EDF Renewables Ireland Ltd.

Kellystown WindFarm

Aquatic Ecology Surveys Report Final

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TABLE OF CONTENTS

Document references

List of Figures

List of Tables

List of Plates

1. Introduction

1.1. Background

APEM Ireland was commissioned by EDF Renewables Ireland Ltd. to prepare an aquatic ecology baseline report in support of the planning application for a 7-turbine windfarm development north of Drogheda, Co. Louth.

1.2. Site Description

The proposed development site ("the Site") is located approximately 7.5 km north of Drogheda, Co. Louth. The Site is centred at Irish Transverse Mercator coordinates 707916 , 783645. The study area for aquatic surveys is the redline boundary as illustrated in Appendix 1, Figure 1.

1.3. Purpose of this Report

The purpose of this report is to describe the results of a series of baseline aquatic ecology surveys conducted at the proposed works sites, which will inform the planning application.

1.4. Aquatic Ecology Survey Site Selection

A desk study was conducted to inform surveys necessary and survey locations. The desk study aimed to identify designated sites of conservation interest and collate records of protected or notable habitats and species that may potentially be affected by the proposed works. Data was accessed from online resources such as National Parks and Wildlife Service, Inland Fisheries Ireland, Biodiversity Ireland, Environmental Protection Agency, and other relevant sources.

Four streams run through the Site, these are: the Hammondstown Stream, which meets the sea ca. 20 km downstream at Annagassan Port in Dundalk Bay Special Area of Conservation (SAC); the Slieveboy Stream, which goes to sea ca. 11 km downstream at Port/Lurganboy Beach; and the Piperstown Stream and Drumshallon Lough Stream, which join together as the Termonfeckin Stream and enter the sea ca. 8.5 km downstream of the Site, at Termonfeckin Beach, along the edge of the Boyne Coast and Estuary SAC.

To assess water quality under baseline conditions at the Site, five sites were selected for collection of macroinvertebrate samples and seven sites were selected for water chemical analysis following an aquatic walkover survey. Two locations were selected for fish habitat surveys to be undertaken. An aquatic walkover survey was conducted across the Site to inform if any surveys further to those planned were necessary. Figure 2 shows the locations where surveys were completed following this walkover. Incidental sightings of invasive alien species were recorded.

Sites were selected based on the location of the proposed turbines in relation to the local streams. Kick samples and water chemistry were taken on each of the nearby streams to understand the baseline aquatic ecology and baseline water quality. Where proposed turbines were within 100 m of waterway, samples were taken upstream and downstream of these locations where feasible. An additional water chemistry sample was taken at Site 8 as an additional tributary with significant flow was observed at this location, to better understand the influence of this tributary on the aquatic ecology at Site 6.

Sites 1, 2, and 4 are located on the Drumshallon Lough Stream which is part of Termonfeckin_010[2]. Site 3 is located on the Piperstown Stream which is also part of Termonfeckin_010. The Termonfeckin_010 was classified as Poor water quality status under the WFD 2016-2021 cycle. It is mapped by EPA as under pressure from agriculture.

Sites 5, 6, and 8 are located on the Hammondstown Stream which is part of the White (Louth)_010. The White(Louth)_010 was classified as Moderate water quality status under the WFD 2016-2021 cycle. It is mapped by EPA as under pressure from agriculture.

Site 7 is located on the Slieveboy_010. The Slieveboy_010 was classified as Moderate water quality status under the WFD 2016-2021 cycle.

1.5. Evidence of Technical Competence and Experience

Gráinne Keogh and Bláithín Ní Ainín prepared this report and it was technically reviewed by Michael Dobson and Fiona Bracken.

Gráinne Keogh is a Senior Ecologist at APEM Ireland and holds an MSc in Marine Biology and a BSc in Ecology and Environmental Biology. Gráinne has carried out field and lab work across marine, terrestrial, and freshwater environments; these include habitat surveys and mapping, species identification, freshwater pearl mussel surveys, electrofishing surveys and chemical and biological water quality analysis including SSRS and Q Value assessments. She has previously worked on the Climate Change Mitigation Research Project in Inland Fisheries Ireland and she has also spent time at sea on research vessels conducting fisheries surveys with the Marine Institute. Grainne has a robust understanding of the impact assessment processes, and Irish and EU wildlife legislation and has written a number of Appropriate Assessments, Natura Impact Statements and Ecological Impact Assessments to support planning applications.

Dr Bláithín Ní Ainín (Senior Ecologist) holds a BSc (Hons) in Environmental Biology from University College Dublin and MSc in Environmental Science and PhD in freshwater ecology from Trinity College Dublin. She is a freshwater biologist with 18+ years of practical experience in water and environment related projects and programmes in Ireland and Australia. She has broad ranging experience including surveying and sampling rivers and lakes across Ireland (particularly using macroinvertebrate communities to determine water quality), in conducting complex research and analysis on the effects of agricultural and industrial activities on receiving waterways, and in facilitating and managing the development of strategies for waterway restoration. Bláithín has extensive skills in the fields of: Biological monitoring (particularly for water quality) including macroinvertebrate survey (both SSRS and Q value assessment); freshwater habitat assessment; freshwater pearl mussel survey and fish habitat assessment; Freshwater ecosystem health and ecological status assessment (especially for the Habitats and Water Framework Directive), freshwater invasive species impacts, control and management and in the creation of distribution maps using GIS. She has worked for the Local Authority Waters Programme in Ireland and the East Gippsland Catchment Management Authority, in Australia as well as working as a Consultant Freshwater Ecologist.

Dr Fiona Bracken (Technical Specialist Freshwater) holds a BSc (Hons) in Zoology from University College Dublin, Ireland and a Ph.D. in Biological sciences from Durham University, UK with a thesis

[2] EPA Maps

focusing on European lamprey (*Lampetra* spp.) ecology. She subsequently secured funding for her postdoctoral research utilising environmental DNA (eDNA) to identify lamprey spawning sites in freshwater systems. Fiona has 16+ years ecological research experience and has worked for regulatory agencies, NGO's and Universities across Europe and Africa. Fiona has significant expertise surveying aquatic habitats and species with a particular interest in species of conservation concern. She has dedicated much of her recent career to the research and development of non-invasive monitoring methods such as environmental DNA and has provided technical expertise for many stakeholders in the development and application of these methods. Fiona has a strong track record in the design and implementation of field surveys as well as managing projects and field teams. Fiona has an excellent understanding of wildlife legislation and is experienced in community and broader stakeholder consultation and participation.

Dr Michael Dobson FLS MCIEEM is a freshwater biologist with over 35 years' experience. He spent 20 years as a research scientist, specialising in ecology and management of rivers and freshwater wetlands throughout Europe and East Africa, along with developing biotic indices for river quality assessment in Central America. He was Director of the Freshwater Biological Association for six years before joining APEM in 2013, working initially in the limnology and water quality team before setting up its dedicated invasive species team in 2019 and moving to APEM Ireland in 2022. Mike has written many peer- reviewed papers in ecology and biogeography, along with two undergraduate textbooks for Oxford University Press (both in their second editions) and seven identification guides to freshwater invertebrates of Britain and Ireland. He has extensive experience of survey design, data analysis and reporting, including publication and verbal reporting for non-technical audiences. He has written and reviewed Habitats Directive assessments in both Ireland and the UK.

2. Water Samples

2.1. Methods

Field water quality measurements and were taken *in situ*, using a multimeter probe, at 7 sites on 21st June 2023. In addition, water samples were collected on 21st June 2023 at the same 7 sites for laboratory analysis. Sites surveyed are shown in **Error! Reference source not found.** Each sample was collected in a pre-sterilised sampling bottle, pre-rinsed with river water. Water samples were taken from just below the surface, ensuring that the riverbed was not disturbed. Once sample bottles were filled, they were transported to an accredited laboratory for analysis within the recommended holding time for the selected water quality parameters. The sampling sites are shown in Plate 3 and Plate 6-Plate 16.

2.2. Results and Discussion

Physiochemical data collected *in situ* in June 2023 is shown in Table 1. Summary of physicochemical readings recorded in situ at each site in June 2023Dissolved Oxygen (DO) varied largely between sites with Site 1 at Drumshallon Lough having a saturation exceeding 100%; Site 2, located in the Drumshallon Lough Stream, and Sites 5 and Site 8, both located on the Hammondstown Stream, had saturations close to 50%.

The three sites with particularly low DO concentrations did not have significantly higher water temperature nor were they sampled at times of the day when DO saturation could be expected to be low owing to respiration. In the case of Sites 5 and 8, this was probably due to the extensive emergent vegetation adding organic matter which bacteria decompose, taking up oxygen, and is therefore a natural phenomenon. Site 2 is more open, and therefore the low oxygen concentration is unexplained It is notable that Site 1 upstream of Site 2 had high DO levels, probably due to daytime photosynthesis by aquatic plants or algae in the lake.

The conductivity was similar across all sites but one. Site 7, located on the Slieveboy Stream, had very high conductivity in relation to the other sampled sites. This may be related to the presence of a quarry upstream of the site.

Table 1. Summary of physicochemical readings recorded in situ at each site in June 2023

Parameter	Unit of Measurement	Site 1	Site 2	Site 3	Site 5	Site 6	Site 7	Site 8
Time of reading	HH:MM	10:15	11:15	10:45	13:00	12:45	11:40	13:20
Temperature	ºC	19.9	16.3	14.8	18.5	15.8	15.8	16.8
Dissolved Oxygen	% Saturation	107.1	49.7	92.6	54.3	82.8	74.8	50.7
Dissolved Oxygen	mg/l	9.68	4.85	9.28	5.01	8.15	7.4	4.81
Conductivity	µS/cm	422	414	442	449	452	1457	450

Laboratory results for water quality parameters are shown in Table 2. Summary of water quality parameters analysed in the laboratory for each site in June 2023 The Biochemical Oxygen Demand (BOD), which is an indicator of organic matter breakdown and often therefore associated with pollution, was low across most sites, with the exception of Site 5, which had moderately high BOD, at 6mg/L. It is of note that Sites 2 and 8 did not have high BOD levels, indicating that in spite of the low DO levels at these two sites, the level of organic matter decaying at these sites is not of concern. However, the high BOD level combined with the low DO level at Site 5 suggests an issue with organic pollution at this site.

Suspended solids were low at all sites bar Site 5 which had very high levels, likely reflecting increased organic matter, localised at this site.

Ammonia as Nitrogen concentrations were low across the sites; all were within the range of concentrations set for High status (S.I. 272; Surface Water Regulations, 2009). Total Oxidised Nitrogen (TON) as N was high at Site 3 but otherwise low, being below limit of detection at Sites 5 and 8. Total Nitrogen followed a similar trend, high levels at Site 3 and lowest at sites 5 and 8; however, the highest concentrations were found at Site 7. Nitrate levels were similar, very high at Site 3 (considered by the EPA to be indicative of poor water quality) and high also at Site 7 (considered indicative of bad water quality; EPA, 2023). They were lowest at Sites 5 and 8. Nitrate concentrations at all other sites were considered indicative of relatively good water quality. Nitrite levels were low at all sites. These results indicate an issue with nitrogen and nitrate at Sites 3 and 7. These are located on the Piperstown Stream in the south and the Slieveboy Stream to the north of the Site, respectively. Of interest is that soil mapping indicates that both of these sites are poorly drained soils, although both sites are adjacent to well drained soils. Pollution Impact Potential (PIP) mapping for Nitrate (mapping modelled Nitrate Critical Source Areas where the land is susceptible to losses of nitrate owing typically to freely draining soils and moderate to high livestock intensity) predicts that neither of the streams is at risk from nitrate losses as they are located on poorly drained soils.

Site 8, on the Hammondstown Stream, had the highest orthophosphate levels at 0.045mg/L, representing moderate water quality at this site. All other sites met the thresholds for either good or high water quality status (S.I. 272; Surface Water Regulations, 2009). Total phosphorus levels were low at all sites except for an exceptionally high reading at Site 5 (again on the Hammondstown Stream), potentially indicating a point source. This stream is located on well drained soils, and therefore PIP mapping for Phosphorus (PIP-P) shows it is not considered a high risk area for phosphorus losses as higher ranking areas are typically resulting from the presence of poorly draining soils and moderate/high livestock intensity. As a result, no PIP-P flow delivery points or paths have been mapped for it.

Total Petroleum Hydrocarbons (TPH), which is an indicator of contaminants such as oil-based fuels, was at low concentrations across all sites. Most sites were ‘Unknown pattern’, which indicates the presence of naturally forming hydrocarbons in the sample that cannot be attributed to manufactured compounds with a known ‘fingerprint’ such as diesel or kerosene. Therefore, there was no evidence for contamination of this type.

Table 2. Summary of water quality parameters analysed in the laboratory for each site in June 2023

Parameter	Unit of Measure-ment	Site 1	Site 2	Site 3	Site 5	Site 6	Site 7	Site 8
Biochemical Oxygen Demand (BOD)	mg/l	2	<1	<1	6	<1	1	2
Suspended Solids	mg/l	<2	<2	2	208	<2	3	<2
Ammonia as N	mg/l	0.011	0.032	0.023	0.024	0.027	0.014	0.035
TON as N	mg/l	0.953	0.919	4.43	<0.1	1.88	0.571	<0.1
Total Nitrogen as N	mg/l	1.34	1.11	3.91	0.500	2.01	5.5	0.526
Nitrate as NO3	mg/l	3.91	4.02	27.1	<0.44	8.57	16.8	<0.44
Nitrite as NO2	mg/l	0.021	<0.017	0.023	<0.017	0.102	0.019	<0.017
Orthophosphate as PO4-P	mg/l	<0.01	<0.01	0.01	0.011	0.022	0.03	0.045
Total Phosphorus as P	mg/l	<0.05	0.1	<0.05	0.64	<0.05	0.05	0.09
TPH (>C5 - C44) by GC-FID	ug/l	22**	22**	<20	26**	<20	22**	34**

** Unknown Pattern

2.3. Conclusions

The results show that, from a water chemistry perspective, there are significant differences in the water quality of the surveyed water bodies. The Slieveboy stream (Site 7) has high levels of Nitrogen and nitrates. Although EPA mapping indicates that the underlying soils are poorly drained it is very close to an area mapped as well-drained to the west, which may be causing loss of nitrogen from pasture in the area. The Drumshallon Lough (Site 1) and its outflowing stream (Site 2) do not have significant water quality issues despite the low DO levels at Site 2. The small lough and stream are located on a small patch of peaty soils which may explain the low DO levels as the still water leaves the boggy lake and the Dissolved Organic Matter (DOM) associated with peat is discharged and starts to decompose. The Hammondstown Stream has significant phosphorus and phosphate related water quality issues at its source (Site 5) where low DO, high suspended solids and very high Total Phosphorus concentrations suggest a point source here. Site 8, located upstream of a tributary, also had low DO and high levels of orthophosphate present, indicating a potential diffuse or possibly point source nearby. Soil mapping suggests that the soils here are well drained, but not far from poorly drained soils which may be contributing phosphorus/phosphate through overland flow off pasture. It is notable that Site 6 which is downstream of both of these sites and had greater levels of flow, does not have water quality issues associated with it.

2.4. Limitations

A key limitation is the number of water quality readings available. Water quality can be variable, and will change under different flow and runoff conditions, so a single sample or set of readings can only give an indication of conditions at that point of time.

3. Macroinvertebrate Survey

3.1. Methods

Five of the sites used for water quality analysis were also sampled for macroinvertebrates (Figure 2), Two different sampling methods were used, depending on the habitat type.

For the river sites, kick-sampling was carried out at 4 sites on 19-21 June 2023 according to the standard methodology used by the EPA (Toner *et al.,* 2005). The sites surveyed are shown in **Error! Reference source not found.** A two-minute macroinvertebrate kick sample was conducted at each site using a standard 1 mm mesh size long-handled net, principally from the faster flowing riffle habitats, but glides, margins and pools were included according to their proportional presence. A further one-minute hand search was carried out to locate macroinvertebrates that attached themselves to solid structures such as the underside of the cobbles. Each sample was preserved on site with >90% Isopropanol solution and returned to the laboratory for further analysis. Specimens were identified, under a binocular microscope, to either genus or family level, depending on the taxa, according to the requirements of the Q-value method, in the laboratory using the standard range of identification keys published by the Freshwater Biological Association, AIDGAP and others, and their relative abundance was recorded.

An EPA Q-value classification was assigned to each site. The Q-values were assigned based on the presence and relative abundance of sensitive groups and the consideration of additional qualifying criteria, as described by Toner *et al.* (2005) and outlined in more detail in Appendix C.

For the single lake site, a three-minute pond net sweep sample was taken in the Drumshallon Lough (Site 1). This sample was taken from a range of habitats present in the Lough, these include a deep area with submerged vegetation, an area with emergent vegetation and an area of floating vegetation, deep pool and reeds, this methodology was based off of the Predicative System for Multi-metrics (PSYM; Howard, 2002) which was designed for habitat survey and the assessment of standing waters by the Freshwater Habitats Trust and Environment Agency in the UK. The purpose of taking this sample was to gain an understanding of the different pond macroinvertebrate communities present in the different habitats using a standardised method.

The sampling sites are shown in Plate 1-Plate 15.

3.2. Results

Results from the macroinvertebrate survey of river sites are provided in Table 3. Summary of Q values assigned, BMWP, WHPT and PSI and total number of taxa observed at each site in June 2023 and a full taxa list is provided in Appendix C. All sites were classified as Q3, indicating moderate pollution (and representing poor ecological status). The greatest taxa richness was found at Site 6, which had the sensitive mayfly *Rhithrogena* sp. (a single individual was also present at Site 3) from Group A; it also had a number of less sensitive cased caddis from three different families from Group B, suggesting slightly better water quality than the other sites. All sites had small numbers of the less sensitive cased caddis *Agapetus* sp. from Group B. The lowest number of taxa were found at Site 7, which also had a large number of very tolerant taxa such as the water *louse Asellus aquaticus* and the bivalve Sphaeriidae as well as large numbers of the invasive mud snail *Potamopyrgus antipodarum*, suggesting slightly worse water quality than at the other sites. Similarly, Site 6 had the highest SSR Score and Site 7 had the lowest score, but all sites were categorised 'at risk'. WHPT scores also reflected this, with highest scores at Site 6 and lowest scores at Site 7. However, when scores were averaged per taxon present (WHPT-ASPT), the highest scores were found at Site 2, only slightly higher than Sites 6 and 3, but with all scores showing Site 7 to have the lowest score overall. These suggest that there are only slight differences in ecological quality between Sites 2, 3 and 6 but that Site 7 is of slightly worse ecological quality than the other sites.

The PSI (Proportion of Sediment-sensitive Invertebrates) Score uses macroinvertebrate community composition as a proxy to describe the extent to which riverbeds are covered by, fine sediment, with a higher score indicating less sedimentation. PSI scores indicated that Sites 3 and 6 were unsedimented, with Site 2 displaying slight sedimentation, and Site 7 being considered 'sedimented'.

Table 3. Summary of Q values assigned, BMWP, WHPT and PSI and total number of taxa observed at each site in June 2023

Parameter			Site 2	Site 3	Site 6	Site 7
Q Value	**Score**		**Q3**	**Q3**	**Q3**	**Q3**
	No. of Taxa	Group A (sensitive)	-	-*	1	-
		Group B (less sensitive)	1*	1*	3	1
		Group C (tolerant)	8*	8*	10	4*
		Group D (very tolerant)	-*	1	1	2*
		Group E (most tolerant)	-	-	1	-
		Total	14*	13*	16	10*
SSRS	SSR Score		3.2	4	5.6	1.6
	Risk Level		At Risk	At Risk	At Risk	At Risk
WHPT	WHPT Score		89.5	79.1	103.3	46.9
	WHPT-ASPT		6.4	6.1	6.1	4.7
PSI	PSI Score		76.0	83.3	83.9	40.9
	River Bed Condition		Slightly sedimented	Unsedimented	Unsedimented	Sedimented

*Other taxa were present and counted in the total number of taxa but either had only one individual and were therefore discounted from Q value classification, or were not a taxon considered in the classification system

There was low taxonomic diversity within the pond sample from Drumshallon Lough, with only 12 macroinvertebrate taxa recorded (Table 4). PSYM scores for the macroinvertebrates indicated that the ecological quality of the site was degraded, as evidenced by the low BMWP and ASPT scores and limited presence of Odonota and Megaloptera taxa. The sample was dominated by pollution tolerant taxa such as the Chironomidae (midge larvae) and the water louse *Asellus aquaticus* (PSYM group 7 and 8 respectively, with low corresponding BMWP values, indicating tolerance to organic pollution). Common blue damselfly *Enallagma cyathigerum* larvae were recorded as relatively abundant in the sample and three dragonfly species were also present: Common darter *Sympetrum striolatum,* Four-spotted chaser *Libellula quadrimaculata* and Hairy dragonfly *Brachytron pratense.* These species were all pollution sensitive (PSYM Group 2) with a high BMWP score. However, no rare species were present in the sample. The absence of aquatic Coleoptera (beetles) may indicate issues with bank quality. Unfortunately a macrophyte survey could not be conducted on the day owing to unforeseen circumstances. While conducting the sampling, fish were observed topping in the lake.

Table 4. List of taxa and total abundance recorded at Site 1 in June 2023

Class/Order	Family	Genus/species	PSYM Group	Abundance / Score
Gastropoda	Bithyniidae	*Bithynia* sp.	Group 7 (BMWP 2)	3
	Lymnaeidae		Group 7 (BMWP 2)	1
Isopoda	Asellidae	*Asellus aquaticus*	Group 7 (BMWP 2)	12
Lepidoptera	Crambidae			4
Ephemeroptera	Baetidae	*Baetis rhodani*	Group 6 (BMWP 4)	1
	Caenidae	*Caenis* sp.	Group 3 (BMWP 7)	8
Odonata (Zygoptera)	Coenagrioniidae	*Enallagma cyathigerum*	Group 4 (BMWP 6)	14
Odonata (Anisoptera)	Aeshnidae	*Brachytron pratense*	Group 2 (BMWP 8)	1
	Libellulidae	*Sympetrum striolatum*	Group 2 (BMWP 8)	1
		Libellula quadrimaculata	Group 2 (BMWP 8)	1
Hemiptera	Notonectidae		Group 5 (BMWP 5)	5
Diptera	Chironomidae		Group 8 (BMWP 2)	25
Total				76
BMWP				40.9
Total number of PSYM taxa				10
ASPT				4.9
Number of Odonota and Megaloptera taxa (OM)				3
Number of Coleoptera taxa				0

3.3. Conclusions

The results from macroinvertebrate indices indicate that all sites sampled are moderately polluted, with limited evidence of slightly better ecological quality at Site 6 on the Hammondstown stream than that of the others, and Site 7 on the Slieveboy stream displaying slightly worse ecological quality for all metrics, including sedimentation. This trend is consistent with the water quality results. PSYM scores for the macroinvertebrates also indicated degraded ecological quality at Drumshallon Lough (through PSYM scores), similar to its outflowing stream measured at Site 2.

3.4. Limitations

The dataset is from a single sampling event and while it will integrate environmental conditions over the several months coved by the life cycles of the taxa recorded, it cannot give an indication of interannual variation. Where possible, therefore, it is always advisable to take repeat samples in multiple years.

4. Fish and Habitat Surveys

4.1. Methods

4.1.1. Fish habitat survey

Habitat walkover surveys were conducted in order to identify suitable habitat for the key fish species and life stages of importance. These took place along reaches of Drumshallon Lough stream and Hammondstown stream. Walkover habitat surveys were conducted on 20 June 2023. Weather conditions were dry and sunny with c. 40% cloud cover, light wind[3], air temperature 21°C. The river flow at this time was considered low and therefore allowed for good visibility during habitat surveys. Surveys considered habitats suitable for salmonids and lamprey; an outline of the requirements for each survey is detailed in Appendix D.

The methodology applied to the habitat survey follows Hendry & Cragg-Hine (1997). This field mapping technique involves hand drawing onto a high-resolution map (OS 1 km tiles) at a scale of 1:10,000 using a field tablet. The riverbank was walked, noting habitat features in the river channel and drawing these directly onto the map, with the boundaries of the different habitat classifications being drawn to represent their actual position within the river, and with annotations as required. Prominent features, such as log jams, macrophyte beds, weirs and bridges, were noted and their locations confirmed using handheld GPS unit. This allows exact representation of the areas of individual habitat types encountered. In this manner, a mosaic of the different habitat types can be drawn along the whole section of the river. Definitions of habitat types included in the survey are outlined in Appendix D. The drawings of the habitat types along the section of the river were subsequently digitised using QGIS (Figure 3 to Figure 5).

4.1.2. Fish species present

A desk study of the Inland Fisheries Ireland (IFI) Water Framework Directive (WFD) Fish Ecological Status 2008-2021 database was carried out to find previous records of fish species present in the waterways on Site.

4.1. Results and Discussion

4.1.1. Fish Habitat Surveys

Drumshallon Lough Stream

The fish habitat survey covered ca 515 m of the Drumshallon Lough Stream (Plate 17 - Plate 24). This was a first order modified stream drain surrounded by agriculture on both banks. The channel was largely overgrown with in stream vegetation including abundant watercress *Nastiurum officianalis.* Other instream vegetation included common rush *Juncus effusus,* speedwell *Veronica sp.*, horsetails *Equisetum arvense,* willowherb *Epilobium sp..* In this section of stream, it was not possible to see the stream substrate, where water was visible it was still or very flow slowing.

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[3] https://www.met.ie/forecasts/marine-inland-lakes/beaufort-scale

At the corner at the downstream end of the fish habitat survey stretch the stream begins to flow beyond a small blockage of branches and litter, there is a short riffle section present here which flows back into watercress vegetation approx. 7 m downstream. Three outflows flow from the Northern bank into the stream at this point. A stretch approx. 300 m long to the next field boundary just downstream of the fish habitat survey section was also walked while on site and this stretch of the stream showed areas of instream vegetation and areas of slow riffle similar to that at the downstream end of the Fish Habitat stretch.

There were no ideal habitats for salmonids or lamprey observed during this survey.

A number of mammal tracks were recorded while completing the Fish Habitat survey. Possible otter spraint was recorded at the downstream end, at the location of Kick Sample 2.

Hammondstown Stream

The fish habitat survey covered ca. 400 m of the Hammondstown Stream (Plate 25-Plate 51). This was a first order stream which was a modified drain in areas and surrounded by agriculture on both banks. The channel was heavily vegetated with up to 100% macrophyte cover in areas.

At the upstream end of the fish habitat survey there was a U-shaped stagnant pool with *Typha latifolia* and *Equisetum arvense.* Rudd were observed swimming in this area. Access further upstream of this area was limited due to vegetation cover. The channel was accessible for a spot check approximately 150 m upstream of this area and at this location it was overgrown with macrophytes (Plate 54-Plate 56). The spot check location has been included in Figure 2 but has not been mapped for fish habitat in Figure 4-Figure 5.

The channel was approximately 1.5 m wide and well covered by brambles in areas. In stream vegetation throughout the channel included *Mentha aquatica, Nasturtium officinale, Lemna* sp., *Callitriche stagnalis* and *Epilobium* sp.. There was a stone bridge structure approximately 300 m downstream of the fish habitat survey starting point (Plate 40). Upstream off this bridge the channel was mainly stagnant with a silty bottom and was heavily vegetated. Bankside vegetation in this section consisted of a mature treeline along the channel which included *Fraxinus excelsior* and *Acer pseudoplatanus* along with brambles.

Downstream of this structure <5 m an unmapped channel joins the stream from the left-hand bank (Plate 52-Plate 53). This channel was approximately 2 m wide and flowing at the confluence. At this confluence, the substrate is mainly boulder and cobble and there are undercut banks present with tree roots in the water, some stickleback were observed in this area and a kingfisher feather was found in the channel. Possible otter spraint was also observed at this location. Downstream of this confluence the channel varies between pockets of riffle, glide and slow/stagnant areas with emergent vegetation.

The unmapped channel is well shaded and flowing across riffle habitat just upstream of the confluence. Further upstream this channel becomes more stagnant with a silty substrate. There is a conifer plantation upstream making it inaccessible.

There were no ideal habitats for salmonids or lamprey observed during this survey.

4.1.2. IFI Database Desk Study

IFI electrofishing data is available for the White[Louth]catchment, of which the Hammondstown stream is part. The closest IFI electrofishing point is ca 5 km downstream of the fish habitat survey completed on the Hammondstown stream. There is further data available ca 3.5 km downstream of this point. The available data are summarised in Table 5 and Table 6.

Table 5. IFI electrofishing data White [Louth] River, ca 5 km downstream of Hammondstown stream Fish Habitat Surveys

Year	Brown trout	European eel	Lamprey *Sp.*	Minnow	Salmon	Stone loach	Three-spined stickleback
2013	x	x		x		x	x
2014	x			x		x	x
2015	x			x		x	x
2016	x			x		x	x

Table 6. IFI electrofishing data White [Louth] River, ca 8.5 km downstream of Hammondstown stream Fish Habitat Surveys

Year	Brown trout	European eel	Lamprey *Sp.*	Minnow	Salmon	Stone loach	Three-spined stickleback
2013	x	x	x	x	X	x	X
2014	x	x	x	x	X	X	
2015	x	x		x	X	x	X
2016	x			x	X	x	x

4.2. Conclusions

The reaches surveyed on both the Drumshallon Lough Stream and the Hammondstown Stream are not suitable for salmonid spawning with little value for anything other than passageway.

Lack of observed lamprey ammocete habitat does not mean it is absent from the Site. Ideal lamprey ammocete habitat is areas of stable fine sediment or sand which is greater than 15 cm deep with a low water velocity. The substrate was not fully visible throughout both sites due to instream vegetation and overgrown bankside vegetation in places, and therefore possible suitable areas of ammocete habitat may have been present but not recorded. However, there was no extensive habitat of this type in either reach surveyed.

4.3. Limitations

Conditions were suitable for carrying out fish habitat surveys. Areas of the streams surveyed were inaccessible due to bankside vegetation. Based on the accessible areas of the surveyed streams it is likely that these overgrown areas of channel with impassible bankside vegetation also have poor habitat suitability.

5. Invasive Alien Species

While on site there were incidental invasive species sightings. The species which were recorded are Japanese knotweed, *Fallopia japonica,* and Himalayan balsam, *Impatiens glandulifera* (Plate 58-Plate 60). The locations of these sightings were recorded and have been mapped in Figure 6.

6. General conclusion

The baseline aquatic ecology surveys conducted revealed the watercourses on Site to be small overgrown streams with little value for salmonid or lamprey spawning. Macroinvertebrate metrics indicated degraded ecological quality at all sites, with the Slieveboy Stream (Site 7) observed to be more ecologically degraded than the other sites. From a water chemistry perspective no consistent pollution patterns were observed, however the Piperstown Stream (Sites 3), Hammondstown Stream (Site 5) and Slieveboy Stream (Site 7) all recorded high levels of nutrients, corroborating macroinvertebrate results. Although Site 6 on the Hammondstown stream displayed evidence of slightly better water quality than that of the others in the snapshot of water chemistry, there is strong evidence of water pollution upstream of it, particularly at Site 5.

Site 7 on the Slieveboy stream displayed the worst water quality, for both the macroinvertebrate metrics and the water quality results, with strong evidence of nutrient pollution (in the form of nitrogen/nitrates) in its water chemistry consistent with its macroinvertebrate results. High conductivity and possible sedimentation at Site 7 on the Slieveboy Stream may be linked to the presence of a quarry upstream if this is discharging into the river, but the quarry itself was not investigated and a detailed walkover of the river is recommended if the source of this contamination is to be identified. Further investigations of the Slieveboy Stream, upstream of the quarry, would allow a greater understanding of the baseline water quality of the Slieveboy Stream, which would allow separation of impacts on water quality caused by windfarm construction from those caused by existing sources.

PSYM scores for the macroinvertebrates indicated degraded ecological quality also at Drumshallon Lough (through PSYM scores), similar to its outflowing stream (Site 2). Snapshot water chemistry indicated no specific issues detected in the lake or the stream, aside from a low DO reading on the stream that is of some concern.

Surveyed sites were chosen with regard to the proposed turbine locations supplied. While there was nothing of specific conservation interest recorded within the Site it is still important to consider and minimise impacts downstream of the Site by applying appropriate mitigation when working near watercourses.

Incidental sightings of third schedule invasives species were noted at the Site. The European Communities (Birds & Natural Habitats) Regulations 2011 – 2023 restrict the importation, distribution, sale or release of approximately 70 species of plants and animals considered to be the most harmful Invasive Alien Species. Japanese knotweed and Himalayan balsam are two of the plant species listed in Part 1 of the Third Schedule of the 2011 - 2023 regulations. Japanese knotweed is also listed as a vector material in Part 3 of the Third Schedule. It is an offence to plant, disperse, allow or cause to disperse, spread or otherwise cause to grow in any place any plant included in the Third Schedule. It is an offence under the Wildlife Acts 1976 – 2022 to plant or otherwise cause to grow in a wild state in any place in the State any species of (exotic) flora, or the flowers, roots, seeds or spores of (exotic) flora. Therefore care must be taken and appropriate mitigation must be put in place not to further disperse these species during the construction of the windfarm at Kellystown.

References

EPA (2023). *Water Quality in 2022: An Indicators Report.* Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

Feeley, H.B., Bradley, C., Free, G., Kennedy, B., Little, R., McDonnell, N., Plant, C., Trodd, W., Wynne, C., and O'Boyle, S. (2020). A national macroinvertebrate dataset collected for the biomonitoring of Ireland's river network, 2007–2018. *Scientific Data* 7, 280.

Harvey, J.P. and Cowx, I.G. (2003). *Monitoring the River, Brook and Sea Lamprey, Lampetra fluviatilis, L. planeri and Petromyzon marinus.* Conserving Natura 2000 Rivers Monitoring Series No. 5, English Nature, Peterborough.

Heggenes, J. 1990. Habitat utilization and preferences in juvenile Atlantic salmon (*Salmo salar*) in streams. *Regulated Rivers: Research & Management* 5(4), pp.341-354.

Hendry, K. and Cragg-Hine, D. (1997). *Restoration of riverine salmon habitats.* Fisheries Technical Manual, 4.

Howard S (2002). *A guide to monitoring the ecological quality of ponds and canals using PSYM.* Environment Agency, West Midlands and Freshwater Habitats Trust.

JNCC (2015). *Common Standards Monitoring Guidance for Freshwater Fauna (2015).* Joint Nature Conservation Committee. ISSN 1743-8160.

Maitland P.S. (2003). *Ecology of the River, Brook and Sea Lamprey.* Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough, 54pp.

Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCarthaigh, M., Craig, M. and Quinn, R. (2005). *Water Quality in Ireland: 2001– 2003.* Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

Howard S (2002). *A guide to monitoring the ecological quality of ponds and canals using PSYM.* Environment Agency, West Midlands and Freshwater Habitats Trust.

Appendix A: Figures

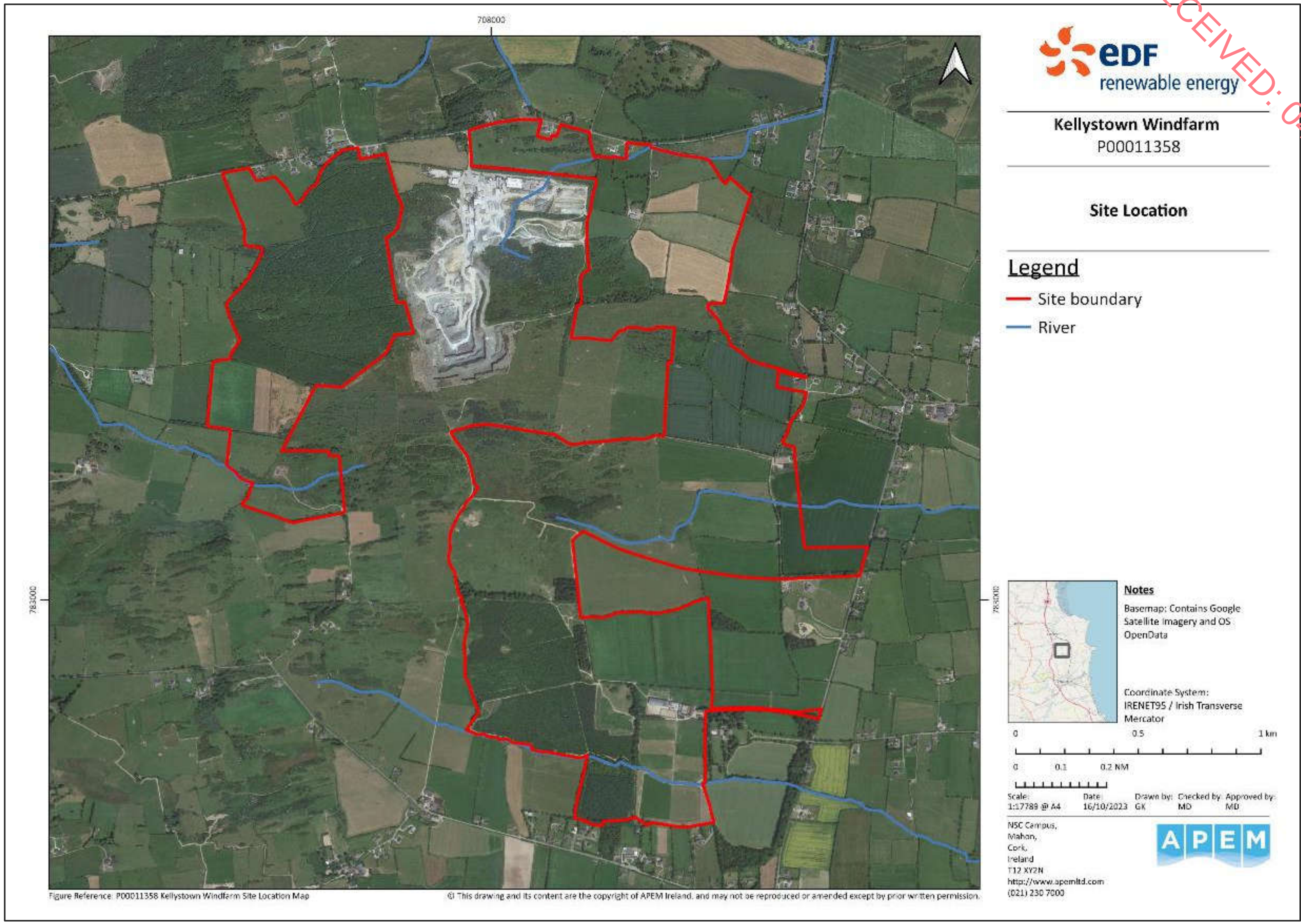

Figure 1 Kellystown Site Boundary

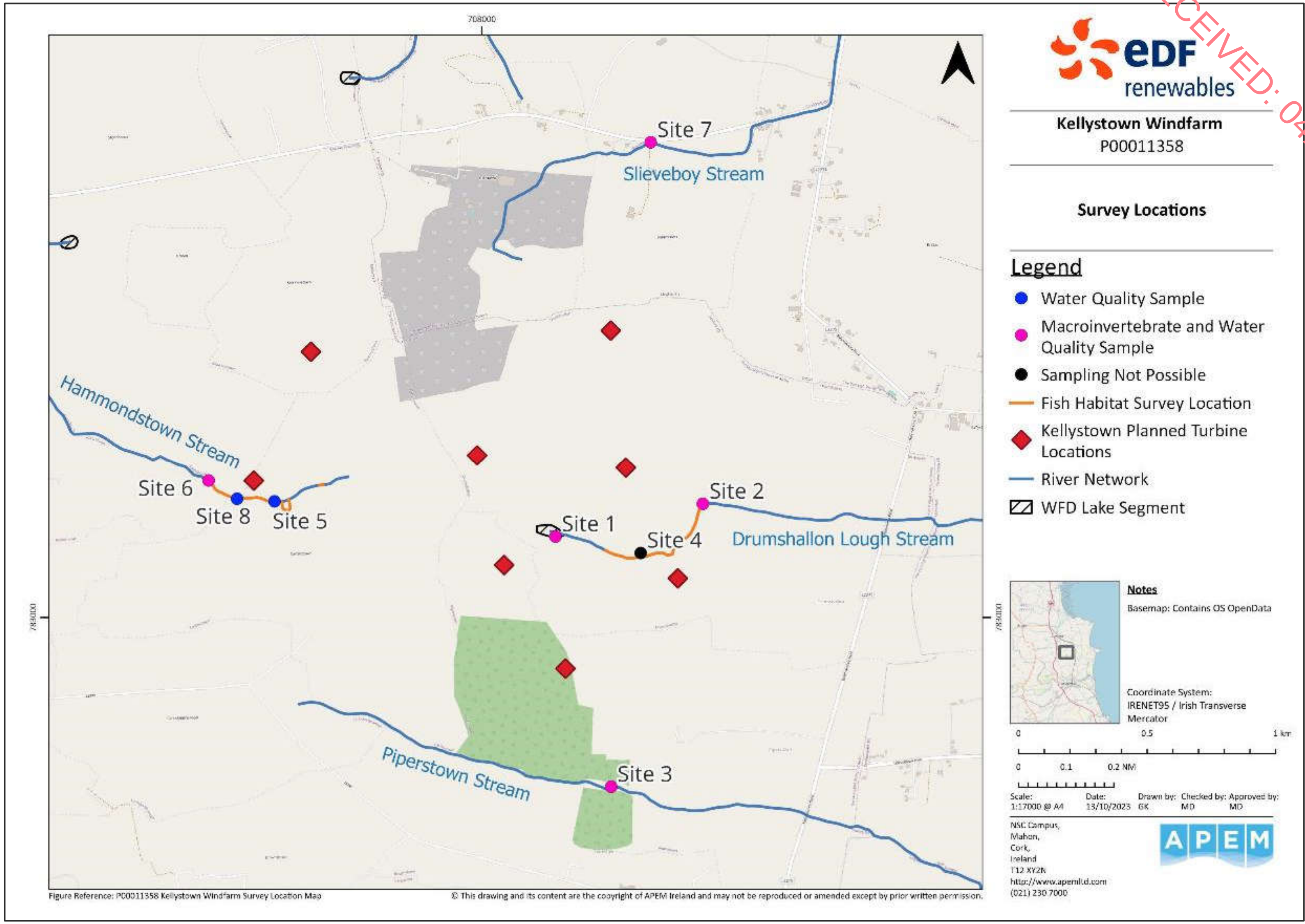

Figure 2 Kellystown Windfarm Survey Locations

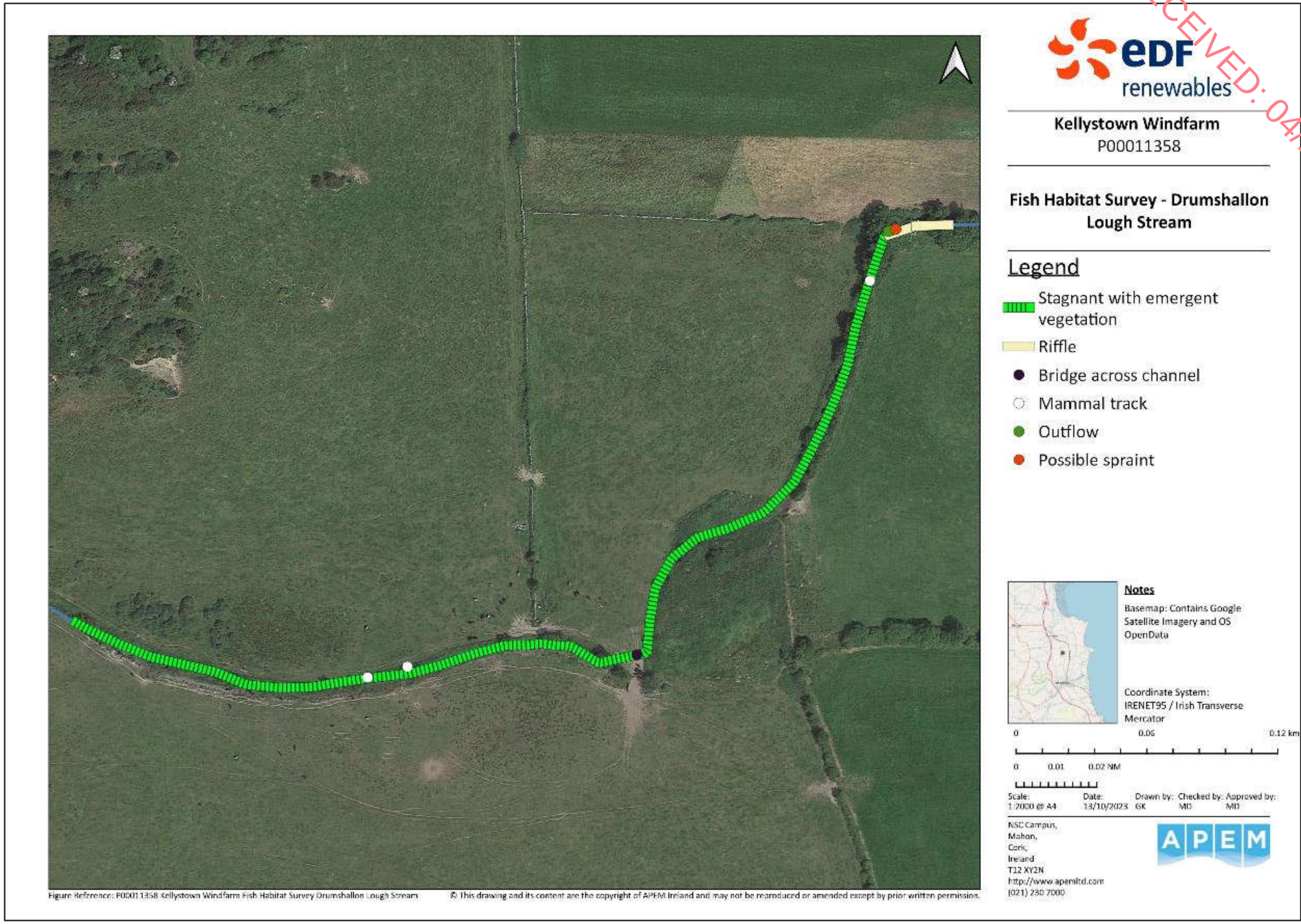

Figure 3 Fish Habitat Survey Drumshallon Lough Stream

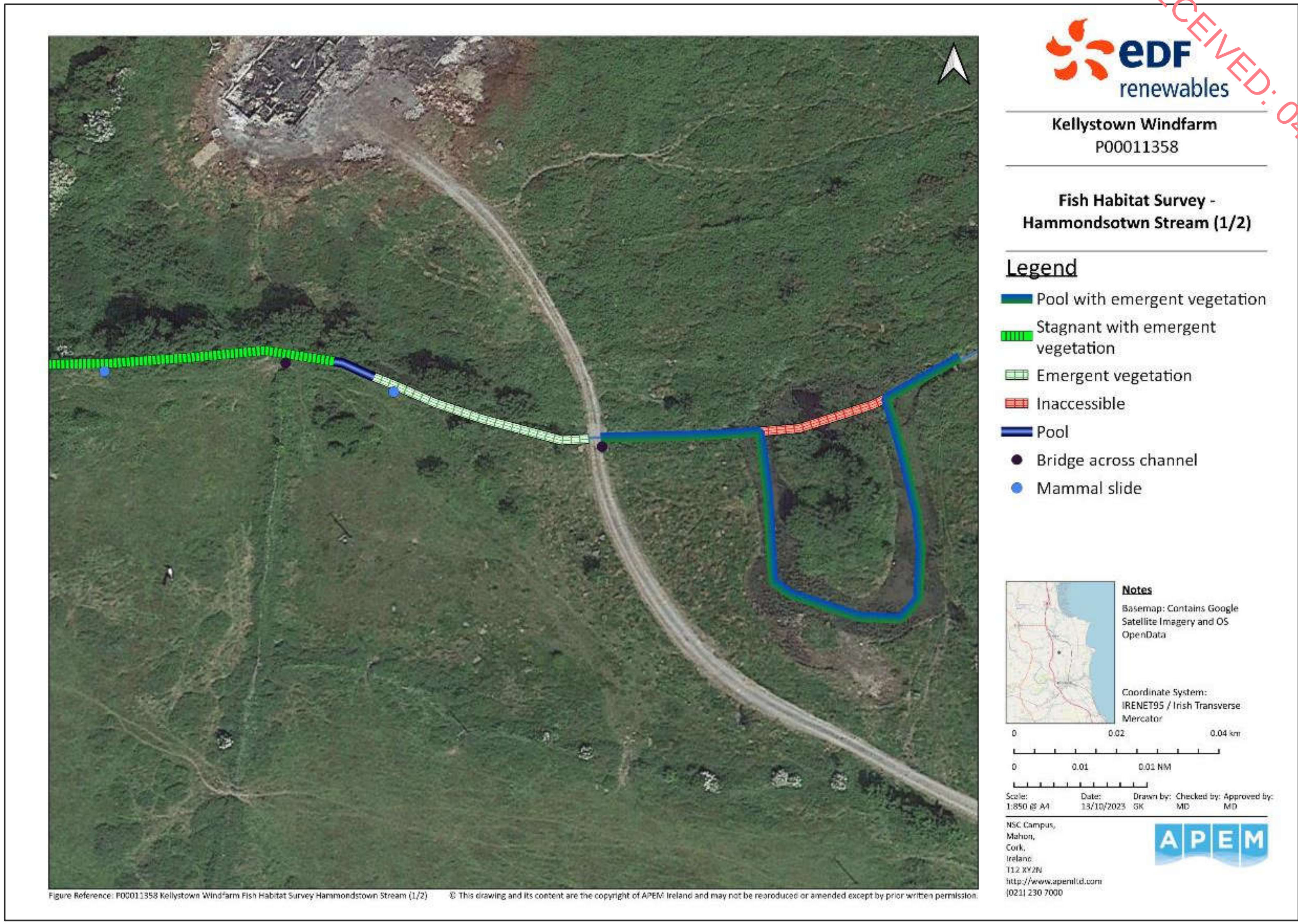

Figure 4 Fish Habitat Survey Hammondstown Stream, upstream section

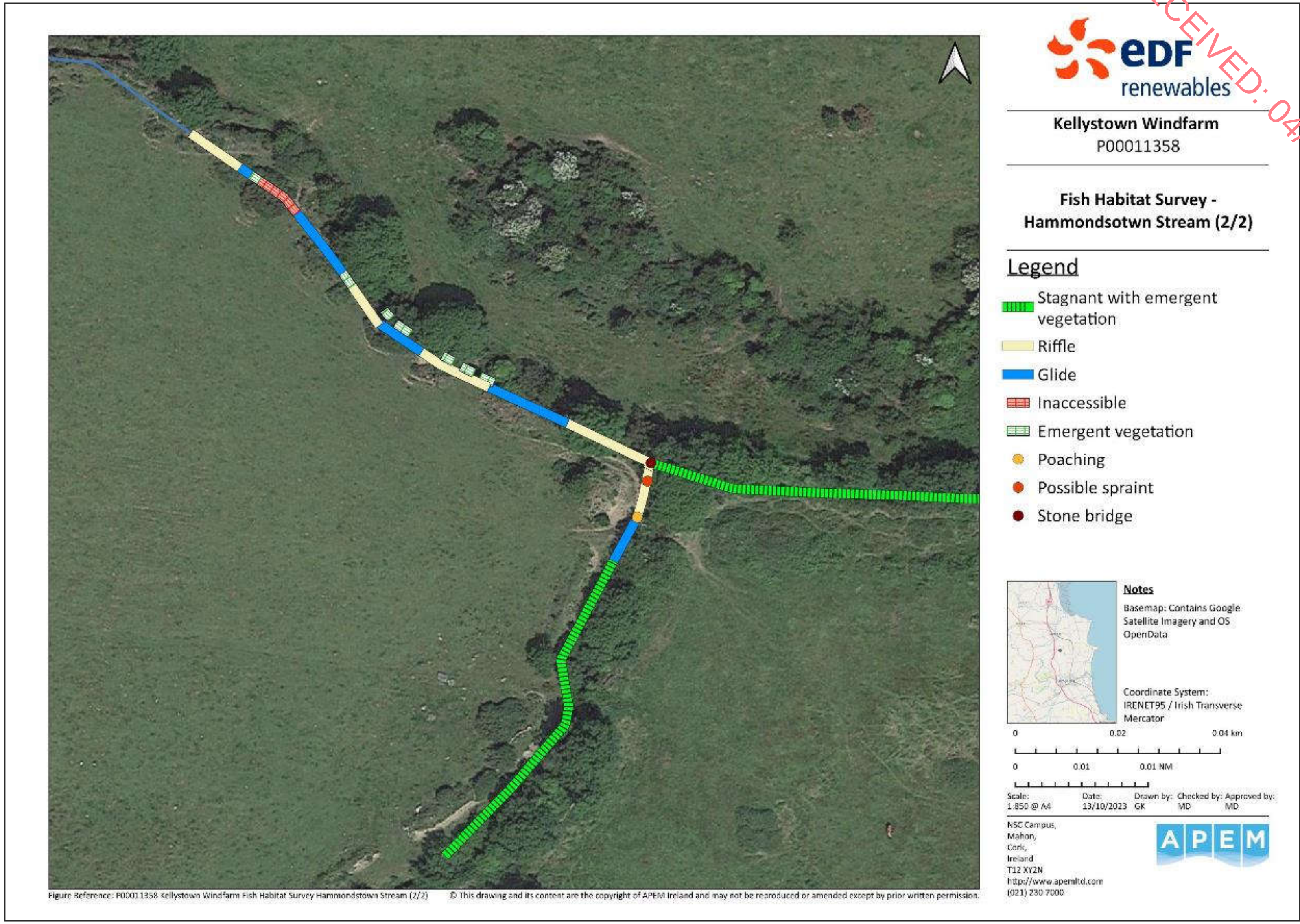

Figure 5 Fish Habitat Survey Hammondstown Stream, downstream section

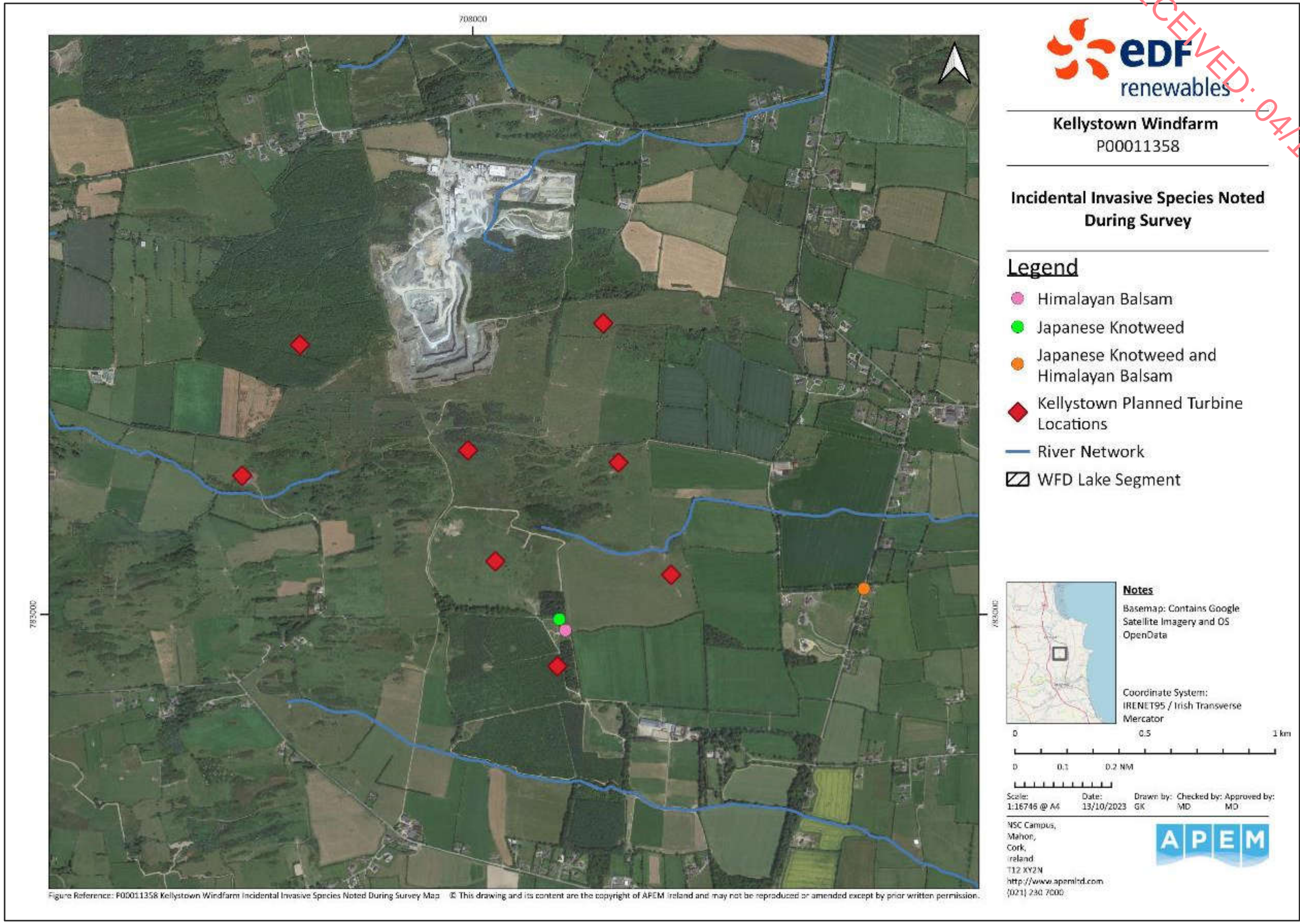

Figure 6 Incidental records of invasive species at Kellystown Windfarm Site

Appendix B: Plates

Plate 1 Drumshallon Lough, from south

Plate 2 Drumshallon Lough, from south east end

Plate 3 Drumshallon Lough, Water Quality Site 1

Plate 4 Drumshallon Lough, from south west end

Plate 5 Drumshallon Lough discharge to river

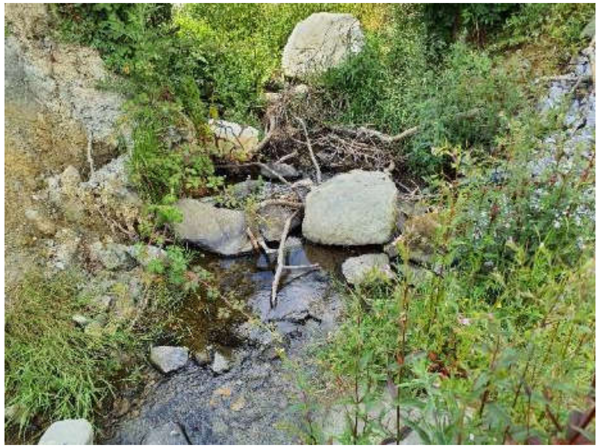

Plate 6 Site 2 water quality and kick sample location, photo facing upstream

Plate 7 Site 2 water quality and kick sample location, facing downstream

Plate 8 Site 3 water quality and kick sample location, facing upstream

Plate 9 Site 3 water quality and kick sample location, facing downstream

Plate 10 Site 4 unsuitable for water quality or kick sampling

Plate 11 Site 5 water quality location, unsuitable for kick sampling

Plate 12 Site 6 water quality and kick sample location, facing upstream

Plate 13 Site 6 water quality and kick sample location, facing downstream

Plate 14 Site 7 water quality and kick sample location, facing upstream

Plate 15 Site 7 water quality and kick sample location, facing downstream

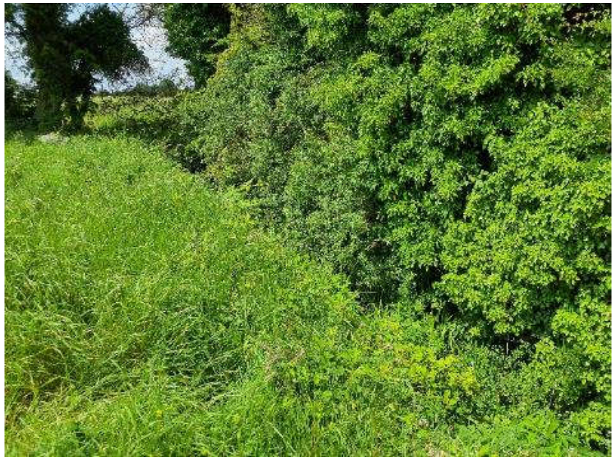

Plate 16 Site 8 water quality location, unsuitable for kick sample

Plate 17 Drumshallon Lough Stream Fish Habitat Walkover, western end facing downstream, overgrown vegetated channel

Plate 18 Drumshallon Lough Stream Fish Habitat Walkover, western end facing upstream, overgrown vegetated channel

Plate 19 Drumshallon Lough Stream Fish Habitat Walkover, middle section, overgrown vegetated channel, no flow seen

Plate 20 Drumshallon Lough Stream Fish Habitat Walkover, middle section, facing downstream, narrow vegetated channel, no flow seen

Plate 21 Drumshallon Lough Stream Fish Habitat Walkover, eastern section upstream of riffle, narrow vegetated channel, no flow seen

Plate 22 Drumshallon Lough Stream Fish Habitat Walkover, east section, facing upstream, some flow and cobbles recorded along with in stream litter

Plate 23 Drumshallon Lough Stream Fish Habitat Walkover, east section, outflows and instream litter

Plate 24 Drumshallon Lough Stream Fish Habitat Walkover, east section, facing downstream, riffle habitat present

Plate 25 Hammondstown Stream Fish Habitat walkover, large stagnant U shaped area at eastern end of survey

Plate 26 Hammondstown Stream Fish Habitat walkover, large stagnant U shaped area at eastern end of survey showing water turbidity

Plate 27 Hammondstown Stream Fish Habitat walkover, large stagnant U shaped area at eastern end of survey with in stream vegetation

Plate 28 Hammondstown Stream Fish Habitat walkover, large stagnant U shaped area at eastern end of survey, water not visible with instream vegetation

Plate 29 Hammondstown Stream Fish Habitat walkover, large stagnant area

Plate 30 Hammondstown Stream Fish Habitat walkover, in stream vegetation

Plate 31 Hammondstown Stream Fish Habitat walkover, flow seen among instream vegetation

Plate 32 Hammondstown Stream Fish Habitat walkover, middle section stagnant with emergent vegetation

Plate 33 Hammondstown Stream Fish Habitat walkover, pool area where stickleback seen

Plate 34 Hammondstown Stream Fish Habitat walkover, glide area

Plate 35 Hammondstown Stream Fish Habitat walkover,in stream vegetation facing upstream

Plate 36 Hammondstown Stream Fish Habitat walkover, in stream vegetation facing downstream

Plate 37 Hammondstown Stream Fish Habitat walkover, stagnant instream vegetation from left hand bank

Plate 38 Hammondstown Stream Fish Habitat walkover, stagnant with instream *Lemna* and *Callitriche*

Plate 39 Hammondstown Stream Fish Habitat walkover, pool area

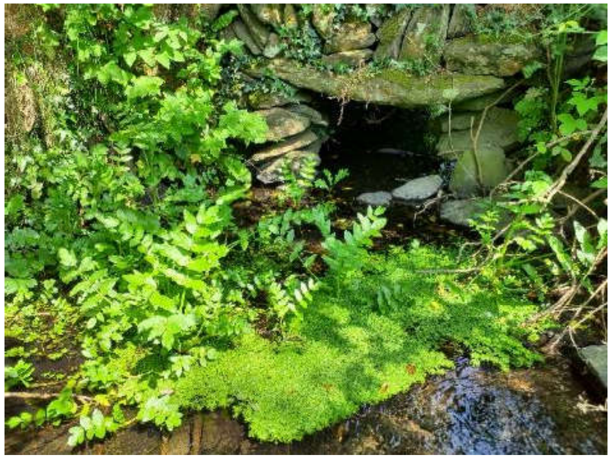

Plate 40 Hammondstown Stream Fish Habitat walkover, stone bridge structure

Plate 41 Hammondstown Stream Fish Habitat walkover, rifle taken instream facing downstream

Plate 42 Hammondstown Stream Fish Habitat walkover, riffle taken instream

Plate 43 Hammondstown Stream Fish Habitat walkover, stagnant with instream vegetation, taken instream

Plate 44 Hammondstown Stream Fish Habitat walkover, shallow glide

Plate 45 Hammondstown Stream Fish Habitat walkover, channel inaccessible due to bankside vegetation

Plate 46 Hammondstown Stream Fish Habitat walkover, channel inaccessible due to bankside vegetation, facing upstream

Plate 47 Hammondstown Stream Fish Habitat walkover, channel inaccessible due to bankside vegetation, facing downstream

Plate 48 Hammondstown Stream Fish Habitat walkover, inaccessible due to bankside vegetation

Plate 49 Hammondstown Stream Fish Habitat walkover, glide area

Plate 50 Hammondstown Stream Fish Habitat walkover, flowing area with instream vegetation

Plate 51 Hammondstown Stream Fish Habitat walkover

Plate 52 Hammondstown Stream Fish Habitat walkover, unmarked tributary facing upstream from confluence

Plate 53 Hammondstown Stream Fish Habitat walkover, unmarked tributary stagnant upstream

Plate 54 Hammondstown Fish Habitat survey, upstream spot check, channel inaccessible due to bankside vegetation

Plate 55 Hammondstown Fish Habitat survey, upstream spot check, instream vegetation

Plate 56 Hammondstown Fish Habitat survey, upstream spot check, inaccessible with bankside vegetation, slight flow seen

Plate 57 Kingfisher feather found near confluence during Hammondstown Stream Fish Habitat walkover

Plate 58 Japanese knotweed, *Fallopia japonica,* found on Site approximately 330 m south of the Drumshallon Lough and 340 m south of the Drumshallon Lough Stream, and approximately 180 m north of turbine T07 location

Plate 59 Japanese knotweed, *Fallopia japonica*, found on Site approximately 330 m south of the Drumshallon Lough and 340 m south of the Drumshallon Lough Stream, and approximately 180 m north of turbine T07 location

Plate 60 Himalayan balsam, *Impatiens glandulifera,* on Site approximately 370 m south of the Drumshallon Lough Stream and 380 m south of the Drumshallon Lough, and approx 140 m north of turbine T07 location

Appendix C: Description of Q Value Assessment and Taxa List

1 Q-Value Assessment

The EPA Q-value classification is assigned based on the assessment of a macroinvertebrate sample, which involves recording the taxa present at a suitable and attainable taxonomic resolution (under field conditions) and their categorical relative abundance determined using approximate counts (as described in Feeley *et al*., 2020). From this, the number of taxa present and categorical relative abundance of sensitive (Group A), less sensitive (Group B), tolerant (Group C), very tolerant (Group D) and most tolerant (Group E) taxa to organic pollution is examined. Additional Qualifying Criteria are also considered, consisting of recording the abundance of *Cladophora* spp, macrophytes, and slime growths / sewage fungus, as well as dissolved oxygen percent saturation and the level of substratum siltation. Then, based on the combination of number and relative abundance of the sensitive or tolerant groups present, a Q-value is assigned. Details on the assignment of the scores can be found in Toner *et al*., (2005).

In Ireland, macroinvertebrates are the main Biological Quality Element (BQE) determining the ecological status in rivers (required by the Water Framework Directive; WFD), based on the Q-value. The WFD requires BQE scores to be expressed as an Ecological Quality Ratio (EQR) to standardize and provide a common scale of ecological quality across participatory Member States using differing national methods. Intercalibration of the Q-value with the EQR and the corresponding ecological status are described in Table 7.

Table 7. EPA water quality status summary

Comparing the Q-value, ecological quality ratio (EQR), corresponding Water Framework Directive (WFD) status and pollution gradient resulting from anthropogenic pressures (Feeley et al., 2020).

Q value Score	EQR	Pollution Gradient	WFD Ecological Status
Q5	1.0	Unpolluted	High
Q4-5	0.9	Unpolluted	High
Q4	0.8	Unpolluted	Good
Q3-4	0.7	Slightly Polluted	Moderate
Q3	0.6	Moderately Polluted	Poor
Q2-3	0.5	Moderately Polluted	Poor
Q2	0.4	Seriously Polluted	Bad
Q1-2	0.3	Seriously Polluted	Bad
Q1	0.2	Seriously Polluted	Bad

2 Whalley-Hawkes Paisley Trigg (WHPT).

The WHPT method is an index of overall biological quality using macroinvertebrates, used in the UK for monitoring, assessing and classifying rivers in accordance with the requirements of WFD. It is analogous to the Q-value, although it uses a wider range of macroinvertebrate taxa. It is an enhancement of the BMWP system that has been calculated for ACP data since its inception. Each taxon is awarded a score based on sensitivity and abundance, giving a total overall score when these are summed. As with BMWP, total score is produced, along with the number of taxa (NTAXA), and from these an average score per taxon (ASPT) is calculated.

As a general principle, the higher the value of these indices the higher the environmental quality indicated. The WHPT-ASPT values typically range from 1 (indicative of sites with high organic pollution and degradation) to 13 (indicative of sites with very low organic pollution and degradation). However, in isolation, the overall score or the two indices tell us relatively little, as there are many natural reasons why these values may vary. Their value lies in comparison, either between sites that are expected to be similar or between dates within a site.

In the UK, a WFD macroinvertebrate classification for a river site is generated by calculating the number of abundance weighted WHPT scoring families found during sampling (WHPT NTAXA), and the WHPT-ASPT, and comparing these values to the values that might be expected under undisturbed or reference conditions for that site. These undisturbed or reference scores are predicted by statistical models produced by the River Invertebrate Classification Tool (RICT) – as RICT predicts invertebrate communities at reference conditions. The observed values of WHPT ASPT and WHPT NTAXA are compared to the predicted values to generate an Environmental Quality Ratio (EQR). EQRs close to 1.0 indicate that invertebrate communities are close to their natural state. However, in Ireland, EQRs cannot be generated from the WHPT system, as the RICT tool has not been developed for Irish rivers.

3 Proportion of Sediment-sensitive Invertebrates (PSI)

The PSI (Proportion of Sediment-sensitive Invertebrates) uses macroinvertebrate community composition as a proxy to describe the extent to which river beds are composed of, or covered by, fine sediment. While sediment inputs can be influenced by a variety of processes, land-use practices such as ploughing or intensive grazing are an important source, if bankside management is inadequate; thus it is a useful indicator of agricultural impact in intensively farmed areas.

Macroinvertebrate taxa are each given a classification, determined by their sensitivity to sediment, and from this a value is produced which is used to classify degree of sedimentation. PSI scores were compared visually among sites.

4 Predictive System for Multimetrics (PSYM).

The PSYM (Predictive System for Multi-metrics) method is designed for habitat survey and the assessment of standing waters (Howard, 2002). PSYM was calculated for Drumshallon Lough based on the assessment of macroinvertebrate assemblages present alone as well as environmental data. PSYM is a predictive tool, comparing observed species assemblages with expected composition based on the type and location of the water body, and metric scores are then combined to provide a single value which summarises the overall ecological quality of the water body. However, the reference data used to enable the prediction is currently only available for England and Wales. Nevertheless, PSYM is still useful as a qualitative measure of ecological quality of ponds.

The macroinvertebrate metrics calculated in PSYM were Biological Monitoring Working Party (BMWP) score, Average Score Per Taxon (ASPT), the number of dragonfly and alderfly (Odonata and Megaloptera) families (OM) and the number of beetle families (Coleoptera). The BMWP and ASPT scores exploit the natural sensitivity of each taxon to organic pollution. Macroinvertebrate families which are sensitive to pollution are assigned high BMWP scores, while pollution-tolerant taxa score low. BMWP index may be altered significantly depending on whether the sampling process captures species found in some habitats but not in others. Standardisation of the BMWP score is therefore provided by the ASPT, allowing robust comparisons among sites. BMWP was developed in the UK and has since been adapted for a range of locations globally, including Iberia (BMWP-I) and Costa Rica (BMWP-CR); the original version works well in Ireland.

5 Macroinvertebrate taxa and proportional abundance recorded.

Table 8. List of taxa and proportional abundance (%) recorded at each site

Class/Subclass/Order	Family	Genus/Species	Q-value group	Site 2	Site 3	Site 6	Site 7
Hirudinea	Glossiphoniidae		D				*
Oligochaeta	Naididae		n/a			0.4	
	Lumbricidae		n/a		0.8		*
Gastropoda	Planorbidae	*Ancylus fluviatilis*	C	3.8			
	Hydrobiidae	*Potamopyrgus antipodarum*	C			0.2	25.7
Bivalvia	Sphaeriidae		D	*			1.9
Isopoda	Asellidae	*Asellus aquaticus*	D		0.6	0.3	21.1
Amphipoda	Gammaridae	*Gammarus* sp.	C	56.1	56.5	47.9	46.8
Ephemeroptera	Heptageniidae	*Rhithrogena* sp.	A		*	0.6	
	Ephemerellidae	*Serratella ignita*	C			0.9	
	Baetidae	*Baetis rhodani*	C	13.1	10.2	20.9	
Hemiptera	Veliidae		C	*	*		
	Mesovelidae	*Mesovelia furcata*	C			*	
Trichoptera	Philopotamidae	*Philopotamus montanus*	C		0.6		
	Philopotamidae	*Wormaldia* sp.	C	*			
	Polycentropodidae		C	0.8		1.0	*
	Glossosomatidae	*Agapetus*	B	5.9	2.7	0.3	3.3
	Rhyacophilidae	*Rhyacophila* sp.	C			0.3	
	Lepidostomatidae		B	*	*		
	Limnephilidae		B			0.2	
	Beraeidae		B	*			
	Sericostomatidae		B			0.3	
Coleoptera	Elmidae		C			1.3	0.9
	Hydrophilidae		C	3.0			
	Scirtidae		C		0.4		
Diptera	Simuliidae		C	11.4	26.0	21.8	
	Pediciidae		C	0.8	0.6	0.4	0.3
	Chironomidae		C	5.1	1.5	3.4	
Total Number of Individuals				237 (5)	481 (3)	1039 (1)	692 (3)
Total Number of Taxa				9 (5)	10 (3)	16 (1)	7 (3)

Appendix D: Fish habitat surveys

1. Salmonid habitat assessment

The principal instream physical habitat variables that determine suitability for juvenile salmonids are water depth, water velocity, streambed substratum and cover (Heggenes 1990). The habitat types and their descriptions are outlined in Table 9 and were recorded, where present, during the survey.

Table 9. Habitat classification system for salmonids

Habitat type	Description
Spawning Gravel	Ideally stable but not compacted, with a mean grain size 25 mm or less for trout, but up to 80 mm for salmon. ‘Fines’ (< 2 mm grain size) to be less than 20% by weight.
Fry (0+) habitat	Shallow, < 20 cm deep, fast flowing (> 30 cm/s), with surface turbulence and a gravel and cobble substrate
Parr (>1+) habitat	20 - 30 cm deep, fast flowing (>30 cm/s), surface turbulent, with gravel / cobble / boulder substrate.
Riffles	Shallow (< 30 cm deep), fast-flowing (> 50 cm/s), surface turbulent, gravel / cobble / boulder substrate.
Glides	= or > 30 cm deep, moderate velocity in range 10-30 cm/sec, surface smooth and unbroken, relatively even substrate of cobbles with finer material
Pools	= or > 40 cm deep, slow flowing (< 10 cm/s), surface unbroken, substrate with a high proportion of sand and silt.
Run	= or > 40 cm deep, moderate flow (>10 – 100 cm/s), broken surface. Often the interface between pool, glide and other habitats
Mixed Juvenile	10 - 30 cm deep, fast flowing (>30 cm/s), surface turbulent, with gravel /cobble / boulder substrate.

In addition to the habitats listed in Table 9, other features within the study site are noted including:

- The existence of physical barriers to fish migration which are graded 1-3 (G1 being impassable at Q90 flow conditions and G3 passable under Q90 flow conditions)
- Areas of excessive erosion which could cause siltation of spawning habitat- e.g., areas where cattle enter the river
- Anthropogenic alterations to the channel which could affect fish migration
- Areas which could cause difficulties for migrating or spawning individuals during periods of low water levels (e.g., shallow areas near weirs, spawning gravels etc.).
- Locations where branches cross the entire channel giving rise to tunnel vegetation.

2. Lamprey habitat assessment

The guidance published in JNCC (2015) was applied to lamprey habitat assessments. Our approach followed Natura 2000 guidance for the monitoring of river, brook and sea lamprey (*Lampetra fluviatilis, Lampetra planeri* and *Petromyzon marinus*; Harvey and Cowx 2003) and included assessment of habitats using visual mapping of substrates suitable for adult and Juvenile lamprey (Maitland 2003). The habitats suitable for lamprey spawning and larval lamprey (ammocoetes) are outlined in Table 10 and were recorded, where present, during the survey.

Table 10. Definitions of ecologically functional habitat types for lamprey
(based on Maitland 2003; Harvey & Cowx 2003)

Species / Life stage	Habitat Description
Lampetra spp. spawning	Areas of small stones and gravel in shallow flowing water
Petromyzon marinus spawning	Flowing water amid larger gravel/cobble
Lampetra spp. ammocoetes	Stable fine sediment or sand > 15 cm deep, low water velocity and the presence of organic detritus
Petromyson marinus ammocoetes	Non-marginal (open channel) sites of >1.5 m depth featuring fine sand and silt accumulations; lower velocity areas of pools and glide habitat