Garrane Green Energy Project-Baseline Aquatic Ecology Report

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BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
QI	Qualifying Interest
NBDC	National Biodiversity Data Centre
NPWS	National Parks and Wildlife Service
SAC	Special Area of Conservation
SPA	Special Protection Area
YSI	Yellow Springs Instruments

1. Introduction

AQUAFACT (Apem Group) was contracted by Garrane Green Energy Limited to carry out an aquatic ecology survey for the proposed Garrane Green Energy Project ("the Project"). The proposed Project includes, 9 No. wind turbines, a permanent meteorological mast, an on-site 110 kilovolt (kV) substation with a 'loop in' grid connection to the existing 110kV overhead line to the south of the site. The Project is located 2.5 kilometres (km) north of Charleville, Co. Cork. The surveys were undertaken to establish baseline aquatic ecology data for the proposed project's Environmental Impact Assessment Report (EIAR).

The proposed Project is not within or bordering any Natura 2000 sites. The closest Natura 2000 sites are the Blackwater River (Cork/Waterford) SAC (site code: 00216) and the Ballyhoura Mountains SAC (site code: 004007) which are approximately 6.5km south and 9km south-east of the proposed Project respectively at the closest point, and both within the Blackwater Catchment (WFD Catchment 18) and not hydrologically connected to the Garrane watercourses. Macroinvertebrate and water chemistry surveys were undertaken in 2022 and again in 2024 due to intervening changes in the proposed wind farm layout necessitating a second round of surveys. There were four macroinvertebrate survey sampling events (17th of August 2022, 10th of November 2022, 26th of April 2024, 23rd-24th of July 2024) and four water chemistry sampling events (17th of August 2022, 10th of November 2022, 26th of April 2024, 6th of August 2024). A note was taken if any otter (*Lutra lutra*) signs were found during the kick sampling and water quality surveys. This included sighting of otter, and signs such as spraint, prints, holts, couches, and slides. While no otter, or sign of otter, were recorded during the surveys, the presence of otter in the area cannot be ruled out due to the presence of otter in the wider catchment, and the availability of suitable foraging in the form of fish within the watercourses.

Additionally, white-clawed crayfish (*Austropotamobius pallipes*) surveys took place on the 23rd of July 2024. An electro-fishing survey was undertaken on the 24th, 25th and 26th of July and 14th of August 2023 by Triturus Environmental Ltd.

2. Statement of Authority

This report was prepared by Daniel Dunleavy (MRes.) and Mícheál McHugh Jewell (BSc.). Daniel Dunleavy is a Graduate Marine Ecologist and Freshwater Ecologist at AQUAFACT. He has a Master of Research from Imperial College London as well as Bachelor's in Zoology from Trinity College Dublin. He is experienced in freshwater ecological surveying, having worked in the UK and Ireland on various field projects. His research project involved detail identification of terrestrial invertebrates, and he has extensive experience writing and editing scientific reports. Mícheál McHugh Jewell is a Graduate Marine & Freshwater Ecologist at AQUAFACT. He has a BSc (First class Hons.) in Applied Freshwater and Marine Biology from Atlantic Technological University in Galway. He has experience with a wide variety of field survey techniques in marine and freshwater environments and has conducted a thesis research project on benthic macroinvertebrate community composition in Irish turloughs.

Benthic macroinvertebrate and water chemistry surveys were carried out by Daniel Dunleavy and Mícheál McHugh Jewell. White-Clawed Crayfish surveys were carried out by Adon MacFarlane. Adon is a Senior Freshwater Ecologist at APEM Ireland. He holds a PhD, which focused on White-Clawed Crayfish and co-authored a paper detailing their breeding habits (Gammell *et al.*, 2018). He is widely experienced in freshwater fieldwork surveys and holds licences to conduct surveys on white-clawed crayfish and freshwater pearl mussel (*Margaritafera margaritafera*), both protected species.

Triturus Environmental Limited was subcontracted to perform the electrofishing survey. Ross Macklin of Triturus Environmental Ltd. carried out the electrofishing survey. Ross has a range of experience in the aquatic ecology sector and is a leading electrofishing surveyor within Ireland. The company has previously conducted fisheries surveys for a variety of clientele and are proficient in a range of aquatic ecology survey techniques.

3. Methodology

3.1 Desk study

Prior to any field surveys, a desk study was carried out by AQUAFACT to provide context and background information on the watercourses of the proposed Project and its surrounding habitats. Online sources such as the Environmental Protection Agency (EPA), National Parks and Wildlife Service (NPWS), and National Biodiversity Data Centre (NBDC) were employed for the purpose of the desk study. Historical Q-values were obtained from the EPA. A search was carried out for records of aquatic species in the area such as white-clawed crayfish (*Austropotamobius pallipes*), river lamprey (*Lampetra fluviatis*), Atlantic salmon (*Salmo salar*), and freshwater pearl mussel (*Margaritafera margaritafera*) from the National Biodiversity Data Centre. The proposed Project's proximity to Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) was investigated using data from the NPWS.

3.2 Field study

3.2.1 Walkover Survey

A walkover survey was carried out at all 2024 survey station locations. The aim of the walkover survey was to identify the general habitats in the vicinity of the surveyed watercourses, along with any sensitive or invasive species that may be present. Images were taken upstream and downstream of the river and any notable species were recorded, as well as general watercourse hydromorphology and aquatic vegetation. The suitability of the habitats for protected species such as white-clawed crayfish (*Austropotamobius pallipes*), river lamprey (*Lampetra fluviatis*), freshwater pearl mussel (*Margaritafera margaritafera*) and salmonids was considered. **Figure 3.1** shows the survey locations visited as part of this assessment.

3.2.2 Biological River Classification System (Q-Scheme)

3.2.2.1 Kick Sampling

Sites were sampled using a standard two-minute kick sampling method followed by a minute of stone washing where suitable. This involved placing a standard hand net of pore size 500µm in the river, facing upstream and disturbing the riverbed in front of the net mouth. The surveyor then moved in a diagonal direction upstream to ensure that different micro-habitats were included in the sample. The kick method dislodges macroinvertebrates from the substrates and submerged plant material. This was continued for approximately two minutes and followed by one minute of stone washing. The resulting sample was transferred from the net to a plastic bucket and fixed using a 70% ethanol solution.

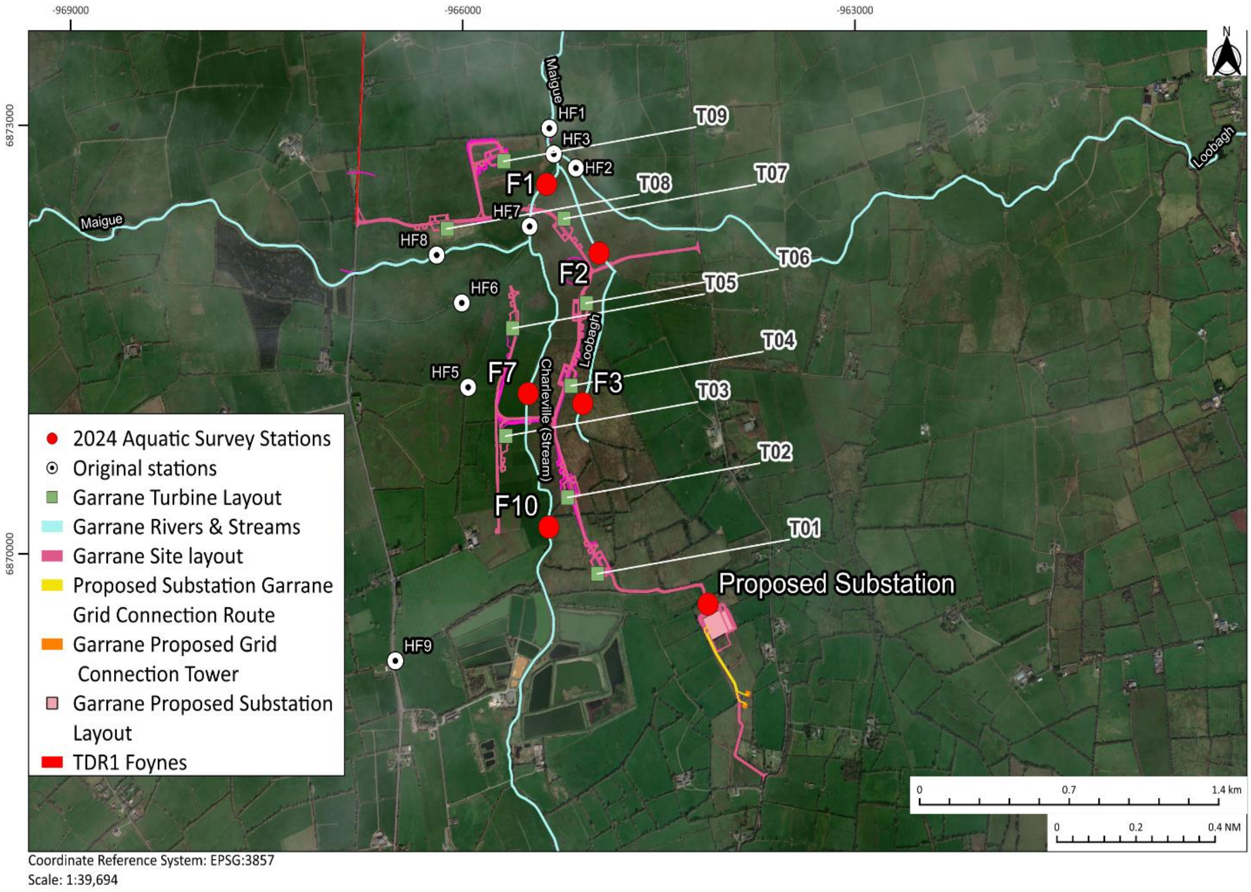

Figure 3.1: Map of the Q sampled sites in 2024 alongside previously sampled sites in 2022.

Table 3.1: 2024 survey location coordinates

Station	Watercourse Name	Latitude	Longitude
F1	River Maigue	52.3989536	-8.6719647
F2	Loobagh River	52.3963252	-8.6683488
F3	Loobagh River	52.3905423	-8.6694811
F7	Charleville Stream	52.3909318	-8.6732232
F10	Charleville Stream	52.3858099	-8.6718022
Proposed Substation	-	52.3828462	-8.6608565

The survey sites in 2024 differed from those in 2022 due to changes in the turbine layout of the proposed wind farm in the intervening period. In August 2022 and November 2022, eight stations were selected for sampling and in April 2024 and July 2024, six stations were selected (**Table 3.1**).

Kick sampling was not possible at all locations primarily due to high water levels, and also due to a lack of safe accessibility for the surveyors into the watercourse. Where kick sampling was not possible due to these reasons, a one-minute sweep net approach was employed to give a qualitative assessment of the river's fauna. This involved sweeping the vegetation on the banks of the river with the net. The two-minute kick and one minute stone wash sampling method was employed to collect samples of macroinvertebrates for analysis. Strict biosecurity measures in the form of Virkon spray and washing of equipment were undertaken to avoid cross-contamination between stations, particularly with respect to the crayfish plague which has a recorded presence in the area.

The samples were then transported to the AQUAFACT laboratories where the macroinvertebrates were removed and identified using stereoscopic microscopes and the appropriate keys by a qualified freshwater taxonomist. The resulting species list was then used to assign a Biotic Index value (Q-Value) to the sampled streams.

3.2.2.2 The Q-Scheme Index

The Biological River Quality Classification System (Q-Scheme) has been in use in Ireland since 1971. It has undergone modifications since then and has been included in the Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998. It is routinely employed by the EPA. For this assessment, benthic invertebrates have been divided into five indicator groups according to tolerance of pollution. This method remains fully compliant with the most up-to-date EPA guidance (EPA, 2022b), which aligns Q-value assessments with the EU Water Framework Directive (WFD) through the use of Ecological Quality Ratios (EQRs). Each Q-value is now mapped to a WFD ecological status category to ensure compatibility with European-wide assessment standards.

To determine the biological quality of the river, the Q-scheme index is used whereby the analyst assigns a Biotic Index value (Q-Value) based on macroinvertebrate results. The Biotic Index is a quality measurement for freshwater bodies that range from Q1 – Q5 with Q1 being of poorest quality and Q5 being pristine/unpolluted (**Table 3.2**).

Table 3.2: Biotic Index scoring system for the Q-scheme (Toner *et al*., 2005)

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4,	Slightly Polluted	Class B
Q3, 2-3	Moderately Polluted	Class C
Q2, 1-2, 1	Seriously Polluted	Class D

3.2.2.3 Water Sampling

Water sampling was carried out at all survey locations in 2022 and 2024. Physicochemical data including temperature, dissolved oxygen, pH and turbidity were recorded using a Yellow Springs Instruments (YSI) EXO2 probe. Water samples were also taken and tested for BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), suspended solids, Total Nitrogen, Nitrate, Nitrite, Phosphate, and TPH (Total Petroleum Hydrocarbons). Two bottles were used for collection. A plastic water sampling bottle was washed out and then slowly filled with water while facing downstream, taking care to minimise air bubbles forming in the sampling bottle. The process was repeated using a glass sampling bottle for testing TPH in the water. Samples were delivered to Complete Laboratory Solution (CLS) in Galway within 24hrs of sampling. In-situ probe readings were not taken at F3 during the April 2024 and August 2024 sampling period due to a low water level.

3.2.3 White-Clawed Crayfish Survey

Prior to carrying out field surveys of white-clawed crayfish (*Austropotamobius pallipes*), a check for previous records in the catchment was carried out using data from the NBDC and NPWS. Licences for white-clawed crayfish surveys were secured from NPWS prior to commencement of the survey (Licence No. C164/2024).

Surveys were carried out at five sites F1, F2, F4, F8 and F10 (Figure 3.2) on the 22nd and 23rd of July 2024 according to the standard methodology used by Peay (2003), Reynolds *et al*. (2010), and Gammell *et al*. (2021). Hand-searching of 50 potential refuges within five patches was carried out in this chosen 100m stretch at the site. Potential refuges were defined as any suitable substrate (*e.g.*, gravel, cobble, woody debris) that would be resistant to high flows and capable of providing cover for white-clawed crayfish.

Sites F1, F2, F4 and F8 were unsuitable for hand-searching due to the deep silt and muddy substrate, so a string of four trappy funnel baited crayfish traps were laid out on the 22nd of July 2024 and left overnight within an area of suitable habitat (**Figure 3.2**). Traps were left overnight and checked early the following morning on the 23rd of July 2024 (**Figure 3.3**). Deploying four traps has proven sufficient for determining crayfish presence or absence at sites where hand-searching is not feasible, based on consistent results from previous surveys. While IWM 131 recommends ten traps for estimating abundance (CPUE), this higher effort is not necessary for presence/absence surveys.

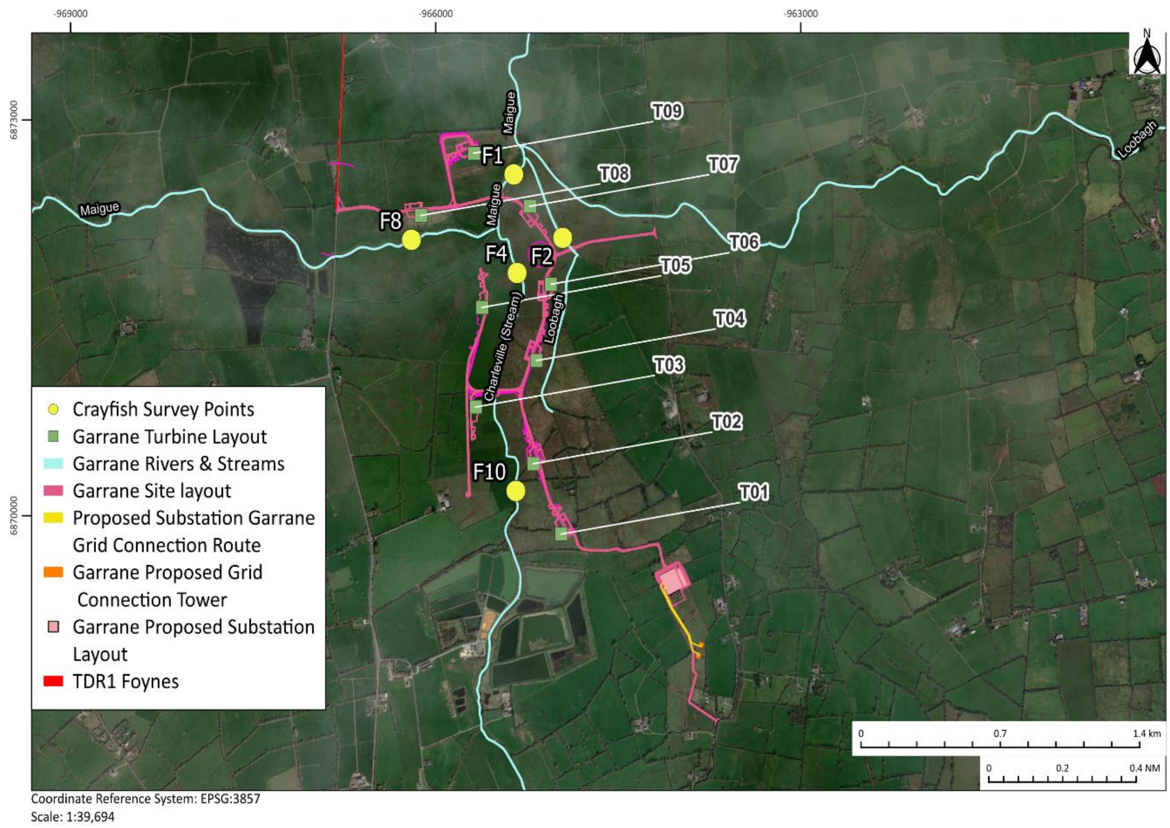

Figure 3.2: Map of Crayfish survey points at Garrane.

Figure 3.3: Crayfish traps submerged and tethered at F1 – River Maigue.

4. Results

4.1 Desk Study

The streams at the proposed Project are found within the CHARLEVILLE STREAM_020 river sub-basin, which makes up part of the Maigue_SC_010 subcatchment (Subcatchment ID: 24_6) within the Shannon Estuary South catchment (Catchment ID: 24). The River Maigue and its tributaries are known to support European eel (*Anguilla anguilla*), brown trout (*Salmo trutta*), and Atlantic salmon (*Salmo salar)*. The invasive dace (*Leucisus leuciscus*) has also been recorded. There are historical records of the annex II and V protected species white-clawed crayfish (*Austropotamobius pallipes)* within the Maigue.

The proposed Project is approximately 6.5km from the Blackwater River SAC site. The Blackwater River contains priority annex habitat such as perennial vegetation of stoney banks and water courses of plain to montane levels with *Ranunculion fluitantis* and Callitricho-Batrachion vegetation [3260] which is a priority annexed habitat. White-clawed crayfish (*Austropotamobius pallipes*), otter (*Lutra lutra*), and Atlantic salmon (*Salmo salar*) are all Qualifying Interests (QIs) of these SACs. The nearest SPA is the Kilcolman Bog, approximately 14km south of the proposed Project and provides suitable habitat for wetland and waterbirds including whooper swan (*Cygnus cygnus*), teal (*Anas creca*), and shoveler duck (*Anas clypeata*).

The latest available Q value data for the River Maigue in this area was recorded in 2023 by the Environmental Protection Agency (EPA) and showed Q-scores of Q3-4 (“Slightly Polluted”) and Q3 (“Moderately Polluted”) in the vicinity of the site though data for the Loobagh River was not found (EPA, 2023). The other most recent Q-values are displayed in **Table 4.1**.

Table 4.1: Historical Q-value data from stations on the proposed wind farm site

River Name	Station Name	Q-Value	Year
CHARLEVILLE STREAM_020	Just u/s Maigue R. confluence	Q3-4 “Slightly Polluted”	2023
CHARLEVILLE STREAM_020	~200m d/s Charleville confluence	Q3 “Moderately Polluted”	2014
CHARLEVILLE STREAM_020	MAIGUE – Creggane Br (M43)	Q3-4 “Slightly Polluted”	2002

4.2 Walkover Survey

The area surrounding the sample stations is a mosaic of (GA1) Improved Agricultural Grassland and (GS4) Wet Grassland, with a silt/clay soil type and some scattered (WN5) Riparian woodland and (WS1) Scrub (Fossitt, 2000). All rivers had heavily overgrown bankside (WS1) Scrub during all sampling events. The riverbeds had muddy substrates or a mixture of muddy and stoney substrates at all stations. The presence of instream vegetation was a sign of eutrophication in the area.

All stations are classified as (FW2) Depositing/lowland rivers under the Fossitt (2000) classification system. FW2 includes all watercourses where fine sediments are deposited on the riverbed. The streams were characterised by slow flowing water, low discharge, and heavily vegetated banks. In their natural state FW2 rivers erode their banks and meander across floodplains and because of this most are modified by being canalised, dredged, and deepened with artificial earth banks. This is the case in the Garrane stations, and access to every station was via a steep 45° sloping bank. Due to the surrounding land use, stream order, cattle access, and abundance of macrophytes present, it is likely that all stations are experiencing some degree of eutrophication because of nutrient input from agricultural pollution. Notably, the streams present within the site are maintained by the Office of Public Works (OPW).

4.2.1 F1 – River Maigue

Station F1 was located on the River Maigue (**Plate 4.1**). The morphology of the Lowland/Depositing River (FW2) was modified with steep 200cm tall banks cut at a 45° angle and a straightened channelised stream. The bank width was approximately 700cm while the river was 300cm wide. The 100cm deep water consisted entirely of slow-flowing glide with a heavily silted muddy bottom. The station had abundant common clubrush (*Schoenoplectus lacustris*) in the stream and banks overgrown with dense Scrub (WS1) mostly taking the form of nettle (*Urtica dioica*), bramble (*Rubus fructicosus* agg.), hedge bindweed (*Calystegia sepium*) and great willowherb (*Epilobium hirsutum*) with some scattered poplar (*Populus* spp.) Treelines (WL2) in adjacent fields. The surrounding fields were noted as a mosaic of Improved Agricultural Grassland (GA1) and Wet Grassland (GS4).

Plate 4.1: Representative photo of station F1 on the River Maigue showing abundant vegetation

4.2.2 F2 – Loobagh River

Station F2 on the Loobagh River (**Plate 4.2**) was a very narrow Lowland/Depositing River (FW2) with poor connectivity to the River Maigue surrounded by a mosaic of Improved Agricultural Grassland (GA1) and Wet Grassland (GS4). The channel had been used as a water access point for cattle and was heavily poached as a result with very poor hydromorphology and imperceptible flow in places. The banks were approximately 50cm high and 350cm wide, while the channel was 150cm at its widest point and at most 20cm deep with highly turbid muddy water. Where the flow was slowest, pools filled with duckweed (*Lemna minor*) formed. The sampling station was located four metres upstream of a stone cattle bridge, classified under (BL1) Stone Walls and other Stonework, with more dense Riparian Woodland (WN5) consisting of willow (*Salix* spp.) and hawthorn (*Crataegus monogyna*). The channel was surrounded by common club-rush (*Schoenoplectus lacustris*) with yellow iris (*Iris* *pseudacorus*), nettle (*Urtica dioica*), and bramble (*Rubus fructicosus* agg.). The surrounding pasture was a mosaic of Improved Agricultural Grassland (GA1) and Wet Grassland (GS4).

Plate 4.2: Representative photo of station F2 on the Loobagh River

4.2.3 F3 – Loobagh River

Station F3 (**Plate 4.3**) was located approximately 630m upstream of station F2, close to the uppermost reaches of the Loobagh River. It consisted of a small Depositing Lowland channel (FW2), which had been straightened and deepened, resulting in poor hydromorphology and an almost stagnant flow, with water collecting in a few deep pools produced by cattle poaching. The banks were steeply cut and approximately 150cm high and 500cm wide, and the channel itself approximately 150cm wide and 40cm deep, though broken up into small discontinuous pools. The water was turbid and heavily silted with very deep fine mud at the bottom. The banks were overgrown with Scrub (WS1), with common club-rush (*Schoenoplectus lacustris*), yellow iris (*Iris pseudacorus*), nettle (*Urtica dioica*) and bramble (*Rubus fructicosus* agg.). There was a stone cattle bridge upstream of the station, classified under Stone walls and other Stonework (BL1), and a linear Hedgerow (WL1) consisting of willow

(*Salix* spp.) and hawthorn (*Crataegus monogyna*). Surrounding fields consisted of Wet Grassland (GS4) and Improved Agricultural Grassland (GA1).

Plate 4.3: Representative photo of station F3 on the Loobagh River

4.2.4 F7 – Charleville Stream

Station F7 (**Plate 4.4**) was located on the Charleville stream approximately 600m downstream of station F10. This Lowland/Depositing River (FW2) was bordered by steep 200cm tall, modified banks cut at a 45° angle. The bank width was approximately 400cm, while the river was 200cm wide and at most 35cm deep. There were a few riffle sites areas over cobbles, though most of the river was slow-flowing glide. Although there was a cattle access path from the adjacent pasture, the banks were not heavily poached. The trapezoidal banks were covered by dense Scrub (WS1) consisting of nettle (*Urtica dioica*), bramble (*Rubus fructicosus* agg.), hedge bindweed (*Calystegia sepium*) and great willowherb (*Epilobium hirsutum*). The surrounding fields consisted of Wet Grassland (GS4), and Improved Agricultural Grassland (GA1), and this river lacked any shading or in-stream vegetation.

Plate 4.4: Representative photo of station F7 on the Charleville Stream

4.2.5 F10 – Charleville Stream

Station F10 (**Plate 4.5**) was located on the Charleville stream approximately 600m upstream of station F7. This Lowland/Depositing river (FW2) was bordered by steep 200cm tall, modified banks cut at a 45° angle. The bank width was approximately 400cm while the river was 200cm wide and at most 35cm deep. The substrate consisted of mud over cobble and gravel as well as dead wood and leaves. The flow was relatively fast in comparison to the other stations with developing riffle and glide areas and undercut banks with shading tree roots. The river was heavily shaded by dense Riparian Woodland (WN5) consisting of willow (*Salix* spp.), and the overgrown banks covered in nettle (*Urtica dioica*), ivy (*Hedera helix*), and bramble (*Rubus fructicosus* agg.). The river was surrounded by a mosaic of Improved Agricultural Grassland (GA1), and Wet Grassland (GS4)) dominated by rushes (*Juncus* spp.), sedges (*Carex* spp.), water mint (*Mentha aquatica*), and marsh thistle (*Cirsium palustre*) with occasional yellow iris (*Iris pseudacorus*).

Plate 4.5: Representative photo of station F10 on the Charleville Stream, with crayfish traps in-situ

4.2.6 Sample site adjacent to the Proposed Substation Location

The proposed Substation Location (**Plate 4.6**) was located east of F10 at the border of an agricultural field. A sample was taken from a narrow Drainage Ditch (FW4) within a small patch of Riparian Woodland (WN5) near the proposed substation location. The steep modified banks were trapezoidal in shape with irregular edges and approximately 200cm high and 400cm wide. The channel itself was 150cm wide at most and 35cm deep. The substrate was mud over stone with a high density of fallen leaves and decomposing vegetation and a sluggish flow. The river was heavily shaded by dense Riparian Woodland (WN5) consisting of willow (*Salix* spp.), and the overgrown banks covered in nettle (*Urtica dioica*), ivy (*Hedera helix*), and bramble (*Rubus fructicosus* agg.). The surrounding land consisted of a mosaic of Wet Grassland (GS4) and Improved Agricultural Grassland (GA1) dominated by rye grasses (*Lolium* spp.).

Plate 4.6: Representative photo of Proposed Substation Location

4.3 Biological River Classification System

4.3.1 2022 Results

In November 2022, HF1 and HF8 could not be sampled due to flooding conditions at the rivers. Q-values for the stations are provided in **Table 4.2**. All stations except for HF7 in August obtained a Q-value of 3 which is classified as "Moderately Polluted" under the scheme, while HF7's score of Q2 is considered "Seriously Polluted" (**Table 3.1**). All species found are listed in Appendix 1.

Table 4.2: Biological sampling results for the 2022 period

Location	Q-value August 2022	Q-value November 2022
HF1	Q3	No data
HF2	Q3	Q3
HF3	Q3	Q3
HF5	Q3	Q3
HF7	Q2	Q3
HF8	Q3	No data
HF9	Q3	Q3
HF10	Q3	Q3

4.3.2 2024 Results

Sweep nets were carried out for the F1 station in April 2024 and for the F3 station in July 2024. As the Q-value system is intended to be used only on samples obtained by the kick method, Q scores cannot be assigned to samples obtained by sweep net. Site F3 could not be sampled in July 2024 as the conditions were too dry for kick sampling. Kick sampling requires shallow running water, if running water is not present it is not possible to carry out a kick sampling survey. These stations are therefore excluded from the survey, however this did not significantly alter the survey results as stations downstream were sampled. Q-values for the 2024 sampling events are provided in **Table 4.3**. All stations received a Q-value of Q3 save for F3 which received Q2-3 ("Moderately Polluted") in April, and F2 which received Q2-3 in April and Q2 ("Seriously Polluted") in July. All species found are listed in Appendix 1.

Table 4.3: Biological sampling results for the 2024 period

Location	Q-value April 2024	Q-value July 2024
F1	Q3	No data
F2	Q2-3	Q2
F3	Q2-3	No data
F7	Q3	Q3
F10	Q3	Q3
Proposed Substation Location	Q3	Q3

4.4 Water Sampling

4.4.1 2022 Results

Regulation parameters for surface waters and salmonid waters are provided in **Table 4.4**. Table 4.5 shows the water chemistry results for the August 2022 sampling event. Dissolved Oxygen was highest at HF10 (84.2%; 8.19 mg/l) and lowest at HF5 (39.8%; 4 mg/l). The BOD was highest at HF3 (2 mg/l), while HF5, HF8, and HF9 had BOD <1. Suspended solids were highest at HF6 (11 mg/l) and lowest at HF8 and HF9 (2 mg/l). Nitrate as N was highest at HF10 (3.9 mg/l) and lowest at HF6 (0.2 mg/l). Nitrite as NO_2 was highest at HF10 (0.159 mg/l) and lowest at HF2 (0.019 mg/l). Phosphate as P filtered was highest at HF8 (0.173 mg/l) and lowest at HF5 (0.06 mg/l).

Table 4.4: Regulation parameters for surface waters and salmonid waters

Test	Unit	Surface water regulations 2009		Salmonid waters
Biological Oxygen Demand (BOD)	mg/l	High </= 2.2	Good </= 2.6	</= 5
Suspended solids	mg/l			</= 25
Nitrate as N	mg/l	High </= 0.09	Good 0.14	
Nitrite as NO_2	mg/l			</= 0.05
Phosphate as P filtered (low level SW or saline)	mg/l	High </= 0.045	Good </= 0.075	

Table 4.5: Water chemistry results for August 2022 sampling event

Test	Units	HF1	HF2	HF3	HF5	HF6	HF7	HF8	HF9	HF10
Dissolved Oxygen	%	74.5	82.9	77.9	39.8	43.1	79.7	69.9	75.5	84.2
Dissolved Oxygen	mg/l	7.59	8.38	7.88	4	4.46	8.09	7.15	7.45	8.19
Temperature	˚C	15.07	15.42	15.39	15.75	14.36	15.26	14.89	16.54	17.25
pH		7.49	7.75	8.08	7.83	7.86	8.22	8.03	7.88	8.07
Turbidity	NTU	6.5	4.1	6.3	7.8	10.4	6.9	6.5	4.6	5.7
BOD	mg/l	1	1	2	<1	1	1	<1	<1	1
Suspended Solids	mg/l	10	6	7	5	11	5	2	2	3
COD	mg/l	33	17	36	26	21	34	36	19	16
Total Nitrogen 3-day TAT	mg/l	2.16	1.23	2.36	1.59	0.665	2.3	1.84	2.07	4.75
Nitrate as NO_3 (Ammonia)	mg/l	6.58	4.45	6.63	4.03	0.772	7.19	4.47	8.03	17.3
Nitrate as N	mg/l	1.5	1	1.5	0.9	0.2	1.6	1	1.8	3.9
Nitrite as NO_2	mg/l	0.041	0.019	0.042	0.09	0.096	0.039	0.032	0.06	0.159
TPH (>C5 - C44) by GC-FID	µg/l	40	47	31	38	89	58	72	87	95
Phosphate as P filtered (low level SW or saline)	mg/l	0.165	0.087	0.164	0.06	0.07	0.167	0.173	0.09	0.168

Table 4.6 shows the water chemistry results for the November 2022 sampling event. Dissolved Oxygen and the other parameters measured by the in-stream probe were not recorded. The BOD was <1 for all sampling stations. Suspended solids were highest at HF3 (8 mg/l) and lowest at HF5 (<2 mg/l). Nitrate as N was highest at HF9 and HF10 (2.53 mg/l) and lowest at HF7 (<0.099 mg/l). Nitrite as NO_2 was highest at HF10 (0.371 mg/l) and lowest at HF7 (<0.017 mg/l). Phosphate as P filtered was highest at HF8 (0.145 mg/l) and lowest at HF7 (0.46 mg/l).

Table 4.6: Water chemistry results for November 2022 sampling event

Test	Units	HF1	HF2	HF3	HF5	HF6	HF7	HF8	HF9	HF10
BOD	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	<1
Suspended Solids	mg/l	7	6	8	<2	2	3	7	7	4
COD	mg/l	24	18	27	34	36	31	32	14	21
Total Nitrogen 3-day TAT	mg/l	1.79	1.67	2.05	2.06	1.64	0.712	1.83	2.8	3
Nitrate as NO_3 (Ammonia)	mg/l	6.25	6.8	5.75	4.67	3.7	<0.44	4.62	11.2	11.2
Nitrate as N	mg/l	1.412	1.54	1.30	1.05	0.84	<0.099	1.04	2.53	2.53
Nitrite as NO_2	mg/l	0.068	0.025	0.075	0.068	0.081	<0.017	0.042	0.044	0.371
TPH (>C5 - C44) by GC-FID	µg/l	<20	<20	<20	<20	<20	<20	<20	<20	<20
Phosphate as P Filtered (low level SW or saline)	mg/l	0.096	0.069	0.137	0.118	0.089	0.046	0.145	0.081	0.107

4.4.2 2024 Results

Table 4.7 shows the water chemistry results for the April 2024 sampling event. YSI probe data was not available for F3 due to low water levels and turbidity was not recorded for all stations save for the Proposed Substation Location. Dissolved Oxygen was highest at the Proposed Substation location (94.1%; 9.12 mg/l) and lowest at F2 (65.8%; 6.79 mg/l). The BOD was highest at F1, F7, and F10 (2 mg/l), while F2, F3, and the Proposed Substation Location had BOD of 1 mg/l. Suspended solids were highest at F7 (12 mg/l) and lowest at F3 and the Proposed Substation Location (<2 mg/l). Nitrite as NO_2 was highest at F7 (0.27 mg/l) and lowest at F3 (0.02 mg/l). Phosphate as P filtered was highest at F7 (0.27 mg/l) and lowest at F3 (0.02 mg/l).

Table 4.7: Water chemistry results for April 2024 sampling event

Test	Units	F1	F2	F3	F7	F10	Proposed Substation
Dissolved Oxygen	%	84.7	65.8	N/A	92.6	76.5	94.1
Dissolved Oxygen	mg/l	8.88	6.79	N/A	9.77	7.85	9.12
Temperature	˚C	13.172	13.853	N/A	14.44	14.091	13.779
pH		7.98	7.65	N/A	8.10	7.84	7.92
Turbidity	NTU	N/A	N/A	N/A	N/A	N/A	3.00
BOD	mg/l	2	1	1	2	2	1
Suspended Solids	mg/l	5	4	<2	12	9	<2
COD	mg/l	19	19	23	19	23	20
Total Nitrogen as N	mg/l	2.82	0.828	<0.5	6.93	7.07	1.18
Nitrate as NO_3 (Ammonia)	mg/l	8.82	1.04	<0.44	21.7	16.5	1.08
Nitrite as NO_2	mg/l	0.08	0.06	0.02	0.27	0.12	0.06
TPH (>C5 - C44) by GC-FID	µg/l	99	46	102	96	90	60
Phosphate as P filtered (low level SW or saline)	mg/l	0.09	0.06	0.02	0.27	0.12	0.06

Table 4.8 shows the water chemistry results for the August 2024 sampling event. Station F3 could not be sampled due to low water levels. Dissolved Oxygen was highest at the Proposed Substation location (100.9%; 10.21 mg/l) and lowest at F2 (23.78%; 2.3 mg/l). The BOD was highest at F2 (26 mg/l), while F1 and the Proposed Substation location had the lowest BOD of <1 mg/l. Suspended solids were highest at F2 (441 mg/l) and lowest at F1 and the Proposed Substation location (<2 mg/l).

Nitrite as NO_2 was highest at F10 (0.195 mg/l) and lowest at F1 and the Proposed Substation location (<0.017 mg/l). Phosphate as P filtered was highest at F2 (0.173 mg/l) and lowest at the Proposed Substation location (0.044 mg/l).

Table 4.8: Water chemistry results for August 2024 sampling event

Test	Units	F1	F2	F3	F7	F10	Proposed Substation
Dissolved Oxygen	%	89.53	23.78	N/A	96.76	91.11	100.9
Dissolved Oxygen	mg/l	8.95	2.3	N/A	9.58	8.96	10.21
Temperature	˚C	15.33	16.83	N/A	15.84	16.07	14.86
pH		8.03	7.43	N/A	8.06	7.94	7.99
Turbidity	NTU	1.71	269.01	N/A	5.68	4.35	1.24
BOD	mg/l	<1	26	N/A	1	2	<1
Suspended Solids	mg/l	<2	441	N/A	2	7	<2
COD	mg/l	<10	180	N/A	14	<10	<10
Total Nitrogen 3-day TAT	mg/l	2.07	1.73	N/A	7.6	7.51	<0.33
Nitrate as NO_3 (Ammonia)	mg/l	8.13	<0.44	N/A	34.6	33.4	1.08
Nitrite as NO_2	mg/l	0.039	<0.017	N/A	0.169	0.195	<0.017
TPH (>C5 - C44) by GC-FID	µg/l	42	483	N/A	24	69	28
Phosphate as P filtered (low level SW or saline)	mg/l	0.046	0.173	N/A	0.103	0.112	0.044

4.5 White-Clawed Crayfish Survey

No white-clawed crayfish were found during surveys and the traps laid overnight were empty when retrieved. Of the 5 sites surveyed, only site F10 had extensive areas of suitable habitat in the form of large cobble, boulders, and woody debris as well as along river margins with tree roots being present within water channel and overhanging vegetation.

Notably Crayfish plague, caused by the water mould *Aphanomyces astaci*, is present in the Maigue subcatchment, with the most recent records from the National Crayfish Plague Surveillance Programme during 2020/2021 (NPWS, 2022) and updates from Fish Health Unit at the Marine Institute. The presence of Crayfish plague may have been responsible for the absence of white-clawed crayfish.

5. Discussion

The watercourses sampled were Lowland/Depositing Rivers (FW2) and Drainage ditches (FW4). The surrounding land was predominately Improved Agricultural Grassland (GA1) with Wet Grassland (GS4) and dense Scrub (WS1) around the stream banksides. Agricultural pollution and land alteration is likely to be the main contributing factor to the low levels of habitat diversity.

Sites on the same watercourse were most likely to experience similar pollutants, although at different degrees of severity.

In 2022, all sites were awarded a Q value of Q3 (moderately polluted), apart from HF7 in August 2022. A combination of high nitrate as Ammonia and Phosphate (See Table 4.5) from agricultural fertiliser addition and surface run off may have resulted in a poorer Q value score and lower incidence of species sensitive to pollution.

In 2024, abundances of pollution-tolerant taxa differed between sampling events, with overall much greater abundance during the July 2024 sampling period. Sites F2 and F3 had the lowest Q values, with scores of Q2-3 in April 2024. F2 dropped further in August 2024 to a Q2 score. At both F2 and F3 there was an evident, heavy impact of agriculture on the area. Both sites were saturated with organic matter from cattle herds with free access to the water courses. In agreement with this, Dissolved oxygen was lowest in F2 at 65.8% in April and in August was at 23.78%. A probe reading for Dissolved Oxygen concentration could not be detected at F3. All other sites in 2024 with values recorded had Dissolved Oxygen above 80%.

HF1 is located upstream to all the 2024 sample points on the main river Maigue and is hydrologically connected to F2 and F3. The Maigue is a larger river, still surrounded by farmland but not as apparently impacted by organic matter enrichment. The distinction between the Q values corresponds with the differing levels of cattle faecal matter present in the watercourses. F1, F7 and F10 were all on the same watercourse downstream from HF7. Q values were consistent across years apart from HF7.

Concerning the status of White Clawed Crayfish *Austropotamobius pallipes* in the study area, the presence of Crayfish plague (caused by the water mould *Aphanomyces astaci*) may have been responsible for their absence. The proposed Garrane wind farm was found to support fish species of high conservation value, namely Annex II Atlantic salmon and Red-listed European Eel. While the electrofishing report accompanying this application noted some high value salmonid habitats, on the River Maigue and its tributary the Charleville stream, it concluded that due to siltation pressures the spawning capacity of these watercourses had significantly reduced. Its results showed that salmonids were absent from all other watercourses surveyed reflecting siltation and eutrophication pressures in addition to poor hydromorphology. Despite suitability elsewhere, European eel was only recorded from the River Maigue. Here, deeper glide and pool areas with high macrophyte cover and broader prey resources provided superior eel habitat compared with other survey watercourses. In 2024 all sites were categorised as moderately to seriously polluted with no change at most of the sampling stations between April and July 2024 apart from F2 which declined from Q2-3 to Q2 (Table 4.1).

In 2022, all samples were categorised as moderately to seriously polluted with no change except for HF7 which improved from Q2 (seriously polluted) in August to Q3 (moderately polluted) in November (Table 4.2). HF3 had the lowest species richness in 2022 with a total of three species found in November 2022 (See Appendices for full species list and abundances).

6. Conclusion

All streams at the proposed Garrane Green Energy Project were moderately to seriously polluted in both the 2022 and 2024 macroinvertebrate sampling periods. While salmonids were found and notably a European Eel (*Anguilla anguilla*) was recorded at one site, the streams were deemed to be poor spawning sites. White Clawed Crayfish were not found at the site, possibly due to the presence of Crayfish Plague in the catchment.

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Appendix 1

Species List

HF1

Taxa	August 2022	November 2022
Odonata		
Calopteryx	2	
Ephemeroptera		
Serratella ignita	2	
Trichoptera		
Rhyacophila	present	
Mollusca		
Hydrobiidae	6	
Coleoptera		
Haliplidae	6	
Elmidae	2	
Annelida		
Pisicola	Present	

Species List

HF2

Taxa	August 2022	November 2022
Odonata		
Calopteryx		2
Ephemeroptera		
Baetis rhodani	2	
Ephemerellidae	7	
Caenidae		3
Diptera		
Chironomidae	6	13
Simuliidae		2
Crustacea		
Gammarus sp.	103	23
Asellus		3
Trichoptera		
Rhyacophila	1	
Hydropsyche	1	
Goeridae	1	
Mollusca		
Hydrobiidae	237	
Sphaeriidae	1	
Lymnaeidae		1
Coleoptera		
Haliplidae	13	
Elmidae		2
Annelida		
Glossiphoniidae		1

Species List

HF3

Taxa	August 2022	November 2022
Heteroptera		
Vellidae	1	
Diptera		
Chironomidae	8	33
Simuliidae	2	
Coleoptera		
Haliplidae	2	
Gyrinidae		2
Mollusca		
Bithynia	5	
Hydrobiidae	3	
Lymnaeidae	1	
Trichoptera		
Limnephilidae	2	
Crustacea		
Gammarus		2

Species list

HF5

Taxa	August 2022	November 2022
Diptera		
Chironomidae	44	83
Sciomyzidae	1	
Crustacea		
Gammarus sp.	3	2
Asellus	1	134
Trichoptera		
Phryganeidae	1	
Limnephilidae		1
Mollusca		
Physidae	9	8
Planorbidae	24	1
Lymnaeidae	8	
Sphaeriidae		2
Coleoptera		
Hydrophilidae	1	
Gyrinidae	4	
Helophorus		4
Dytiscidae		3
Annelida		
Glossiphoniidae	2	

Species list

HF6

Taxa	August 2022	November 2022
Diptera		
Chironomidae		7
Crustacea		
Asellus sp.		28
Trichoptera		
Limnephilidae		3
Mollusca		
Planorbidae		5
Lymnaeidae		5
Sphaeriidae		6
Coleoptera		
Dytiscidae		1
Annelida		
Lumbriculidae		17

Species list

HF7

Taxa	August 2022	November 2022
Diptera		
Chironomidae	14	5
Chironomus sp.	7	28
Odonata		
Calopteryx	2	
Trichoptera		
Limnephilidae		2
Mollusca		
Planorbidae	1	20
Hydrobiidae	10	
Lymnaeidae	1	4
Sphaeriidae	5	8
Physidae		2
Coleoptera		
Dytiscidae		2
Hygrobia		1
Annelida		
Glossiphoniidae	1	

Species list

HF8

Taxa	August 2022	November 2022
Diptera		
Chironomidae	7	
Crustacea		
Gammarus sp.	20	
Ephemeroptera		
Caenis sp.	1	
Mollusca		
Hydrobiidae	32	
Lymnaeidae	4	
Sphaeriidae	1	
Coleoptera		
Chrysomelidae	1	
Annelida		
Glossiphoniidae	2	

Species list

HF9

Taxa	August 2022	November 2022
Diptera		
Chironomidae	72	312
Crustacea		
Gammarus sp.	63	8
Asellus	12	10
Heteroptera		
Gerridae	1	
Notonectidae	1	
Trichoptera		
Sericostomatidae		1
Limnephilidae	1	3
Mollusca		
Planorbidae	9	
Hydrobiidae	34	
Sphaeriidae		12
Coleoptera		
Dytiscidae		3
Annelida		
Glossiphoniidae	4	9
Lumbriculidae		12
Naididae		5

Species List

F1

Taxa	April 2024	July 2024
Odonata		
Calopteryx sp.	2	
Ephemeroptera		
Baetis rhodani	2	
Caenis sp.	4	
Diptera		
Chironomidae		
Ceratopogonidae		
Heteroptera		
Corixidae	1	
Crustacea		
Gammarus sp.	24	
Asellus aquaticus	2	
Trichoptera		
Hydroptilidae	1	
Polycentropodidae	1	
Mollusca		
Bithynia sp.	33	
Potamopyrgus antipodarum	6	
Sphaeriidae	20	
Coleoptera		
Elmidae	6	
Oligochaeta		
Lumbricidae	6	

Species list

F2

Taxa	April 2024	July 2024
Ephemeroptera		
Baetis rhodani	1	
Diptera		
Chironomidae	46	
Chironomus		340
Heteroptera		
Gerridae	1	
Crustacea		
Gammarus sp.	38	18
Asellus aquaticus	15	
Crangonyx sp.		1
Trichoptera		
Limnephilidae	5	
Mollusca		
Bithynia sp.	5	
Lymnaea sp.	2	
Sphaeriidae	3	9
Physa fontinalis	1	
Valvata sp.	1	
Coleoptera		
Dytiscidae	3	
Helophorus sp.		6
Annelida		
Tubificinae	53	112
Glossiphoniidae	12	

Species list

F3

Taxa	April 2024	July 2024
Diptera		
Chironomidae	20	
Chironomus sp.	1	
Crustacea		
Gammarus sp	2	150
Asellus aquaticus	17	324
Crangonyx sp	8	452
Trichoptera		
Limnephilidae	19	2
Mollusca		
Bithynia sp	50	16
Planorbidae	1	
Physa fontinalis	4	2
Radix balthica	8	4
Aplexa hypnorum		1
Sphaeriidae	7	46
Coleoptera		
Gyrinidae	1	
Helophorus sp.		33
Agabus sp.		3
Ilybus sp.		2
Hydroporus sp.		2
Hydrophilidae		6
Chrysomelidae		4
Staphylinidae		1
Annelida		
Tubificinae	20	

Species list

F7

Taxa	April 2024	July 2024
Ephemeroptera		
Baetis rhodani	30	20
Caenis sp.	7	
Diptera		
Chironomidae	3	1
Simuliidae	2	
Heteroptera		
Pediciidae	14	
Crustacea		
Gammarus sp	440	264
Asellus aquaticus	1	
Crangonyx sp.		1
Trichoptera		
Limnephilidae	4	1
Polycentropodidae		1
Goeridae	1	
Hydropsychidae		1
Mollusca		
Potamopyrgus antipodarum	3	
Sphaeriidae	18	1
Coleoptera		
Elmidae	27	
Annelida		
Oligochaeta		2

Species list

F10 (2022 – 2024)

Taxa	August 2022	November 2022	Apr 2024	Jul 2024
Odonata				
Calopteryx sp.			**2**	
Ephemeroptera				
Serratella ignita			1	
Baetis rhodani		27		
Caenis sp.		1	2	
Diptera				
Chironomidae	2	39	31	125
Pediciidae		5	4	
Tipulidae				3
Simuliidae		1		
Heteroptera				
Corixidae			1	
Crustacea				
Gammarus sp.	170	207	856	1404
Asellus aquaticus		14	24	
Trichoptera				
Limnephilidae	3	4	11	2
Hydropsyche sp.			7	
Agapetus sp.		19	3	
Glossomatidae				1
Mollusca				
Planorbidae			1	3
Potamopyrgus antipodarum			31	277
Aplexa hypnorum				1
Valvatidae	4			
Hydrobiidae	5			
Sphaeriidae	7	31	16	13
Ancylus fluviatilis		1		
Coleoptera				
Elmidae	33	12	44	137
Haliplidae				1
Annelida				
Oligochaeta		12		3
Glossiphoniidae		1		1

Species list

Proposed Substation Location

Taxa	April 2024	July 2024
Ephemeroptera		
Baetis rhodani	1	
Diptera		
Chironomidae		176
Pediciidae	2	2
Limoniidae	1	
Crustacea		
Gammarus sp.	176	432
Asellus aquaticus	1	4
Trichoptera		
Limnephilus sp.	9	
Limnephilidae		1
Philopotamidae		1
Mollusca		
Potamopyrgus antipodarum	32	
Sphaeriidae	2	34
Coleoptera		
Elmidae	3	2
Gyrinidae	2	
Scirtidae		9
Coleoptera larva	1	
Annelida		
Glossiphoniidae	5	15
Naididae		9

Appendix 2

Site photos

HF1 looking upstream August 2022

HF2 looking downstream, August 2022

HF1 in flood, November 2022

HF2

HF2 looking upstream, August 2022

HF2 looking downstream, August 2022

HF2 in flood, November 2022

HF3

HF3 looking upstream, August 2022

HF3 looking downstream, August 2022

HF3 in flood looking downstream, November 2022

HF3 in flood, looking upstream November 2022

HF5

HF5 looking upstream, August 2022

HF5 looking downstream, August 2022

HF5, November 2022

HF5, November 2022

HF6

HF6 upstream, August 2022

HF6 downstream, August 2022

HF6 November 2022

HF7

HF7 upstream, August 2022

HF7 downstream, August 2022

HF7, November 2022

HF7, November 2022

HF8

HF8 representative image, August 2022

HF8 downstream, August 2022

HF8, November 2022

HF9

HF9 downstream, August 2022

HF9 upstream, August 2022

HF9, November 2022

HF10

HF10, upstream, August 2022

HF10, downstream, August 2022

F1

F1, April 2024

F1, April 2024

F1 emergent vegetation, August 2024

F2

F2 looking upstream, April 2024

F2 looking downstream, April 2024

F2 in-stream macrophytes, April 2024

F2 looking upstream, August 2024

F2 looking downstream showing abundance of duckweed (*Lemna minor*), August 2024

F3

F3, April 2024

F3, April 2024

F3 looking upstream with cattle bridge visible at top of image and stagnant water, July 2024

F3 looking downstream showing no/low water level, August 2024

F7

F7, April 2024

F7, April 2024

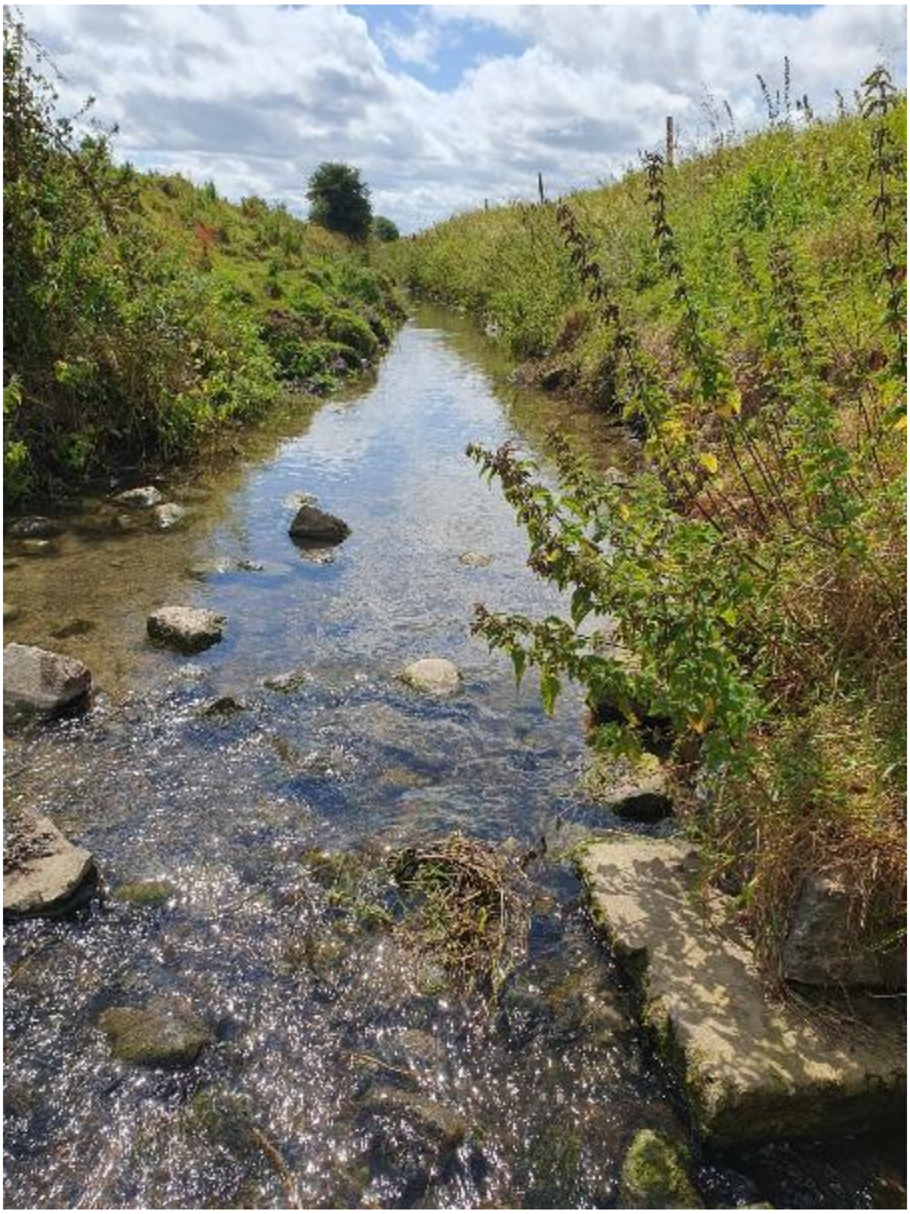
F7, April 2024

F7, April 2024

F7 looking downstream showing cattle access on left, July 2024

F7 looking upstream, July 2024

F7 looking downstream, August 2024



F7 looking upstream, August 2024

F10

F10 looking downstream, April 2024

F10 looking upstream, April 2024

F10 looking downstream, July 2024

F10 looking upstream, July 2024

Proposed Substation Location

Proposed Substation Location, April 2024

Proposed Substation Location, April 2024

Proposed Substation Location, looking downstream, August 2024

Proposed Substation Location, August 2024