Aquatic Ecology and Fish Report

Ballinla Wind Farm

Ballinla Wind Farm Ltd.

April 2025

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MWP

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1. Introduction

Malachy Walsh and Partners (MWP) have been commissioned by Ballinla Wind Farm Ltd. to prepare an Environmental Impact Assessment Report (EIAR) to accompany a planning application for the Ballinla Wind Farm in Co. Offaly. 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.

This report outlines the survey methods deployed to collect field data and also presents the data. The ecological features covered in this report are fish, macroinvertebrates and aquatic ecology with water quality assessments also carried out.

1.1 Statement of authority

Surveying to inform this report was completed by Gerard Hayes and Orla van der Noll of at Malachy Walsh and Partners (MWP) Engineering and Environmental Consultants. This report was prepared by Gerard Hayes and reviewed by Orla van der Noll.

Gerard (BSc.) is a Senior Aquatic Ecologist with over 15 years' experience in environmental consultancy. Gerard is a full member of the Chartered Institute of Ecology and Environmental Management MCIEEM), the main society in Ireland for professional ecologists. Gerard has a diverse ecological profile, with aquatic fauna, phase 1 habitat, mammal (including bats), bird, amphibian, macroinvertebrate, and tree survey experience. He has had numerous responsibilities including report writing (EIS, EIA, EA, AA, NIS), waste assimilation capacity assessment, and ecological monitoring. His project involvement has been primarily in the areas of wind energy development, waste-water treatment plants, roads/bridges, water supply, flood defense and hydro schemes. He is co-author and/or carried out surveys for NPWS Irish Wildlife Manual Nos. 15, 24, 26, 37, 45. This included juvenile lamprey electrical fishing surveys in the Boyne, Corrib, Moy and Suir catchments, the latter which he led. He has collated field data and prepared river water quality assessment reports for EPA biological monitoring of rivers as part of Water Framework Directive (WFD) monitoring. He has been formally trained in WFD river monitoring (Environmental Protection Agency), Stage 1 and Stage 2 Freshwater Pearl Mussel Surveying (Dr. Evelyn Moorkens), aquatic macroinvertebrate identification (Freshwater Biological Association).

Orla (MSc, BSc) is an Ecologist who has been working full-time with MWP since September 2022. She has been working in the ecology sector since March 2021 where she has completed numerous ecological reports for a range of projects across Ireland. In 2020 Orla qualified with a first-class honours Master's degree in Marine Biology from Bangor University, Wales, and a Bachelors (hons) degree in Ecology and Environmental Biology from University College Cork in 2018. Orla is registered with the CIEEM as a Qualifying member.

1.1.1 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 and 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 the 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.

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2. Methodology

2.1 Desktop 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)[1] and Inland Fisheries Ireland (IFI) on 12th November 2023[2]. The database of the National Biodiversity Data Centre (NBDC)[3] was consulted on 12th November 2023 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. Watercourses names follow EPA nomenclature. Stream order is described using the classification system given in Strahler (1964) which defines stream size based on a hierarchy of tributaries (with 1st order streams being the smallest).

Chemistry data relevant to the study area was downloaded from catchments.ie (https://www.catchments.ie/data/#/?_k=zc2iqj) on 3rd November 2023. Results were compared to chemical status on a scale of High-Good-Moderate-Poor-Bad based on water quality standards given in Surface Water Regulations (DoEHLG, 2012, the Freshwater Fish Directive (78/659/EEC) and the Salmonid Water Regulations (1998)[4]. Table 1 gives chemical parameter thresholds for achievement of Water Framework Directive 'High' and 'Good' Status.

Historical findings by the author were also used, including results from biological sampling in the Esker Stream in 2014.

Maps were produced using shapefiles of the layout of the proposed development site, grid route and publicly available GIS mapping data.

Table 1: Physico-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) or ≤2.2 (95%ile)	≤1.5 (mean) 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 Field surveys

2.2.1 Scope of field surveys

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. Survey sites were selected on waterbodies within and downstream of the proposed development as indicated in Figure 1 and Table 2. While survey locations down-gradient of the proposed development area are influenced by

[1] https://www.npws.ie/maps-and-data
[2] https://www.fisheriesireland.ie/
[3] http://www.biodiversityireland.ie/
[4] http://www.irishstatutebook.ie/eli/1988/si/293/made/en/print

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 to obtain 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. It is noted that there was once a standing waterbody in a field to the northeast of Site 4. This waterbody, which appeared to be a semi-natural pond, based on historical aerial imagery has been infilled.

The field surveys comprised an evaluation of aquatic habitats, fish assessments and biotic assessment using aquatic macroinvertebrates, as well as on-site physico-chemical water quality measurements. Water quality affects the viability and quality of salmonid habitat so is useful in assessing habitats for aquatic organisms, including trout (*Salmo trutta*) and salmon (*S. salar*). To this end biological sampling and water quality indices were used to evaluate watercourses at selected locations. This field work was carried out on the 14th and 15th June (biological sampling) and 2nd and 3rd August (electric fishing) during 2023. A survey was also undertaken on 26th January 2024 when water levels were higher to determine if any waterbodies within the proposed development site drained to the north.

Table 2: Aquatic ecology and fish survey locations on watercourses draining the proposed Ballinla Wind Farm[5]

Hydrometric Area	Sub-basin	Watercourse	River Segment Code	Site	Coordinate (ITM)		Survey		
					x	y	Aquatic habitat	Fish survey	Biological sampling
Boyne	BOYNE_020	Not registered	n/a	Site 1	657139	732086	✓	✓	✓
		Not registered	n/a	Site 2	657054	731889	✓	✓	✓
		Not registered	n/a	Site 3	656037	732053	✓	✓	✓
		Not registered	n/a	Site 4	656561	732047	✓	✓	✓
		Leitrim	14_1844	Site 5	656648	731817	✓	✓	✓
Barrow	ESKER STREAM_020	Leitrim	14_1844	Site 6	656330	730714	✓	✓	✓
		Leitrim	14_249	Site 7	656159	729842	✓	✓	✓
		Lumville	14_506	Site 8*	656731	730173	✓		
		Lumville	14_506	Site 9	656282	729762	✓	✓	✓
		Leitrim	14_248	Site 10	655774	728475	✓	✓	✓
		Rathmoyle	14_1872	Site 11*	655143	730738	✓		
		Esker (Stream) [Offaly]	14_251	Site 12	655808	727272	✓	✓	✓

**No surface water at Site 8 or Site 11*

[5] NB: Site locations based on EPA/WFD river basin boundaries but see Section 3.1 for actual ground conditions.

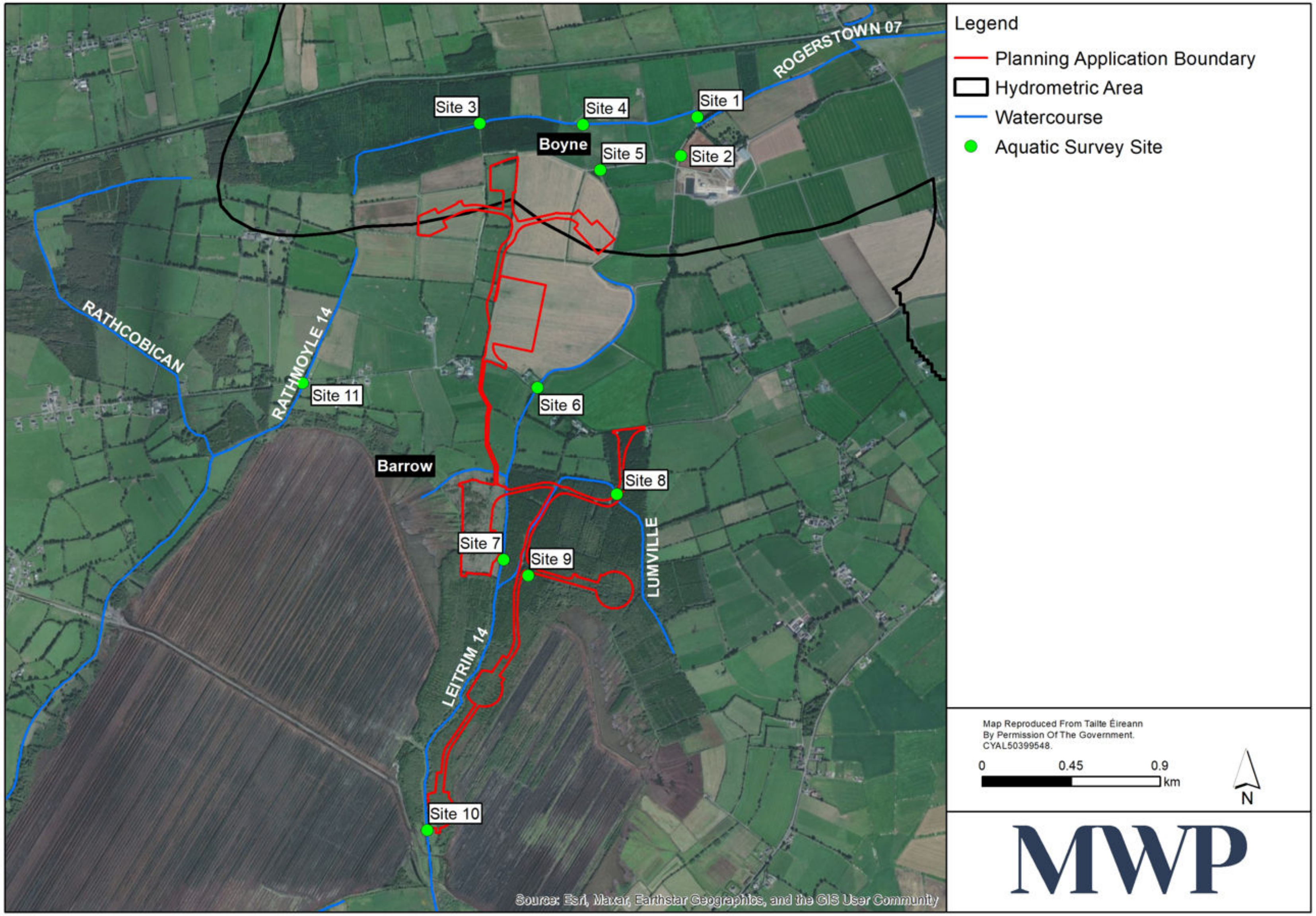

Figure 1: Watercourses and aquatic survey sites examined as part of the aquatic ecology studies for the proposed Ballinla Wind Farm.

2.3 Aquatic habitats

Habitat assessment was carried out at survey 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[6], glide[7] and pool[8] 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.

2.3.1 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.

2.3.2 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.

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.

[6] Described in EA (2003) as shallow, fast-flowing, water with a distinctly disturbed surface over unconsolidated gravel-pebble, or cobble, substrate
[7] Laminar flow where water movement did not produce a disturbed surface
[8] Little/no observable flow

2.4 Benthic macroinvertebrates

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 1). 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 were carried out for each site using biotic indices, based on the range and abundances of macroinvertebrates recorded. Details of biotic indices are provided in Appendix 2.

Plate 1: Electrical fishing sampling apparatus employed during the on-site investigations (left). Macroinvertebrate sampling kit used during biological water quality assessment (right).

Plate 2: Site 1 (left) and Site 2 (right).

Plate 3: Site 3 (left) and Site 4 (right) on the Leitrim River

Plate 4: Site 5 (left) and Site 6 (right) on the Leitrim River.

Plate 5: Site 7 on the Leitrim River (left) and Site 8 on the Lumville Stream (right).

Plate 6: Site 9 on the Lumville Stream (left) and Site 10 on the Leitrim River (right).

Plate 7: Site 11 on the (left) and Site 12 on the Esker Stream (right).

2.5 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 1).

2.5.1 Biotic indices

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

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

2.5.1.2 EPT Index

Biological water quality was also assessed using the EPT (Ephemeroptera Plecoptera Trichoptera) 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.

2.6 Fish

An electric fishing survey was carried out under authorisation from the Department of Environment, Climate and Communications under Section 14 of the Fisheries Act (1980), see Figure 1 for locations. Table 3 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). An electrical fishing sampling apparatus was used during the assessment (see Plate 1).

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 then released alive and spread evenly over the sampling area.

Table 3: Downstream and upstream limits of the electrical fishing surveys undertaken on watercourses draining the proposed development.

Tributary - Sub-tributary	River segment code	Site	Upstream co-ordinate (ITM)		Downstream co-ordinate (ITM)		Length fished (m)	Area fished (m^2)
			X	X	X	Y		
Not registered	n/a	1	657132	732114	657139	732086	30	
Not registered	n/a	2	657048	731849	657054	731889	40	
Not registered	n/a	3	656015	732046	656037	732053	28	
Not registered	n/a	4	656582	732048	656561	732047	25	
Leitrim	14_1844	5	656642	731827	656648	731817	18	
Leitrim	14_1844	6	656358	730738	656330	730714	35	
Leitrim	14_249	7	656160	729877	656159	729842	32	
Lumville	14_506	8*					n/a	n/a
Lumville	14_506	9	656320	729786	656282	729762	40	
Leitrim	14_248	10	655770	728502	655774	728475	25	
Rathmoyle	14_1872	11**					n/a	n/a
Esker (Stream) [Offaly]	14_251	12	655807	727241	655808	727272	26	

**marshy habitat - no fish*
*** channel dried out – no fish*

Following completion of the fishing, the dimensions and physical habitat characteristics of each site were recorded, including area and flow characteristics. 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.

2.7 Amphibians

Wetland habitats considered suitable for amphibian breeding were noted during all site visits. During biological sampling, any detected tadpoles were recorded. The site was surveyed for evidence of frog spawn on 15th and 16th February 2024.

2.8 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.

2.9 Survey limitations

Electrical fishing efficiency was reduced at some locations due to difficult access and the extent of dense instream vegetation. The sites in the northern component of the proposed development site were on drainage ditches with steep banks and unstable soft substrates. Consequently, these reaches could not be continuously fished. However, the degree of surveying carried out was deemed sufficient to assess the importance of the surface water features examined.

3. Results

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

3.1 Description of surface water features

The proposed development site comprises flat land where drainage is by overland flow and percolation to ground. The northern extent of the proposed development site features fields used primarily for agricultural purposes. Extensive field drains run along field boundaries at the northern extent of the proposed development site.

EPA mapping indicates that the northernmost part of the proposed development site is within the River Boyne catchment and drains to the north via a 1st order stream that flows under the Grand Canal. During the field surveys completed in summer 2023, the flow direction in linear surface waters was seen to be to the south, as illustrated in Figure 2. The water flow direction at Site 1 - Site 5 is south to the Barrow catchment. There was no apparent flow in the drainage ditch at the northeastern extent of the site in summer 2023, but when surveyed in January 2024, water was seen to flow to the east along a course of a channel referred to the EPA as the Rogerstown

Stream. Approximately 700m of this channel appeared to flow to the east, in the Boyne catchment, the remainder to the west, in the Barrow catchment (see Figure 2). It is considered therefore that all lands at the proposed development site, with the exception of a small portion at the northeast are drained by the Leitrim River. The relevant watersheds in the study area may be poorly defined due to the low gradient and highly modified nature of the landscape in the region.

According to EPA mapping, the Leitrim River rises near Site 5. Field surveys found that the drains upon which Site 1 – Site 4 were located all drain to Site 5. The Leitrim River is classified as a 'drainage ditch' and a 'depositing/lowland river' at the northern and southern extents of the proposed development site respectively, with reference to Fossitt (2000).

The Leitrim River facilitates field and forestry drainage at the northern and southern extents of the proposed development site respectively. The 1st order Lumville Stream feeds the Leitrim River from the east. This watercourse is classified as a 'drainage ditch' where it flows north and did not follow the route mapped by the EPA. It was found to be dry at Site 8 during summer 2023. The primary flow path is west along the route indicated in Figure 2 where it is mapped as a 'depositing lowland river'. The only other EPA mapped stream within the study area is the 1st order Rathmoyle Stream which drains the north-western extent of the study area. EPA mapping indicates that this stream flows south to meet the Rathcobican Stream which in turn flows into the 3rd order Esker (Offaly) Stream ca. 17 km upstream of the Leitrim River confluence.

The watercourses draining the proposed development site collectively support fool's watercress (*Apium nodiflorum),* brooklime (*Veronica beccabunga*), watercress (*Rorippa nasturtium-aquaticum*), lesser water-parsnip (*Berula erecta*), water starwort (*Callitriche* sp.), duckweed (*Lemna* sp.), reed canary grass (*Phalaris arundinacea*) and great willowherb (*Epilobium hirsutum*).

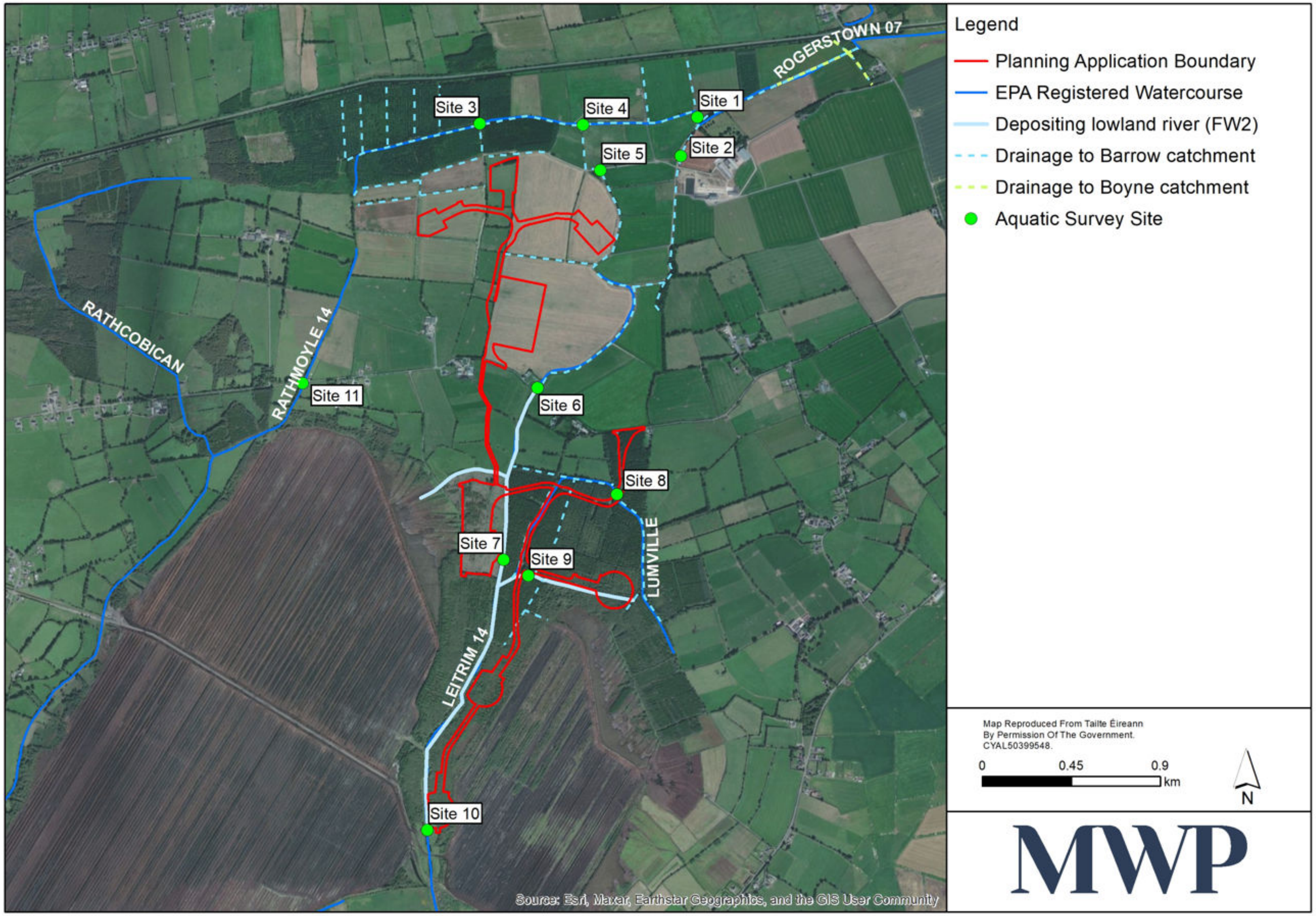

Figure 2: Surface water features at the proposed development site.

Plate 8: Part of the site previously a pond, in June (left) and August (right), now infilled.

Plate 9: Typical drainage ditches within the proposed development site in June 2023: upstream of Site 1 (left), downstream of Site 2 (right).

Plate 10: The Lumville Stream is a drainage ditch along most of its course (left). Lumville Stream (depositing/lowland river) as it flows west towards the Leitrim River (right).


Plate 11: The Leitrim River ca. 1km downstream of Site 7 (left) has been deeply drained. The Leitrim River near Site 10 features a constructed silt pond (right).

3.2 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 3.2.1) and fish (Section 3.2.2 is a function of watercourse characteristics in the receiving riverine environment. The physical characteristics of survey sites are listed in Table 4.

The watercourses draining the proposed development site are low gradient streams. Their lotic[9] carrying capacity is limited by certain characteristics including morphological condition, small size, riparian conditions (e.g. overshading) and / or pollution.

Table 4: Physical characteristics of the aquatic survey sites

Site No.	1	2	3	4	5	6	7	9	10	12
Wetted width (m)	1.2	1.5	1.5	1.6	1.8	1.6	1.1	1.4	4.7	4.2
Riffle (%)	0	0	0	0	0	20	5	0	0	40
Glide (%)	10	50	0	0	0	60	55	50	40	40
Pool (%)	90	50	100	100	100	20	40	50	60	20
Instream vegetation cover (%)	95	35	45	80	40	55	5	0	50	20
Mean depth (cm)	25	25	40	35	60	25	25	20	60	50
Max depth (cm)	35	50	80	60	120	55	50	35	150	100
Boulder (%)	5	2	0	0	0	0	0	0	5	10
Cobble (%)	5	3	0	5	0	0	10	0	10	55
Gravel (%)	10	15	15	10	20	50	45	0	20	20
Sand (%)	30	5	5	5	5	15	10	25	10	5
Mud/silt (%)	50	75	70	80	75	35	35	75	55	10
Shade (%)	0	10	50	5	5	10	100	100	0	0
Buffer strip	No	No	No	No	No	No	Yes	No	No	No
Bank erosion	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No

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

Site No.	1	2	3	4	5	6	7	9	10	12
Siltation (Clean/Slight/Moderate /Heavy/Not Visible)	H	H	H	H	H	H	M	H	H	H
Plume (Heavy/Moderate/ Slight/None)	H	H	H	H	H	H	H	H	H	H
Notes		Very unstab le bed				Highly mobile bed		Highly mobile bed	Highly mobile bed	

**No surface water at Site 8 and Site 11*

The stream substrates comprise mainly of loose fine sediments with significant silt deposits. The subject watercourses are characterised primarily by glide-pool sequences. Significant substrate siltation was observed at all locations at the northern extent of the proposed development at Site 1 – Site 6 on drainage ditches. The bed of the drainage ditch at Site 3 comprised almost entirely of peat silt. Finely deposited silt had accumulated at Site 2 – Site 5, owing to low gradient and luxuriant instream vegetation, which attenuates flow. The bed of the channel at Site 6 was extremely unstable and considered affected by collapsing banks. Substrate siltation in the Leitrim River at Site 7 was moderate, but heavy further downstream at Site 10 and Site 12, attributable mostly to peat.

The northern extent of the study area lies in lands primarily used for production of milk and beef, and observations of riparian and instream impacts from cattle access and runoff from denuded riparian areas were common during the surveys undertaken. The excessive siltation recorded across the study area was considered to reduce the habitat availability and quality to benthic macroinvertebrates and fish alike. Evidence of enrichment in the form of luxuriant macrophytes and/or filamentous algae was also recorded at these locations, the occurrence of these flora dependent on light. Primary instream production in these watercourses is considered strongly influenced by emergent vegetation, which dominated some reaches of the drainage channels. Along with stressors like siltation and eutrophication, this likely limits the biodiversity of these aquatic ecosystems. Overshading and substrate siltation in areas further south (downstream), as observed in the Lumville and Esker Streams also likely reduce ecological value.

No surface water was found at Site 8 on the Lumville Stream or at Site 11 on the Rathmoyle Stream during June 2023. The small size of the channels at these locations coupled with their propensity to drying out are factors that severely limit their aquatic value.

3.2.1 Macroinvertebrate habitats

The physical habitat suitability assessment of the survey sites for macroinvertebrate production is provided in Table 5. Based on the physical attributes of the surveyed sites and assessment criteria, the sites were rated poor with the exception of Site 7 on the Leitrim River and Site 12 on the Esker Stream. The 'poor' rating was applied, due to the domination of substrates by one size class (silt), poor habitat complexity (homogenous physical character), coupled with marginal pool quality (<1m deep), bank stability (eroding in some instances) and canopy conditions (little/no shade). The drainage ditches such as those exemplified at Site 1 - Site 4) were rated least suitable for aquatic macroinvertebrates. Habitats of this classification can limit taxa richness as there are fewer ecological niches available, noting that mixed gradient streams are generally suitable for macroinvertebrates with morphologies evolved for fast flows (such as Heptagenid mayflies) as well as those with other life strategies (e.g. burrowing larvae of Ephemeridae mayflies). With increasing size and depth, corresponding to distance downstream from the proposed development site, the stream macroinvertebrate suitability generally increases. The best habitat score was at Site 7, where the Leitrim River appeared to be in a semi-natural condition, this reach featuring some riffle-glide-pool sequences and the channel size appropriate to the base flow. Similarly, the Esker Stream at Site 12 was comparably heterogenous and scored relatively high (marginal).

Table 5: Physical habitat assessment of the survey sites regards suitability for macroinvertebrate production (adapted from Barbour and Stribling, 1991)

Tributary - Sub-tributary	Site	Bottom substrate	Habitat complexity	Pool quality	Bank stability	Bank protection	Canopy	Score	Average score	Overall Assessment[1]
Not registered	1	5	5	5	10	10	5	40	7	Poor
Not registered	2	5	10	5	10	5	5	40	7	Poor
Not registered	3	5	5	5	5	5	5	30	5	Poor
Not registered	4	5	5	5	10	5	5	35	6	Poor
Leitrim	5	5	5	5	10	10	5	40	7	Poor
Leitrim	6	5	5	5	5	5	5	30	5	Poor
Leitrim	7	10	10	5	15	15	15	70	12	Marginal
Lumville	8	n/a	n/a	n/a	n/a	n/a	n/a	0	0	n/a
Lumville	9	5	5	5	5	5	5	30	5	Poor
Leitrim	10	10	10	5	5	5	5	40	7	Poor
Rathmoyle	11	n/a	n/a	n/a	n/a	n/a	n/a	0	0	n/a
Esker (Stream) [Offaly]	12	10	15	10	10	15	5	65	11	Marginal

[1] *scale: poor (5) - marginal (10) – suboptimal (15) – optimal (20)*

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 macroinvertebrate assemblage results at the study sites (See Section 2.3.1).

3.2.2 Fish habitats

It is considered that the drainage ditches at the northern end of the proposed development site are unsuitable for fish with the exception of three-spined stickleback (*Gasterosteus aculeatus*). Flows in watercourses were of low velocity. As mentioned above, riffles were an irregular feature of the surveyed channels. The predominant flow type across the study area is pool, where this was taken to mean little/no observable flow. This flow type was dominant in drainage ditches (no flow) and in the Leitrim River at Site 10 (no perceptible flow/laminar flow). In EA (2003), pool is a feature characterised by distinctly deeper parts of the channel that are usually no longer than one to three times the channel's bankfull width, and where the hollowed river bed profiles are sustained by scouring. It is important to note that the 'pool' habitat associated with the physical habitat descriptions do not conform to that in EA (2003), rather just water that was not moving due to low gradient. Riffle is described in EA (2003) as shallow, fast-flowing, water with a distinctly disturbed surface over unconsolidated gravel-pebble, or cobble, substrate and the riffles described in the habitat descriptions coincide with this habitat feature characterisation. The only location with any significantly riffled habitat was at Site 7 on the Leitrim River and at Site 12 on the Esker Stream. Glide in the habitat descriptions pertains to laminar flow where water movement did not produce a disturbed surface. Bank profiles of all watercourses in the study area were indicative of past modification, being re-sectioned steep (>45^{o}). Table 6 gives the habitat rating of the watercourses examined with reference to salmonid habitats.

Table 6: Salmonid habitat rating at the aquatic survey sites.

Site	Watercourse	Spawning		Nursery		Holding		Overall evaluation
		Habitat grade[1]	fluvial cover[2] (≈%)	Habitat grade[1]	fluvial cover[2] (≈%)	Habitat grade[1]	fluvial cover[2] (≈%)	
1-4	Not registered	unsuitable	n/a	unsuitable	n/a	unsuitable	n/a	unsuitable
5	Leitrim	unsuitable	n/a	unsuitable	n/a	unsuitable	n/a	unsuitable
6	Leitrim	4	5	4	25	4	5	unsuitable
7	Leitrim	4	10	3-4	35	4	10	marginal
8	Lumville	unsuitable	n/a	unsuitable	n/a	unsuitable	n/a	unsuitable
9	Lumville	unsuitable	n/a	unsuitable	n/a	unsuitable	n/a	unsuitable
10	Leitrim	unsuitable	n/a	4	5	3	35	marginal
11	Rathmoyle	unsuitable	n/a	unsuitable	n/a	unsuitable	n/a	unsuitable
12	Esker (Stream) [Offaly]	3-4	10	3	50	3	10	suboptimal

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*

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 only watercourses draining the site deemed suitable for salmonids were the Leitrim River (at Site 7 and environs) and the Esker Stream at Site 12. Riffle (broken water), instream rocks, irregularities in the stream bed and dappled shade, or combinations thereof, generally provide some salmonid nursery habitat in these areas. Overall, however, the Leitrim River and the Esker Stream are considered suboptimal and marginal respectively for the early life stages of salmonids and for spawning adult salmonids. It is noted by Crisp (2000) that small trout may spawn in quite small gravel patches between large stones. Such features are likely of importance to spawning trout in the Esker Stream. Water features at other aquatic watercourses are deemed too small and lack the physical features required for salmonid reproduction i.e. well aerated clean gravels, gravel substrates at the end of pools can provide spawning areas.

There are some water quality problems associated with siltation and enrichment which reduce the quality of salmonid spawning and nursery habitat. Salmonids, especially at early life stage require good water quality. Generally, unsatisfactory water quality conditions (See Section 3.4.2) 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.

Lampreys have similar habitat requirements for spawning to small trout. There are adequate silt deposits in the watercourses draining the proposed development, a requirement for juvenile lamprey larvae but as for salmonids, there is poor lamprey spawning habitat. This is considered the limiting factor for lampreys in the study area. Lamprey may occur in the subject watercourses in very low densities and any present are considered brook lamprey *Lampetra planeri*. This assertion takes account of the poor swimming ability of lampreys, as per Reinhardt *et al.* (2009) and the presence of multiple weirs on the lower reaches of the River Barrow, and distance from the sea.

3.3 Macroinvertebrate diversity and abundance

3.3.1 Existing information

Existing NBDC records indicate that the surface waterbodies in the hectads N52 and N53 support an array of macroinvertebrate life, including larvae of mayfly (*Ephemera danica, Baetis rhodani, Seratella ignita, Caenis* sp.), caddisfly (*Limnephilus* sp,, Glossosomatidae, Phyrganeidae, Polycentropodidae, Hydropsychidae), molluscs (*Ancylus fluviatilis, Theodoxus fluviatilis, Potamopyrgus antipodarium, Radix balthica*), the dragonfly *Agrion* sp. and the crustacean *Gammarus* sp. There is a 2017 record of the 'vulnerable' moss bladder snail (*Aplexa hypnorum*) from N52. There is an old (1947) record of the 'near threatened' mayfly *Kageronia fuscogrisea* from N53. The macroinvertebrate assemblages in the Esker Stream, from which many of the above species have likely been recorded, a watercourse that drains agricultural and peatland, can be expected to coincide with those that generally occur in the Leitrim River catchment, i.e. pollution tolerant taxa.

The most notable record is white-clawed crayfish (*Austopotamobius pallipes*), for which there are EPA records from the national macroinvertebrate dataset collected for the biomonitoring of Ireland's river network at Esker Bridge (EPA station 14E010200, corresponding to Site 12). This species is evaluated as being 'Vulnerable' according to the IUCN 'Red List' (Byrne et al., 2009).

Jenkins' spire snail (*Potamopyrgus antipodarum*) is a medium impact invasive species that occurs in watercourses in N52 and N53.

3.3.2 Survey results

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 discussed below.

The greatest diversity of macroinvertebrates was recorded at Site 10 on the Leitrim River where 19 taxa were recorded. The reason for good diversity at Site 10 could be attributed to habitat quality, as described in Section 3.2. Eighteen families were found at Site 7 on the Leitrim River and Site 12 on the Esker Stream. Family diversity is shown in Table 7.

Table 7: Family diversity at the aquatic survey sites

Site	1	2	3	4	5	6	7	8	9	10	11	12
Family richness	5	14	6	9	10	16	18	1	7	19	0	18

Larvae of *Baetis rhodani, Alainites muticus, Seratella* sp. and *Ecdyonurus* sp. were the only Ephemeropterans (mayflies) recorded. This group were recorded only at locations where habitat was of suboptimal quality or better. Order Plecoptera (stoneflies) were only recorded at Site 7 (*Protonemura* sp.) and Site 12 (*Nemoura* sp.).

Three cased (Group B) and three caseless (Group C) families were recorded. Cased caddisfly larvae in families Limnephilidae, Sericostomatidae and Goeridae occurred. Caseless caddisfly larvae of *Hydropsyche* sp., *Polycentropus* sp. and *Rhyacophila* sp. had patchy distribution within the study area and generally 'few'.

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. Other true fly larvae recorded were *Dicranota sp*. and *Tipula sp.* Beetles in five different families were recorded: Elmidae, Dytiscidae, Helophoridae and Gyrinidae. Mollusc species recorded were the snails *Potamopyrgus antipodarum, Physa fontinalis*, *Radix balthica* and *Planorbis carinatus*. The crustacean *Gammarus deubeni* and hog louse *Asellus aquaticus* were the only members of Order Crustacea recorded during the current study, the former accounting for a significant proportion of the macroinvertebrate biomass at most locations.

Plate 12: Larvae of cased caddisfly at Site 7 (left). Molluscs from Site 2 (right).

3.4 Water quality

3.4.1 Existing information

3.4.1.1 Biological water quality

The EPA carries out biological monitoring at stations at various locations along the Esker Stream which drains the proposed development site. The Esker Stream flows into the Figile River. The following is the most recent EPA biological assessments[10] for the watercourses draining the proposed development, based on surveys in 2020 and 2022:

- Esker Stream: Moderate ecological conditions returned at Esker Bridge (0200) in June 2020. Filamentous algae is still prominent.
- Figile River: In 2022, Station 0400 has maintained the Poor ecological condition which was first assigned in 2020.

3.4.1.2 Physico-chemical water quality

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.

[10] http://www.epa.ie/QValue/webusers/PDFS/HA24.pdf?Submit=Get+Results

Nutrient concentrations were available for the Esker Stream at the Newtown Bridge (monitoring station code 14E010100) as part of WFD surface water monitoring. This station is located ca. 3.5 km upstream of the Leitrim River confluence. The results of the key parameters are presented in Appendix 4 and summarised below in Table 8. The results are discussed by parameter below and based on three samples, taken on 09/02, 12/04 and 04/07 in 2023. The results at these locations are deemed representative of conditions in streams draining the proposed development site, taking account of catchment characteristics and land use.

Table 8: Chemistry results for the Esker Stream (monitoring station code 14E010100) in 2023.

Parameter	Unit	Limit of Detection	N	Mean	Max
Ammonia-Total (as N)	mg/l	0.02	3	0.051	0.074
BOD - 5 days (Total)	mg/l	1	3	1	2
Dissolved Oxygen	% Saturation	1	3	79	91
Dissolved Oxygen	mg/l	0.1	3	9.1	11.4
ortho-Phosphate (as P) - unspecified	mg/l	0.01	3	0.02	0.022
Total Hardness (as CaCO3)	mg/l	10	3	309	342

3.4.1.2.1 *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).

The Total Ammonia mean concentration of 0.051mg/l was considered high. 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 samples met this objective and were well below the mandatory values of the 'Freshwater Fish Directive (78/659 EEC) of <1mg/L NH_4^+.

3.4.1.2.2 *Biochemical Oxygen Demand (BOD) and Oxygenation*

BOD serves as an indicator of the presence of organic matter in a watercourse (eutrophication) and is a useful measure of water quality. The mean BOD result was 1 mg/l, consistent with WFD good status with respect to this parameter. The mean DO result was 79% and 9.1 mg/l. The result is outside the recommended range of $\geq$ 6 and $\leq$ 9 mg/L O_2 for salmonid species (based on the Salmonid Waters Regulations [1988]).

3.4.1.2.3 *Orthophosphate*

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 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 average value for orthophosphate was 0.02 mg/l, meeting the 'high' quality status requirements for the 95%ile value.

3.4.1.2.4 ***Total Hardness***

The average water hardness was 342 mg/l. According to the EPA's classification table for water hardness (EPA, 2001), water in the study area is classified as 'Hard (251 mg/l – 350 mg/l)'. Harder water can reduce the effect of toxicity of some metals including zinc, copper and lead (EPA, 2001).

3.4.2 Survey results

3.4.2.1 Biological water quality

Q-ratings and EPT indices derived from the diversity and relative abundance of the macroinvertebrates at the study sites are given in Table 9. The biological water quality of the watercourses in the receiving environment is degraded due to excessive siltation and enrichment. Based on macroinvertebrate assemblages and the EPA scheme, unsatisfactory ecological conditions were recorded at all locations. Based on the biological water quality results and Water Framework Directive (WFD) intercalibration, Site 1, Site 7 and Site 12 were rated Q3-4, corresponding to 'Moderate status'. Site 6 was rated Q3, equivalent to WFD 'Poor' status.

The remainder of the aquatic survey locations were unsuitable for the Q-rating scheme, given that this biotic index was designed for use in fast flowing water and riffled habitat, these features absent in many of the channels in the study area.

The EPT (Ephemeroptera, Plecoptera, Trichoptera) index of water quality varied between 0 (Site 1) to 7 (Site 1, 3, 4, 8, 9, 11). Based on the EPT index, macroinvertebrate richness is highly variable and generally indicative of degraded water quality.

Another biological metric of water quality, the Salmonidae, were absent from all sites examined with the exception of Site 10 and Site 12. This is attributed mostly to habitat suitability but also in part to water quality, noting that these two parameters were inter-related in the small channels draining the site. Biological water quality is largely compromised in the study area.

Overall, the biological water quality results are suggestive of an unstable aquatic ecosystem in some of the smaller channels in the study area. The most pervasive influencer of water quality in the study area is considered loss of soils to streams, and associated enrichment. This could be attributed to a lack of buffer strips adjacent to watercourses. As noted in Kelly-Quinn & Reynolds (2020), excess fine sediment is highly damaging to both the diversity and abundances of river invertebrates through the coating and clogging of benthic substrates, loss of interstitial habitat, abrasion of delicate feeding and breathing structures, and smothering/burial of eggs, nymphs, and larvae. Loss of soil from land to watercourses can result in importation of many nutrients, especially phosphorus. This can result in excessive plant and algae growth which severely impacts the normal functioning of aquatic environments. This results in changes in the natural biological communities and an undesirable disturbance to the overall ecology (EPA, 2018).

Table 9: Biological water quality results and interpretations at study sites on watercourses potentially affected by the proposed wind farm.

Site	Watercourse	Q-rating	Quality Status	Corresponding WFD Status	EPT
1*	Not registered	n/a	n/a	n/a	0
2*	Not registered	n/a	n/a	n/a	1
3*	Not registered	n/a	n/a	n/a	0
4*	Not registered	n/a	n/a	n/a	0

Site	Watercourse	Q-rating	Quality Status	Corresponding WFD Status	EPT
5*	Leitrim	n/a	n/a	n/a	1
6	Leitrim	3	Moderately Polluted	Poor	2
7[1]	Leitrim	3-4	Slightly Polluted	Moderate	4
8	Lumville	n/a	n/a	n/a	0
9	Lumville	n/a	n/a	n/a	0
10	Leitrim	3-4	Slightly Polluted	Moderate	3
11[1]	Rathmoyle	n/a	n/a	n/a	0
12	Esker (Stream) [Offaly]	3-4	Slightly Polluted	Moderate	7

**unsuitable for Q-rating scheme due to small size/poor habitat*

[1] *little/no surface water*

During a site visit in February 2024, the upper reach of the Lumville Stream was polluted as evidenced by submerged sewage fungus and scum on the surface. The source of this organic pollution indeterminable at the time but most likely of agricultural origin.

3.5 Fish

3.5.1 Existing information

The proposed development is located in the 10km grid squares N52 and N53. The distribution and range of protected fish in the 10km grid squares containing the proposed development are illustrated in Table 11. The only NBDC record of fish from these hectads is stone loach (*Barbatula barbatula*), which has been recorded in N52.

In McGinnity *et al.* (2003), which classifies Irish rivers in terms of salmonid habitats, the 2nd order reaches of the Leitrim River and the Esker Stream are indicated as 'Producers of salmon/seatrout'. The salmon *Salmo salar* faces many obstacles and problems both at sea and in freshwater. Arterial drainage has interfered with the fishery value of the watercourses in the study area. Salmon are protected under both European (Habitats Directive, 92/43/EEC) and Irish legislation (Fisheries consolidation Act, 1959). The River Barrow and its tributaries are currently 'closed' for salmon, as per the Salmon Angling Regulations for 2023.

Sea trout are the migratory form of brown trout. Sea trout > 40cm 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. The 1st order streams draining the proposed development are deemed too small to be of importance to trout, and such watercourses are not shown in McGinnity *et al.* (2003).

During the most recent Inland Fisheries Ireland fish sampling of the River Barrow for Water Framework Directive purposes (2020), electrical fishing was carried out at three sites in the Philipstown River[11], with similar catchment characteristics to the Esker Stream and the lower reaches of the Leitrim River. The only fish captured during these surveys were pike (*Esox lucius*), stone loach and three-spined stickleback.

[11] http://wfdfish.ie/index.php/river-barrow-catchment-2020/

The distribution and range of protected fish in the 10km grid squares containing the proposed development are illustrated in Table 10. This is based on Article 17 (2013 - 2018) Assessments in NPWS (2019).

Brook lamprey are listed in Appendix II of the Habitats Directive (92:43:EEC) and Appendix III[12] of the Bern Convention. The brook lamprey is the smallest of the three lamprey species native to Ireland and it is the only one of the three species that is non-parasitic and spends all its life in freshwater (Maitland & Campbell 1992). The river lamprey is larger in size than the brook lamprey while the sea lamprey is the largest of the Irish lampreys; both of these species exhibit an anadromous[13] life cycle. The distribution of anadromous lampreys i.e. river and sea lampreys in the Barrow catchment is likely to be influenced by the presence of weirs at on the lower reaches of the River Barrow. According to Reinhardt *et al*. (2009), lampreys are poor swimmers and cannot jump or climb. Lamprey do not have the same swimming strength as salmonids and salmonid fish pass designs and weir structures frequently do not allow for the passage of these migratory species. Brook lamprey occur within the study area of the proposed development, but only in low densities, being encountered during the current 2023 survey.

Table 10: Distribution and range of aquatic Annex II listed habitats and species in the 10km grid squares R24 and R34 containing the proposed development

	Code	N52		N53		Likely reason for distribution in the 10km grid squares
		CD*	CR*	CD¹	CR¹	
Floating river vegetation	3260	Yes	Yes	Yes	Yes	The extent of this habitat has not been mapped and the area is based on the distribution of rivers. There are no particularly important watercourses draining the PDS with respect to 3260.
Sea lamprey	1095	No	No	No	No	n/a
River lamprey	1099	No	No	No	No	n/a
Brook lamprey	1096	Yes	Yes	Yes	Yes	Common species likely to occur in most fluvial habitats with suitable spawning and nursery habitats. CD and CR within N53 owing to presence in the Boyne catchment, beyond the zone of influence, to the north of proposed development site.
Atlantic salmon	1106	Yes	Yes	Yes	Yes	CD and CR within N53 owing to presence in the Boyne catchment, beyond the zone of influence, to the north of proposed development site.
White-clawed crayfish	1092	Yes	Yes	Yes	Yes	Not recorded during EPA biological sampling in 2022.

**CD = Current distribution, ¹CR = Current range*

3.5.2 Survey results

Brown trout, pike, dace (*Leuciscus leuciscus*), minnow (*Phoxinus phoxinus*), perch (*Perca fluviatilis*), stone loach, brook lamprey (*Lampetra planeri*) and three-spined stickleback were recorded during the electrical fishing investigations of watercourses draining the proposed development site. Some notes on the ecology of these species can be found below. A total of 125 fish were recorded during electrical fishing: minnow (41); three spined stickleback (N=36); stone loach (N=25); brown trout (N=15), dace (4), pike (2), perch (1), brook lamprey (N=1).

The Salmonidae were restricted to brown trout, which were found only at Site 10 and Site 12 in the Leitrim River and Esker Stream respectively. This was related to habitat suitability, which was poor in terms of providing cover for fish. No fish were recorded at Site 8 or Site 11 as these sites had no surface water.

[12] Annex III Berne Convention: Protected fauna species.
[13] Anadromous fish spend most of their adult lives in salt water and migrate to freshwater rivers and lakes to reproduce.

Table 11 gives length descriptive statistics for all fish species captured. Table 12 gives Catch Per Unit Effort (CPUE) indices for trout captured. All electrical fishing data is presented in Appendix 5. It is noted that European eel (*Anguilla anguilla*) was not recorded. The classification of the European eel as 'Critically Endangered', is a reflection of its significant decline in Ireland and the Europe-wide decline in eel populations.

Table 11: Length descriptive statistics for fish species captured during the 2022 electrofishing survey of watercourses draining the proposed development.

Site	Species	N	Mean	Min	Max	St. dev.
1	Three-spined stickleback	3	5.3	4.6	5.7	0.58
2	Three-spined stickleback	9	3.5	2.4	5.5	1.03
3	Three-spined stickleback	5	2.86	2.6	3.2	0.24
4	Three-spined stickleback	3	3.1	2.8	3.7	0.52
5	Three-spined stickleback	5	3.86	2.6	5.7	1.26
6	Minnow	14	5.7	4.8	6.8	0.58
	Three-spined stickleback	8	3.85	2.6	5.5	1.22
	Dace	1	17.5	17.5	17.5	N/A
	Pike	1	13.3	13.3	13.3	N/A
	Perch	1	10.7	10.7	10.7	N/A
7	Minnow	15	5.47	4.6	6.5	0.53
	Stone loach	4	8.17	7.6	8.8	0.5
	Brook lamprey	1	6.9	6.9	6.9	N/A
	Pike	1	13.4	13.4	13.4	N/A
8	No fish					
9	Minnow	3	6.03	5.9	6.2	0.15
10	Brown trout	5	13.98	9.2	18.6	4.3
	Minnow	4	5.42	5.2	5.6	0.17
	Three Spined Stickleback	3	4.7	4.4	5.3	0.49
11	No fish					
12	Brown trout	10	13.17	7.4	18.3	5.02
	Dace	3	16.53	8.7	22.9	16.53
	Minnow	5	5.32	4.9	5.9	0.36
	Stone loach	21	6.85	3.9	8.8	1.52

Table 12: Catch Per Unit Effort (CPUE) indices for salmonids captured during the 2022 electrofishing surveys of watercourses draining the proposed development.

Site	N	Area	Time	CPUE (Brown Trout)	
				Fish/m2	Fish/m
1	0	36	10	0	0
2	0	60	10	0	0
3	0	42	10	0	0
4	0	40	10	0	0
5	0	32.4	10	0	0
6	0	56	10	0	0
7	0	35.2	10	0	0
9	0	56	10	0	0
10	5	117.5	10	0.04	0.5
12	10	109.2	10	0.09	1

3.5.2.1 Minnow

Minnow is a non-native species of erratic distribution in Ireland, occupying lakes and rivers. The minnow lives in shoals and feeds on plant debris, algae, molluscs, insects and crustaceans. It inhabits clean streams and rivers that have either a sandy or stony bed; it also occurs in well oxygenated cold, running or still water.

3.5.2.2 Three spined stickleback

Three spined stickleback were the most widespread species, occurring within drainage ditches at the northern extent of the proposed development site. Three-spined stickleback is one of the most widely distributed fish in the British Isles (Maitland and Campbell, 1992). According to Byrne *et al.* (2011), it is commonly recorded in fish surveys in rivers, lakes and transitional waters in all parts of the country. The stickleback appears to be a relatively pollution tolerant species and a good coloniser of rivers recovering from chronic historical pollution (Pottinger *et al.* 2002). Stickleback likely occurs at all survey locations.

Plate 13: Three spine stickleback (left) and pike captured at Site 2 (right).

3.5.2.3 Stone loach

The stone loach is native throughout most of Europe and Asia, but it is not native to Ireland. Although it is an introduced species, stone loach are considered benign as they have no significant impact on native species or ecosystems. Although they prefer clean water, stone loach are hardy fish and can tolerate moderate levels of pollution and nutrient enrichment in rivers. Uniquely amongst Irish fish, they are able to gulp air and absorb oxygen in their hindgut, which helps them to survive droughts and low oxygen conditions in shallow waters that other fish species could not survive.

3.5.2.4 Brown trout

Brown trout were recorded only at Site 10 adjacent to the proposed development site and Site 12 downstream. The larger size of the trout recorded indicates that spawning probably occurs in the Esker Stream and less likely in the Leitrim River, corresponding with habitat characteristics.

Brown trout occur in almost every rivulet, brook, stream, river and lake in Ireland (Kennedy & Fitzmaurice, 1971). Populations occur in the upper reaches of estuaries (slob trout) and anadromous (sea trout) populations occur in many river systems all around the coast.

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.

3.5.2.5 Dace

Non-native species. The species has a high fecundity and plasticity of habits. Thus it can occupy a range of niches, generally used by other species, and has the capacity to outcompete these species for space and food. Adults can predate on juvenile cyprinids and salmonids. Management is required to control the impact of this species on native biodiversity.

3.5.2.6 Pike

Pike spawn in the spring in reeds and vegetated areas, in both rivers and lakes Younger fish, up to c. 50 cm, have a diet of invertebrates and of small fish e.g. minnow. Larger pike have an increasing tendency towards a piscivorous diet. Pike appear to occupy defined territories in rivers, where they have a similar habit to lake pike. In rivers, they are to be found primarily in relatively large, low-gradient channels where water velocity is reduced. Some Irish studies have shown a strong homing instinct in pike. Pike is a ‘top carnivore’ in the aquatic systems where it occurs. Long considered to feed preferentially on brown trout, the species can switch to any available prey species. The pike has no natural competitors or predators in aquatic ecosystems in Ireland.

Plate 14: Pike (left) and stone loach captured at Site 6 (right).

3.5.2.7 Perch

Perch is an introduced species, now widespread in lakes, canals and larger rivers in Ireland. Perch are considered non-benign as they compete with brown trout for food, at all life stages. Inhabits a wide range of habitats, found in deeper slow-flowing rivers, in lakes, ponds and canals. Feed on zooplankton, invertebrates and other fish. Larvae and small juveniles usually feed on planktonic invertebrates.

3.5.2.8 Brook lamprey

Brook lamprey is listed on Annex II EU Habitats Directive [92/43/EEC] and is widely spread throughout Ireland. This species occurs in channels ranging in size from small streams to large rivers (Maitland, 2003). Within-catchment distribution can be very patchy and is related to availability of suitable habitat i.e. fine sandy/gravelled areas for adult spawning and areas of deposition of fine sediments for the juvenile or ammocoete stage. According to King & Linnane (2004), brook lamprey are found in a range of water quality conditions, from Q 3 to Q5.

Plate 15: Sample of fish captured at Site 8

3.5.2.9 Red List Status

All fifteen native species of freshwater fish were assessed in Byrne *et al.* (2011) using the latest IUCN categories. The red list status of the fish recorded during the current assessment are provided in Table 13 below.

Table 13: Red list status of the fish recorded during the current assessment (adapted from Byrne *et al.* 2011).

Species	Irish Red List status	Legal status	Rationale for assessment
Trout	Least concern	Fisheries Acts 1959 to 2006	Previously assessed as not threatened. There are serious concerns about the declines in sea trout stocks, particularly in the mid-west. Nonetheless, trout remain widespread in all major river and lake systems on the island, at satisfactory levels in terms of population structure, for the water in question, and of stock density, justifying a conservation assessment of 'least concern'.
Three-spined stickleback	Least concern	Fisheries Acts 1959 to 2006	Previously assessed as least concern and still considered of least concern as it is widely distributed in fishery surveys in rivers of all sizes and in lakes and transitional waters around the coast.

3.6 Amphibians

3.6.1 Existing information

NBDC mapping holds records of both common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris)* in the 10km grid squares overlapping the proposed development site.

3.6.2 Survey results

The proposed development site has some suitable reproductive habitats for frog (*Rana temporaria*). The drainage ditches at the proposed development site provide spawning habitat. Tadpoles were identified at one location, in a drainage ditch (Site 2) during June 2023. When spawning, frogs seem to prefer waterbodies with some open water, probably to allow spawn to rise and fall with water levels. No evidence of spawning was recorded in the other drainage ditches examined but it is likely that frogs do spawn in other drainage ditches at the proposed development site. The Lumville Stream is likely used by spawning frogs also. There was no evidence of successful frog spawning at the site when surveyed in late January 2024. There was a failed spawning recorded in late January 2024.

Plate 16: Tadpole from Site 2 at the proposed development site in June 2023 (left). Unfertilised frog spawn recorded in late January 2024 (right).

Frog can be expected to occur in the Leitrim River, as they will sometimes use streams during summer-time when flows are low. The drainage ditches at the site as well as the Lumville Stream may be used by hibernating frogs. The wet grassland habitats are considered important for froglets and adult feeding.

4. Ecological pressures

The proposed development is located in the Figile_020 subcatchment (subcatchment ID 14_14). An assessment for this subcatchment has been produced as part of the national characterisation programme undertaken for the second cycle of WFD river basin management planning[14]. Significant pressures have been identified for waterbodies that are 'At Risk' of not meeting their water quality objectives under the Water Framework Directive. While there are a multitude of pressures in every waterbody, the significant pressures are those pressures which need to be addressed in order to improve water quality. Many of our waterbodies have multiple significant pressures. A robust scientific assessment process has been carried out to determine which pressures are the significant pressures. This has incorporated over 140 datasets, a suite of modelling tools, and local knowledge from field and enforcement staff from the Local Authorities, Inland Fisheries Ireland and EPA. Water quality issues in this subbasement were driven by sediment and ammonia issues caused by extensive peat harvesting throughout the subcatchment.

[14] https://www.catchments.ie/wp-content/files/subcatchmentassessments/14_14%20Figile_SC_020%20Subcatchment%20Assessment%20WFD%20Cycle%202.pdf

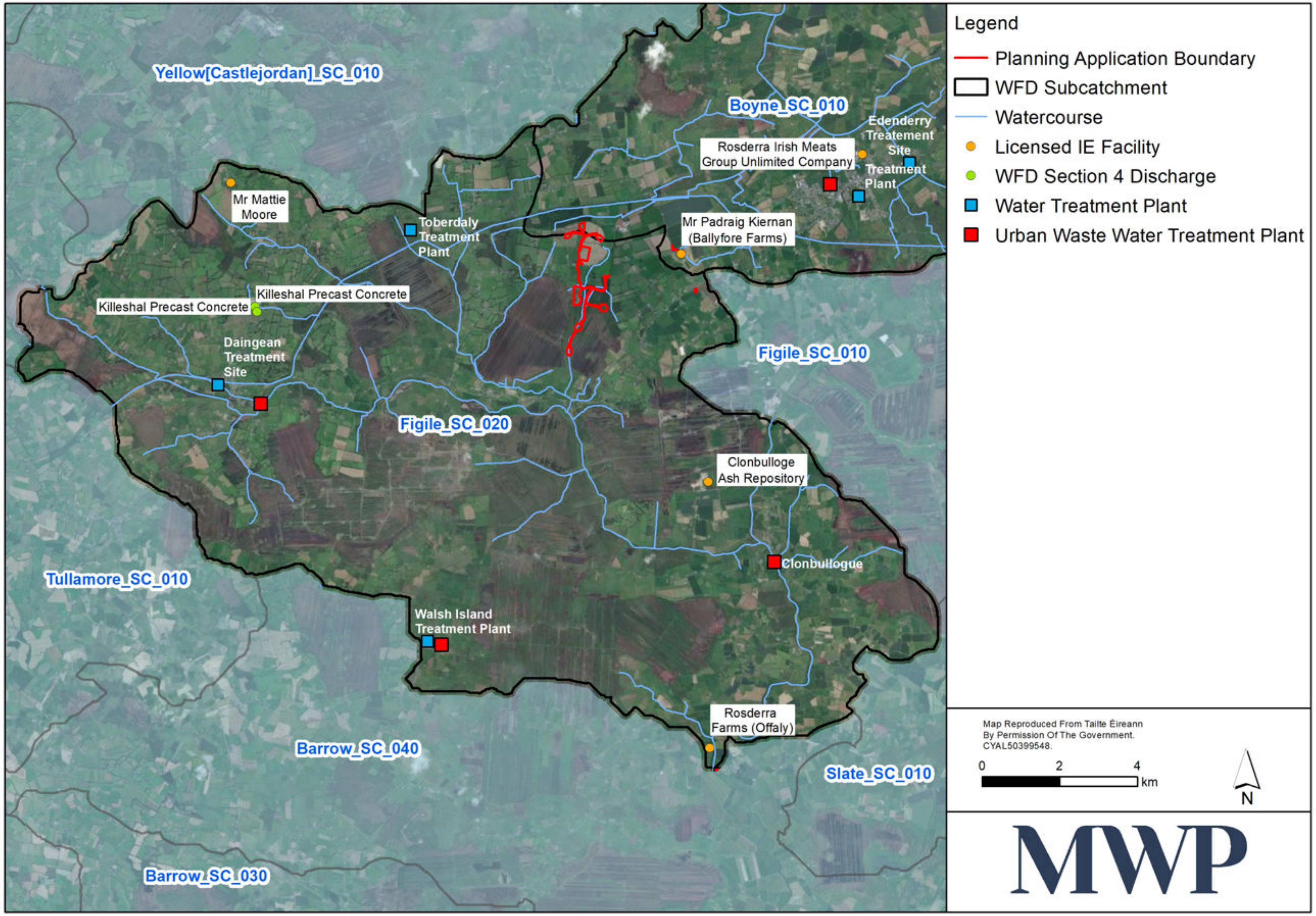

Figure 3: EPA registered activities potentially impacting water quality in the study area.

5. Conclusions

5.1 Water features

The watercourses draining the study area were highly modified, physically degraded and/or artificial. They comprise drainage ditches that have been created for land drainage purposes, small streams some of which are prone to drying out, and rivers that have been deepened. The surface water features in the vicinity of the northern extent of the proposed development site all convey water to the Esker Stream to the south, in Hydrometric Area 14, the River Barrow catchment. The Leitrim River which drains most of the proposed development features two large ponds that were presumably constructed to attenuate water and allow for the settlement of peat silt, taking account of peat harvesting activities that took place in the wider landscape in the past.

5.2 Macroinvertebrates and Water Quality

Habitat for aquatic macroinvertebrates was rated poor to marginal, regarding suitability. The macroinvertebrates recorded are widespread and common across Ireland and mostly pollution tolerant. The macroinvertebrate communities in the study area showed reduced diversity, which is considered to be related to fluvial condition/habitat suitability of the subject surface waters.

Biological water quality was unsatisfactory (Moderate or Poor status) across the study area. Water quality at EPA monitoring sites on watercourses downstream of the proposed development were also rated Moderate status in 2020, with an improvement at Clonbulloge, downstream of the River Figile confluence and more than 10 km downstream of the proposed development site. Substrate siltation could explain the reduced biological diversity and subsequent reduced biological water quality recorded in the study area. 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. 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)[15]. 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[16].

Land use in the surrounding area is having an adverse effect on water quality in the watercourses within the study area. Based on the results of the current surveys, it is concluded that the main water quality problems in the study area are related to agriculture and to a lesser degree coniferous forestry, with some albeit reducing legacy effects of peat harvesting practices in the past.

It is concluded that white-clawed crayfish or other protected aquatic macroinvertebrates are highly unlikely to occur in the ZOI of the proposed development.

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

[16] 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

5.3 Fish

Salmonid spawning and nursery areas were unsuitable at the northern extent of the study area and of poor/suboptimal quality in the Leitrim River to the south. The drainage ditches within the study area support three-spined stickleback. The Leitrim River within the study area is not utilised by salmonids due to morphological characteristics and/or water quality issues. Brown trout occur in the Leitrim River and those found during the current study are deemed to have been spawned in the Esker Stream. It is considered that the Leitrim River does not support salmon due to its small size and generally sluggish nature.

The watercourses draining the proposed development site collectively support three-spined stickleback, brown trout, minnow, pike, dace, perch and brook lamprey. It is concluded that migratory lampreys (sea and river lamprey) are highly unlikely to occur in the reaches of watercourses surrounding the proposed development. Deeper parts of the subject streams are important refugia for trout.

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 water quality problems in the study area reduces the salmonid habitat value of the watercourses and silt is identified as one of the main problems.

5.4 Amphibians

The drainage ditches at the northern extent of the proposed development site are used by breeding frogs. The southern extent of the proposed development site is likely used by foraging frogs.

6. Recommendations

It is imperative that any development in the study area does not cause further surface water quality deterioration in watercourses where water quality is already unsatisfactory. A conclusion of a Davis *et al.* (2018) study was that improving river ecological quality requires improved management of sediment inputs, so sediment control will be a key driver of mitigation to protect water quality.

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. Surface water drainage management has been incorporated designed into the drainage layout drawings for the proposed wind farm. Chapter 8 Water and Chapter 3 Engineering in the EIAR includes the monitoring, mitigation and methodologies for control of surface water management. These measures are incorporated into the CEMP. The CEMP will detail a management plan for protecting water quality in the watercourses affected. The CEMP will be distributed and discussed with all parties involved in construction (including any sub-contractors) to protect aquatic conservation interests within the study area. Silt control will be a primary concern during construction stage, as silt has been identified a sediment source for downstream areas. The CEMP will 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 during the construction phase.

It is recommended that the following measures be implemented on site during design and construction and have been incorporated into the design where appropriate:

- Any new development at watercourse crossings (upgrading/new tracks) will consider fish passage.

- Existing tracks will be used insofar as possible.
- Infrastructure will be placed on areas away from watercourses insofar as possible.
- Any works involving stream crossings will maintain or improve faunal connectivity upstream and downstream of works.
- Ponds will be constructed as part of the surface water drainage design to attenuate water draining denuded areas during construction.

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); and
- '*Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters'* (IFI, 2016).

The following preliminary measures are advised to mitigate habitat loss and promote aquatic biodiversity at the proposed Ballinla Wind Farm site. These will be refined, with further measures outlined in the biodiversity chapter of the EIAR.

Where conditions allow, silt ponds constructed for water quality protection associated with proposed development infrastructure will be retained post construction to allow colonisation by local aquatic flora and fauna. The decision to retain ponds would be dependent on factors including location, stability and whether they retain water or not. The ECoW and site engineer would decide which ponds to retain. These ponds would act as wetland niches during the operation stage and beyond. Silt ponds retained post construction can be expected to act as wetland areas for aquatic and terrestrial macroinvertebrates, amphibians and birds, and a drinking water source for fauna. Physical variation/heterogeneity is a key influence in biodiversity richness. Therefore, sinuosity in pond outline/plan is preferable to linearity, so pond borders/banks and stone filter beds should be of varied shape/angle according to each specific silt pond location, where local topography would dictate design. Wetland habitat creation guidance in Gilbert and Anderson (1998) would be followed.

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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[17]	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.*

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

Table A2.2: Q-value for use in eroding (i.e. riffle-glide) river stretches

EPA Biological Assessment of Water Quality in Rivers and Streams*

Biotic Indices (Q Values) and typical associated macroinvertebrate community structure

WFD Status Groups	Families	High Q5	High Q4-5	Good Q4	Moderate Q3-4	Poor Q3	Poor Q2-3	Bad Q2	Bad Q1-2	Bad Q1
Group A Plecoptera Ephemeroptera Lamellibranchiata	All except Leuctridae Heptageniidae Siphlonuridae *Ephemera danica* *Ameletus inopinatus* *Margaritifera margaritifera*	**At least 3 taxa well represented i.e., common to dominant.** Expect 5 or more Group A taxa outside of June – Sept period	**At least 2 taxa well represented i.e., common to dominant.** Expect >2 Group A taxa outside of June-Sept period	**At least 1 taxon in reasonable numbers**	**At least 1 taxon Few - Common**	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**
Group B Plecoptera Ephemeroptera Trichoptera Odonata Hemiptera	Leuctridae Baetidae (excl *B. rhodani* agg.) Leptophlebidae All Cased Trichoptera Odonata Aphelocheiridae	**Few to Numerous**	**Few to Numerous**	**Few to Numerous**	**Few/Absent to Numerous**	**Few/Absent**	**Absent**	**Absent**	**Absent**	**Absent**
Group C Ephemeroptera	*Baetis rhodani/Baetis atlanticus*	Few to Dominant	Few to Dominant	Numerous to Dominant	Numerous to Excessive	Numerous to Excessive	Few to Common	Absent	Absent	Absent
Trichoptera Hemiptera Coleoptera Hydracarina Diptera	Ephemerellidae Caenidae All Uncased Trichoptera All excl Aphelocheridae All All All (excl. *Chironomus* & *Eristalis*)	**Few to Numerous** Group C taxa can represent over 70% of total abundance with good diversity and no single taxa dominant	**Few to Numerous** Group C taxa can represent over 70% of total abundance with good diversity and no single taxa dominant	**Common to Numerous (Never Excessive)**	**Common to Excessive (usually Dominant or Excessive as a group)** Diversity can be reduced with a few taxa dominant	**Dominant to Excessive** Diversity reduced with a few taxa dominant	**Few to Common** Diversity reduced with a few taxa	**Absent**	**Absent**	**Absent**
	Simuliidae	Few	Few to common	Few to Numerous	Common to Dominant/Excessive	Common to Excessive	Few to Common	Absent	Absent	Absent
Crustacea	All (excl. Asellidae & *Crangonyx* spp.)									
	Gammarus c.f. duebeni	Few to common	Few to common	Common to Dominant	Common to Excessive	Common to Excessive	Few to Common	Absent	Absent	Absent
Gastropoda Lamellibranchiata Hirudinea Platyhelminthes Oligochaeta	All (excl. *Radix peregra, Physella*) *Anodonta* sp. *Piscicola* sp. All Lumbriculidae, Lumbricidae	**Ephemeroptera, Trichoptera may be well represented Others few or absent.**	**Ephemeroptera, Trichoptera may be well represented Others few or absent.**							
Group D Crustacea Megaloptera Gastropoda Lamellibranchiata Hirudinea Oligochaeta	Asellidae, *Crangonyx* Sialidae *Radix peregra, Physella* *Sphaeriidae,* All excl. *Piscicola* Naididae, Enchytraeidae	**Few or Absent**	**Few or Absent**	**Few or Absent**	**Few/Absent to Common**	**Few/Absent to Common**	**Dominant to Excessive**	**Dominant to Excessive**	**Few to common**	**Few or Absent**
Group E Oligochaeta Diptera	Tubificidae, Chironomus, Eristalis spp.	**Few or Absent**	**Few or Absent**	**Few or Absent**	**Few or Absent**	**Few or Absent**	**Few to Common**	**Few/Absent to Common**	**Common to Numerous**	**Dominant**

* This scheme is not intended for assessment of conditions in stagnant waters or where substratum is mud, bedrock or sand. It should be borne in mind that faunal composition is affected by such factors as ground water input, calcification, drainage, canalisation, culverting, marked shading and seasonal factors. Note: **The occurrence/abundance of groups in above table refers to some but not necessarily all the constituents of the group. Single specimens may be ignored.**

Few (<5%), Common (6-20%), Numerous (21-50%), Dominant (51-74%), Excessive (>75%)

Appendix 3

Macroinvertebrate species lists

Table A3.1: Macroinvertebrates recorded during biological sampling on watercourses draining the proposed development during summer 2023.

	Pollution sensitivity group	Functional group	1	2	3	4	5	6	7	8	9	10	11	12
MAYFLIES (Uniramia, Ephemeroptera)														
Autumn dun *Ecdyonurus sp*	A	Scraper & gathering collector												F
Spiny crawler mayflies (Seratellidae)														
Yellow evening dun *Seratella sp*	C	Gathering collector												C
Baetidae														
Large dark olive *Baetis rhodani*	C	Scraper & gathering collector							F					N
Iron blue dun *Alainites muticus*	B	Scraper & gathering collector												
STONEFLIES (Order Plecoptera)														
Brown stoneflies (Nemouridae)														
Protonemura sp.	A	Shredder							F					
Nemoura sp.	A	Shredder										F		
CASED CADDIS FLIES (Tricoptera)														
Northern caddisflies (Limnephilidae)	B	Shredder		F			F	F	F			F		F
Primitive caddisflies (Sericostomatidae)														
Black caperer *Sericostoma personatum*	B	Shredder							C					
Family Goeridae														
Silo pallipes	B	Scraper										F		
CASELESS CADDIS FLIES (Trichoptera)														
Grey flags (Hydropsychidae)														
Hydropsyche sp.	C	Filtering collector												F

	Pollution sensitivity group	Functional group	1	2	3	4	5	6	7	8	9	10	11	12
Green sedges (Rhyacophilidae)														
The sandfly *Rhyacophila dorsalis*	C	Predator												F
Trumpet-net caddisflies (Polycentropodidae)								F						F
DAMSELFLIES (Odonata, Zygoptera)														
Jewelwings/Demoiselles (Calopterygidae)														
Beautiful jewelwing *Calyopterx virgo*	B	Predator						C	C			F		F
TRUE FLIES (Diptera)														
Blackfly (Simulidae)								C	F					
Simulium sp.	C	Filtering collector												C
Craneflies (Tipulidae)	C	Shredder							F					
Tipula sp.														
Pediciidae				C										
Dicranota sp.	C	Shredder					F	F	P					
Family Chironomidae														
Bloodworm *Chironomous sp.*	E	Filtering collector			C							F		
Rheotanytarsus sp.	C	Filtering collector			C									
Green chironomid	C	Filtering collector		F	C	F	C	F	F		F	F		F
BEETLES (Coleoptera)				F										
Whirligig beetle (Gyrinidae)	C	Predator			C	F	F	F	F					
Common whirligig beetle *Gyrinus substriatus*	C	Predator										C		F
Diving beetles (Dytiscidae)														
Sub family Colymbetinae														
Ilybius quadriguttatus	C	Predator/scraper			F							F		
Sub family Hydroporinae														

	Pollution sensitivity group	Functional group	1	2	3	4	5	6	7	8	9	10	11	12
Stictotarsus duodecimpustulatus	C	Predator	F	F				F			F	F		
Crawling water beetles (Haliplidae)									C					
Haliplus confinis	C	Predator										F		
Riffle Beetle (Elmidae)														
Elmis aenea	C	Predator						F				F		F
Limnius sp.	C	Scraper												
Water scavenger beetles (Helophoridae)														
Hydroporous sp.	C	Predator		N	N	C	N	C			F			
SNAILS (Mollusca, Gastropoda)														
Family Lymnaeidae														
Wandering snail *Radix balthica*	D	Shredder	F	F		C	C	F				F		F
Family Planorbiidae									C					
Keeled Ramshorn Snail *Planorbis carinatus*	C	Scraper		F		F								
Family Hydrobiidae														
Jenkin's spire shell *Potamopyrgus antipodarium*	C	Scraper							F					
Orb/Pea Mussels (Sphaeridae)	D	Filtering collector												
Sphaerium sp.	D	Filtering collector												F
Family Physidae														
Bladder Snail *Physa fontinalis*	D	Shredder								E			C	
AQUATIC MILLIPEDES (Diplopoda)	C	Shredder	F	F			F							
CRUSTACEANS (Crustacea)														
Amphipods (Amphipoda, Gammaridae)														
Freshwater shrimp *Gammarus sp.*	C	Shredder	D	E	F	E	C	C	C		C	C		N
Isopods, Asellidae														

	Pollution sensitivity group	Functional group	1	2	3	4	5	6	7	8	9	10	11	12
Asellus aquaticus	D	Shredder										C		F
LEECHES (Hirudinae)														
Erpobdellidae														
Erpobdella testacea	D	Predator						F			F			
Piscicolidae														
Piscicola geometra	C	Predator						F	F			F		
Glossiphonidae														
Glossiphonia complanata	D	Predator										F		
BUGS (Hemiptera)														
Broad shouldered water striders (Veliidae)								F	F		F			
Velia sp.	C	Predator												
Broad shouldered water skaters (Gerridae)														
Gerris sp.	C	Predator		F	F	F	F	F						F
Water scorpion (Nepidae)	C	Predator												
Nepa cinerea	C	Predator		F			C					F		
Greater water boatman (Notonectidae)	C	Predator												F
Pygmy backswimmers (Pleidae)	C	Predator		F		F			C					
Water Measurer (Hydrometridae)	C	Predator										F		
SPIDERS (Crustacea, Arachnida)														
Water mite (Hydrachnidae)	C	Predator							P					
SEGMENTED WORMS (Annelida, Clitellata)														
Aquatic earthworm (Lumbricidae)	D	Gathering collector	F	F		F					F	F		

Few (<5%), Common (6-20%), Numerous (21-50%), Dominant (51-74%), Excessive (>75%)

Appendix 4

Chemistry results

Table A4.1: Chemistry results for the Esker Stream (station code 14E010100) in 2023

Sample Date	Parameter	Unit	Limit of Detection	Result
04/07/2023	BOD - 5 days (Total)	mg/l	1	0.5
09/02/2023	BOD - 5 days (Total)	mg/l	1	0.5
12/04/2023	BOD - 5 days (Total)	mg/l	1	2
09/02/2023	Dissolved Oxygen	% Saturation	1	89
12/04/2023	Dissolved Oxygen	% Saturation	1	58
04/07/2023	Dissolved Oxygen	% Saturation	1	91
12/04/2023	Dissolved Oxygen	mg/l	0.1	6.8
09/02/2023	Dissolved Oxygen	mg/l	0.1	11.4
04/07/2023	Dissolved Oxygen	mg/l	0.1	8.9
09/02/2023	Ortho-Phosphate (as P) - unspecified	mg/l	0.01	0.022
12/04/2023	Ortho-Phosphate (as P) - unspecified	mg/l	0.01	0.018
04/07/2023	Ortho-Phosphate (as P) - unspecified	mg/l	0.01	0.02
09/02/2023	Total Hardness (as $CaCO_3$)	mg/l	10	294
12/04/2023	Total Hardness (as $CaCO_3$)	mg/l	10	292
04/07/2023	Total Hardness (as $CaCO_3$)	mg/l	10	342

Appendix 5

Fish survey results

Table A5.1: Fish survey results based on the 2022 surveys

Site No.	Species	Length (cm)
1	three spine stickleback	5.5
1	three spine stickleback	5.7
1	three spine stickleback	4.6
2	three spine stickleback	3.7
2	three spine stickleback	2.9
2	three spine stickleback	2.9
2	three spine stickleback	2.4
2	three spine stickleback	3.1
2	three spine stickleback	5.5
2	three spine stickleback	4.8
2	three spine stickleback	3.8
2	three spine stickleback	2.7
3	three spine stickleback	3
3	three spine stickleback	2.8
3	three spine stickleback	2.7
3	three spine stickleback	2.6
3	three spine stickleback	3.2
4	three spine stickleback	3.7
4	three spine stickleback	2.8
4	three spine stickleback	2.8
5	three spine stickleback	2.6
5	three spine stickleback	3.2
5	three spine stickleback	3.2
5	three spine stickleback	5.7
5	three spine stickleback	4.6
6	perch	10.7
6	dace	17.5
6	minnow	6.8
6	minnow	5.6
6	minnow	6.4
6	minnow	5.6
6	minnow	6.7
6	minnow	5.5
6	minnow	5.4

Site No.	Species	Length (cm)
6	minnow	5.6
6	minnow	5.7
6	minnow	4.8
6	minnow	5.7
6	minnow	5.6
6	minnow	5.8
6	minnow	4.8
6	three spine stickleback	5.4
6	three spine stickleback	5.5
6	three spine stickleback	4.8
6	three spine stickleback	3.8
6	three spine stickleback	2.8
6	three spine stickleback	2.7
6	three spine stickleback	2.6
6	three spine stickleback	3.2
6	pike	13.3
7	brook lamprey	6.9
7	minnow	5.5
7	minnow	6.2
7	minnow	4.9
7	minnow	6.5
7	minnow	5.5
7	minnow	5.4
7	minnow	5.8
7	minnow	5.3
7	minnow	4.8
7	minnow	5.4
7	minnow	5.4
7	minnow	5.2
7	minnow	5.3
7	minnow	6.2
7	minnow	4.6
7	stone loach	8.8
7	stone loach	8.3
7	stone loach	8
7	stone loach	7.6
7	pike	13.4
8	no fish	
9	minnow	6.2
9	minnow	6
9	minnow	5.9

Site No.	Species	Length (cm)
9	froglet	
10	brown trout	16.5
10	brown trout	18.6
10	brown trout	9.2
10	brown trout	16
10	brown trout	9.6
10	minnow	5.5
10	minnow	5.6
10	minnow	5.2
10	minnow	5.4
10	three spine stickleback	5.3
10	three spine stickleback	4.5
10	three spine stickleback	4.4
11	no fish	
12	brown trout	18.3
12	brown trout	18
12	brown trout	17.5
12	brown trout	17.9
12	brown trout	16.5
12	brown trout	13.2
12	brown trout	7.9
12	brown trout	7.5
12	brown trout	7.5
12	brown trout	7.4
12	dace	18
12	dace	22.9
12	dace	8.7
12	minnow	5.3
12	minnow	5.9
12	minnow	5.2
12	minnow	4.9
12	minnow	5.3
12	stone loach	8.7
12	stone loach	8.4
12	stone loach	7.9
12	stone loach	7.7
12	stone loach	8.8
12	stone loach	8.5
12	stone loach	7.9
12	stone loach	6.5
12	stone loach	5.5

Site No.	Species	Length (cm)
12	stone loach	7.4
12	stone loach	7.6
12	stone loach	7.5
12	stone loach	5.2
12	stone loach	6.3
12	stone loach	7
12	stone loach	7.5
12	stone loach	6.9
12	stone loach	6.6
12	stone loach	4
12	stone loach	4.1
12	stone loach	3.9