.1
	Goeridae	10	9.9	9.8	9.6	12.4
	Lepidostomatidae	10	10.4	10.3	10.7	11.6
	Brachycentridae	10	9.4	9.3	9.7	11
	Sericostomatidae	10	9.2	9.1	9.3	10.3
True flies	Tipulidae	5	5.5	5.6	5	5.1
	Chironomidae	2	3.7	4.1	3.4	2.8
	Simuliidae	5	5.8	5.9	5.1	5.5

Appendix 3 Macroinvertebrate species list

Table A5.1. Macroinvertebrates recorded during biological sampling on watercourses draining the proposed development during July 2019.

Taxa/Species	Pollution Sensitivity Group	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
MAYFLIES (Uniramia, Ephemeroptera)												
Ephemerellidae												
Blue-winged olive *Seratella ignita*	C	*	**	**	**	**		**				
Baetidae												
Large dark olive *Baetis rhodani*	C	**	***	****	****	*****	*****	****	*****	*****	*****	*****
Siphlonuridae	A					*	**					
Family Heptagenidae												
Autumn dun *Ecdyonurus* sp.	A								*	**		**
Yellow may dun *Heptagenia sulphurea*	A									**		
Rhithrogena semicolorata	A									**		
STONEFLIES (Order Plecoptera)												
Chloroperlidae												
Chloroperla torrentium	A	**	****	**			**					
Perlodid stoneflies (Perlodidae)												
Common yellow sally *Isoperla grammatica*	A									****	**	**
Brown stoneflies (Nemouridae)												
Nemoura sp.	A									****	***	***
Amphinemura sp.	A											*
Needleflies (Leuctridae)												
Leuctra sp.	B	******	*****	***			**	**	***	****	***	***
CASED CADDIS FLIES (Tricoptera)												
Northern caddisflies (Limnephilidae)	B		**	**	*	**	**	**	*			
Glossosomatidae												
Little black caddisfly *Agapetus fuscipes*	B						**					
Family Goeridae	B							*		*		
CASELESS CADDIS FLIES (Trichoptera)												

Taxa/Species	Pollution Sensitivity Group	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Grey flags (Hydropsychidae)												
Hydropsyche sp.	C	*		**						**		
Green sedges (Rhyacophilidae)												
The sandfly *Rhyacophila dorsalis*	C	*		**			*	**		**		*
Rhyacophila munda	C							*				
Trumpet-net caddisflies (Polycentropodidae)												
Polycentropus sp.	C	**	**	**		**	**	**			*	
Hydroptilidae	C							**				
DAMSELFLIES (Odonata, Zygoptera)	B										1	
TRUE FLIES (Diptera)												
Blackfly (Simulidae)												
Simulium sp.	C	**	**	**	**	**	**	**		*		***
Craneflies (Tipulidae)	C											
Tipula sp.	C	*				*	**					
Dicranota sp.	C	*	*								*	
Limoniidae (sub family)	-					*						
Family Chironomidae												
Bloodworm *Chironomous sp*.	E		**									
Green chironomid	C	**	**	**	***	**	**	**	**	***	**	***
House/Stable flies (Muscidae)												
Limnophora sp.	C	*										
Biting Midge (Ceratopogonidae)	C				*	**						
Pediciidae	C		*					*				
Stratiomyidae	C						*					
BEETLES (Coleoptera)												
Crawling water beetles (Haliplidae)	C		*									
Brychius elevatus	C											
Riffle Beetle (Elmidae)												

Taxa/Species	Pollution Sensitivity Group	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Elmis sp.	C				*			**		**	*	
Limnius sp.	C		*									
Minute moss beetles (Hydraenidae)												
Hydraena sp.	C			**				**				
SNAILS (Mollusca, Gastropoda)												
Family Ancylidae												
River limpet *Ancylus fluviatilis*	C				**			**				
CRUSTACEANS (Crustacea)												
Amphipods (Gammaridae)												
Freshwater shrimp *Gammarus duebeni*	C	*			**			**	*****	**		**
LEECHES (Hirudinae)												
Erpobdellidae												
Erpobdella sp.	D											
Piscicolidae												
Piscicola geometra	C											
BUGS (Hemiptera)												
Broad shouldered water striders (Veliidae)												
Velia sp.	C	**			**							
Mesoveliidae	D						**	**				
Broad shouldered water skaters (Gerridae)												
WORMS												
Oligochaeta	D	*		*	*		*	*		*		
NEMOTOMORPHA												
Horsehair worm	-				*			**				

**Present (1 or 2 individuals), **Scarce/Few (<1%), ***Small Numbers (<5%), ****Fair Numbers (5-10%), *****Common (10-20%), ******Numerous (25-50%), *******Dominant (50-75%), ********Excessive (>75%)*

Appendix 4 Laboratory Test Report

TEST REPORT NO: 170628 .1

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0151
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 1

Testing
Analysing
Consulting

BHP Laboratories
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Thomondgate
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Tel: +353 61 455399
Fax: +353 61 455261
EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.15		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.9		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	91		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.11		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	23		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	35		10/10/2019	1610
Total Phosphorus (as P)		mg/L	0.090		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<10		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	104		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .2

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0152
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 2

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Consulting

BHP Laboratories
New Road
Thomondgate
Limerick
Tel: +353 61 455399
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EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.16		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.2		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	76		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.12		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	<20		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	35		10/10/2019	1610
Total Phosphorus (as P)		mg/L	0.11		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<10		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	<100		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .3

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0153
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 3

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BHP Laboratories
New Road
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Tel: +353 61 455399
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EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.14		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.1		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	45		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.11		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	<20		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	31		10/10/2019	1610
Total Phosphorus (as P)		mg/L	<0.075		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<5		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	<100		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell, Laboratory Manager **Date Authorised:** 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .4

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0154
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 4

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Tel: +353 61 455399
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EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.13		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	2.0		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	84		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.10		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	21		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	38		10/10/2019	1610
Total Phosphorus (as P)		mg/L	0.10		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<10		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	<100		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .5

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0155
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 5

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Tel: +353 61 455399
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EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	<0.129		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.6		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	83		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	<0.1		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	22		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	45		10/10/2019	1610
Total Phosphorus (as P)		mg/L	<0.075		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<5		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	124		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .6

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0156
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 6

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Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.14		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.0		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	48		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.11		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	<20		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	33		10/10/2019	1610
Total Phosphorus (as P)		mg/L	0.13		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<10		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	112		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

TEST REPORT NO: 170628 .7

Client: Malachy Walsh & Partners

Reen Point
Blennerville
Tralee
Co. Kerry

BHP Ref. No: 19/10/0157
Quote Ref: QC003551
Order No: 22760
Sales Order: 68462
Date Received: 01/10/2019
Date Sampled: 30/09/2019
Date Completed: 10/10/2019
Sample Type: Surface Water

FTAO: Gerard Hayes
Site: 19715
BHP Ref: On Demand_Surface Water
Client Ref: Site 7

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EMail:dervlapurcell@bhp.ie

Test		Units	Results	Customer Limits	Date Analysed	Method
Ammonium (as NH_4)	Acc.	mg/L	0.14		07/10/2019	BHP AC 095
B.O.D.	Acc.	mg/L	1.2		02/10/2019	BHP AC 005
C.O.D.	Acc.	mg/L	41		02/10/2019	BHP AC 006
OrthoPhosphate (as P)	Acc.	mg/L	<0.065		03/10/2019	BHP AC 019
Total Ammonia (as N)	Acc.	mg/L	0.11		07/10/2019	BHP AC 095
Total Hardness (as $CaCO_3$)		mg/L	21		04/10/2019	BHP AC 095
Total Organic Carbon	*	mg/L	20		10/10/2019	1610
Total Phosphorus (as P)		mg/L	<0.075		10/10/2019	BHP AC 095
Total Suspended Solids	Acc.	mg/L	<10		03/10/2019	BHP AC 012
Total Dissolved Solids		mg/L	<100		04/10/2019	BHP AC 011
Nitrate (as NO_3)	Acc.	mg/L	<0.5		03/10/2019	BHP AC 019
Nitrite (as NO_2)	Acc.	mg/L	<0.05		03/10/2019	BHP AC 019

Authorised by: Dervla Purcell
Laboratory Manager

Date Authorised: 15/10/2019

Additional Information:(Opinions, where stated, are not covered by accreditation)

Acc.:	INAB Accredited
ND:	None detected in volume analysed
^	Potable water matrix
*	Subcontracted to an approved accredited laboratory
**	This sample has been analysed outside recommended stability times. It is therefore possible that the results provided may be compromised.
~ :	Sample Condition : ACCEPTABLE

Appendix 5 Electrical Fishing Data

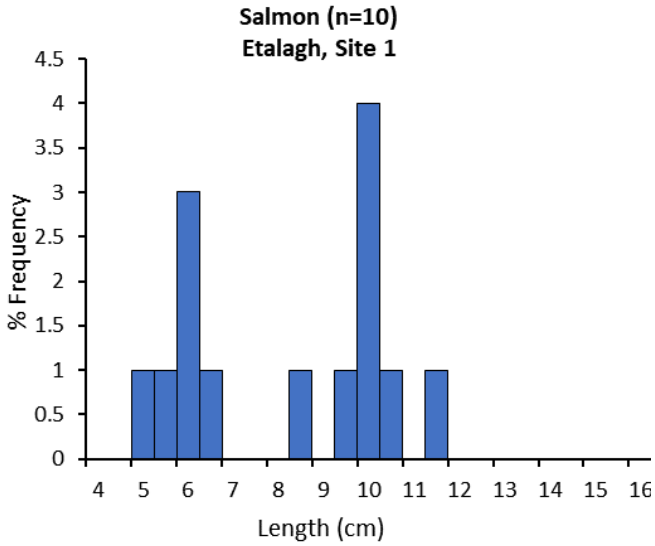
Table A5.1. Results of the electrical fishing surveys undertaken on watercourses draining the proposed development during September 2019.

Site	Species	Length (cm)	Area (m^2)	Time (minutes)	Pass
1	Brown Trout	16.3	400	-	1
1	Brown Trout	15.1	400	-	1
1	Brown Trout	17.7	400	-	1
1	Brown Trout	15.2	400	-	1
1	Brown Trout	12.1	400	-	1
1	Brown Trout	15.2	400	-	1
1	Brown Trout	14	400	-	1
1	Brown Trout	11.7	400	-	1
1	Brown Trout	11.6	400	-	1
1	Brown Trout	13	400	-	1
1	Brown Trout	12.4	400	-	1
1	Brown Trout	12.6	400	-	1
1	Brown Trout	9.4	400	-	2
1	Brown Trout	6.4	400	-	2
1	Brown Trout	9.4	400	-	2
1	Brown Trout	7	400	-	2
1	Brown Trout	6.4	400	-	2
1	Brown Trout	7.1	400	-	2
1	Brown Trout	7	400	-	2
1	Brown Trout	12.5	400	-	2
1	Brown Trout	6.3	400	-	2
1	Brown Trout	7.3	400	-	2
1	Brown Trout	7.2	400	-	3
1	Brown Trout	5.3	400	-	3
1	Brown Trout	12.6	400	-	4
2	Atlantic Salmon	10.8	175	10	1
2	Atlantic Salmon	10.1	175	10	1
2	Atlantic Salmon	12.1	175	10	1
2	Atlantic Salmon	10.8	175	10	1
2	Atlantic Salmon	10.2	175	10	1
2	Atlantic Salmon	10.6	175	10	1
2	Brown Trout	18.3	175	10	1
2	Brown Trout	17.9	175	10	1
2	Brown Trout	12.7	175	10	1
2	Brown Trout	11.6	175	10	1
2	Brown Trout	13.1	175	10	1
2	Brown Trout	12.1	175	10	1
2	Brown Trout	11.7	175	10	1
2	Brown Trout	12.5	175	10	1
2	Brown Trout	14.6	175	10	1
2	Brown Trout	13	175	10	1
2	Brown Trout	12.6	175	10	1
2	Brown Trout	12.4	175	10	1
2	Brown Trout	11	175	10	1
2	Brown Trout	11.1	175	10	1
2	Brown Trout	13.6	175	10	1
2	Brown Trout	12.6	175	10	1

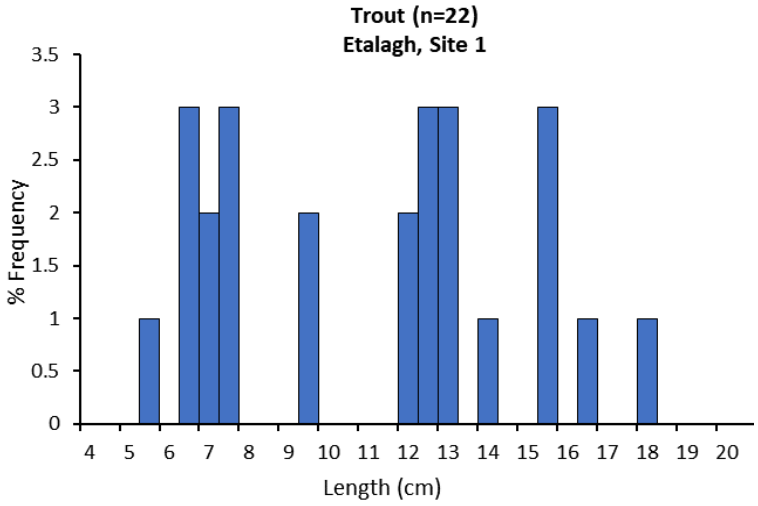
Site	Species	Length (cm)	Area (m^2)	Time (minutes)	Pass
2	Brown Trout	6.6	175	10	1
2	Brown Trout	7.8	175	10	1
2	Brown Trout	7.7	175	10	1
2	Brown Trout	7.1	175	10	1
2	Brown Trout	7.8	175	10	1
2	Brown Trout	6.4	175	10	1
2	Brown Trout	6.1	175	10	1
2	Brown Trout	6.4	175	10	1
2	Brown Trout	5.8	175	10	1
2	European Eel	36.1	175	10	1
3	Brown Trout	15.1	165	10	1
3	Brown Trout	10.8	165	10	1
3	Brown Trout	9.8	165	10	1
3	Brown Trout	17.7	165	10	1
3	Brown Trout	6.2	165	10	1
3	Brown Trout	16.8	165	10	1
3	Brown Trout	15	165	10	1
3	Brown Trout	11.5	165	10	1
3	Brown Trout	9.8	165	10	1
3	Brown Trout	10.8	165	10	1
3	Brown Trout	9.6	165	10	1
3	Brown Trout	11.4	165	10	1
3	Brown Trout	11.4	165	10	1
3	Brown Trout	11.7	165	10	1
3	Brown Trout	8.9	165	10	1
3	Brown Trout	8.8	165	10	1
3	Brown Trout	8.3	165	10	1
3	Brown Trout	10.4	165	10	1
3	Brown Trout	10.4	165	10	1
3	Brown Trout	8.2	165	10	1
3	Brown Trout	6.4	165	10	1
3	Brown Trout	6.1	165	10	1
3	Brown Trout	7.8	165	10	1
3	Brown Trout	9.1	165	10	1
3	Brown Trout	6.7	165	10	1
3	Brown Trout	7.2	165	10	1
3	European Eel	32.1	165	10	1
4	Brown Trout	17.2	150	10	1
4	Brown Trout	15	150	10	1
4	Brown Trout	15.3	150	10	1
4	Brown Trout	11.6	150	10	1
4	Brown Trout	10.7	150	10	1
4	Brown Trout	11.4	150	10	1
4	Brown Trout	9.1	150	10	1
4	Brown Trout	8.1	150	10	1
4	Brown Trout	8.4	150	10	1
4	Brown Trout	8.6	150	10	1
4	Brown Trout	7.6	150	10	1
4	Brown Trout	9.3	150	10	1
4	Brown Trout	8.3	150	10	1
4	Brown Trout	8.6	150	10	1
4	Brown Trout	7.1	150	10	1
4	Brown Trout	8.2	150	10	1

Site	Species	Length (cm)	Area (m^2)	Time (minutes)	Pass
4	Brown Trout	8.2	150	10	1
4	Brown Trout	7.7	150	10	1
4	Brown Trout	7.6	150	10	1
4	Brown Trout	7.2	150	10	1
4	Brown Trout	8.3	150	10	1
4	European Eel	30.5	150	10	1
4	European Eel	30.6	150	10	1
5	Brown Trout	8	105	10	1
5	Brown Trout	7.8	105	10	1
5	Brown Trout	6.7	105	10	1
5	Brown Trout	7.4	105	10	1
5	Brown Trout	7.5	105	10	1
6	No fish		64	10	1
7	Brown Trout	17.2	225	10	1
7	Brown Trout	13.4	225	10	1
7	Brown Trout	15.1	225	10	1
7	Brown Trout	14	225	10	1
7	Brown Trout	15.8	225	10	1
7	Brown Trout	13.1	225	10	1
7	Brown Trout	12.8	225	10	1
7	Brown Trout	11.5	225	10	1
7	Brown Trout	13.8	225	10	1
7	Brown Trout	13.3	225	10	1
7	Brown Trout	10.4	225	10	1
7	Brown Trout	9.2	225	10	1
7	Brown Trout	13.7	225	10	1
7	Brown Trout	7.7	225	10	1
7	Brown Trout	12.6	225	10	1
7	Brown Trout	13.2	225	10	1
7	Brown Trout	7.2	225	10	1
7	Brown Trout	7.6	225	10	1
7	Brown Trout	6.1	225	10	1
7	Brown Trout	6	225	10	1
7	Brown Trout	8.3	225	10	1
7	Brown Trout	6.3	225	10	1
7	Brown Trout	7.2	225	10	1
7	Brown Trout	7.2	225	10	1
7	Brown Trout	7.4	225	10	1
7	Brown Trout	6.7	225	10	1
7	Brown Trout	6.5	225	10	1
7	Brown Trout	7.3	225	10	1
7	Brown Trout	6.5	225	10	1
7	Brown Trout	6.7	225	10	1
7	Atlantic Salmon	7.2	225	10	1
7	Atlantic Salmon	7.1	225	10	1
7	European Eel	38.6	225	10	1

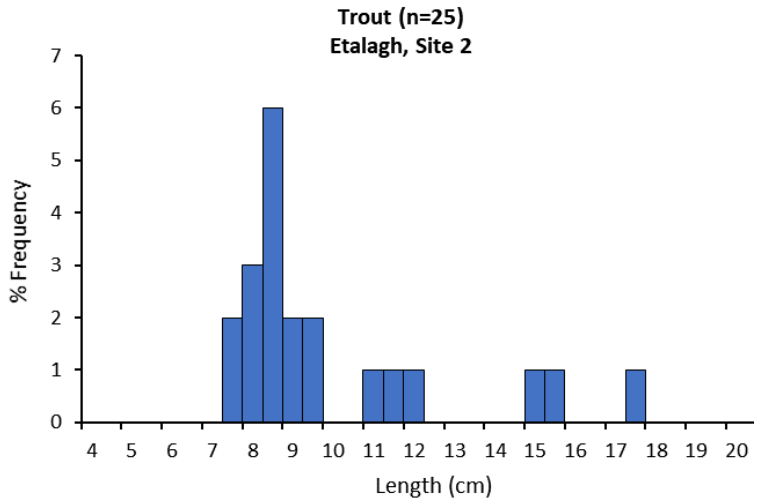
Appendix 6 Length - % Frequency Distributions of fish at Selected Sites



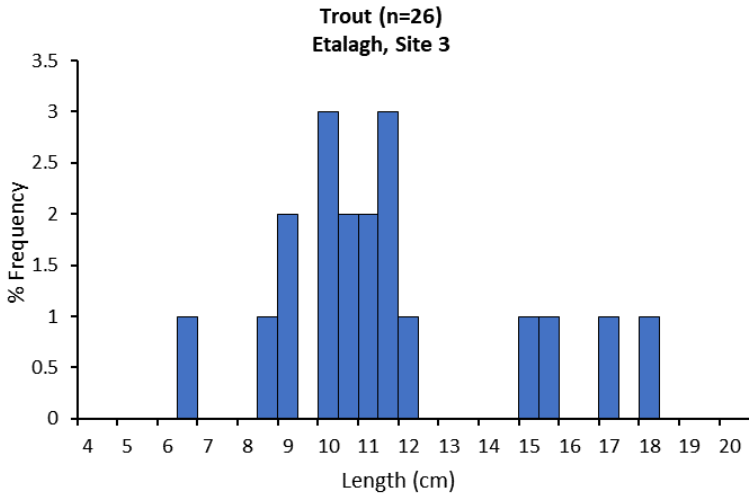
Length - % Frequency distributions for Salmon at Site 1.



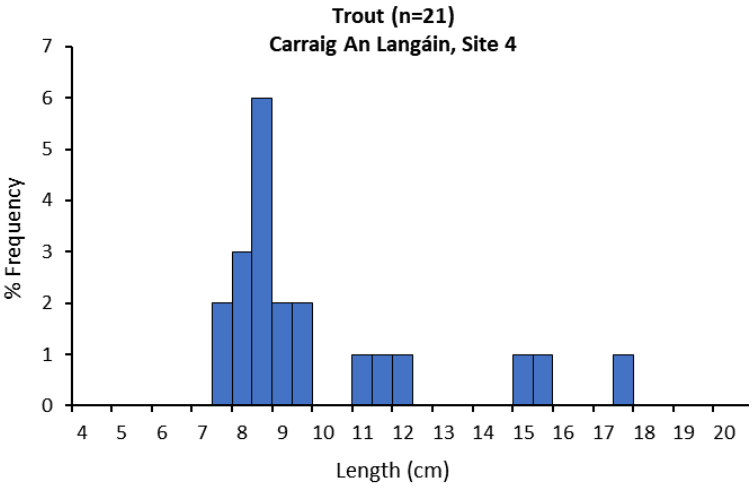
Length - % Frequency distributions for Trout at Site 1.



Length - % Frequency distributions for Trout at Site 2.



Length - % Frequency distributions for Trout at Site 3.



Length - % Frequency distributions for Trout at Site 4.