Balliemeanoch Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 5: Appendices
Appendix 7.1: Aquatic Ecology Baseline Report

ILI (Borders PSH) Ltd

July 2024

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	July 2024	Submission	DL	David Lee	Technical Director

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1. Introduction

1.1 Background

AECOM was appointed by Intelligent Land Investments (ILI) to undertake aquatic ecological baseline surveys, as presented in this appendix, to support Environmental Impact Assessment (EIA) for the proposed Balliemeanoch Pumped Storage Hydro (hereafter referred to as the 'Development').

The area encompassed by the red line boundary of the Development is hereafter referred to as the 'Site' as shown on *Figure 1.1 Location Plan (Volume 3 Figures*).

As part of the EIA process, a study was undertaken to identify potential impacts on aquatic receptors and protected species such as Atlantic salmon *Salmo salar* and freshwater pearl mussel (FWPM) *Margaritifera margaritifera*, amongst others. Hereafter, these species are referred to in the report as "salmon" and "FWPM", respectively.

This baseline report also identifies several Invasive Non-Native Species (INNS) which could potentially be spread during the Development's construction phase.

1.2 Purpose of this Report

This report describes the methodology for freshwater ecology surveys and the results obtained. The results of the field surveys, in combination with the outcomes of desk study and on-going consultation, will be used to inform the EIA. Surveys undertaken include:

- Aquatic macrophyte surveys;
- Aquatic macroinvertebrate surveys;
- Fish habitat assessments;
- Fish surveys;
- FWPM surveys and habitat assessments; and
- Environmental DNA (eDNA) fish surveys.

1.3 Site Description and Survey Site Selection

Survey locations were selected based on their potential to be impacted by the Development. Any watercourses where a channel crossing may be required or had the potential to be impacted by runoff were surveyed to assess their conservation value and establish a baseline. The majority of survey locations assessed for this report are small headwater streams that arise in uplands between Loch Fyne (brackish) and Loch Awe (freshwater) and run through a variety of conifer plantations, broadleaved woodland, open fields, and moorland areas. A small number of additional survey locations included potentially impacted freshwater bodies (lochs), and proposed developments (engineering works) on the shores of Loch Fyne and Loch Awe. For example, one of the proposed transportation routes includes the construction of a temporary Marine Facility on the western shore of Loch Fyne, near Inveraray.

1.4 Legislative and Policy Context

This assessment has been undertaken within the context of the following relevant legislative instruments, planning policies and guidance documents and legislative instruments (refer to Chapter 7: Aquatic Ecology (Volume 2 Main Report) for further detail on the relevance of this legislation and policy in the context of the EIA):

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive');

- Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the 'Water Framework Directive');
- Regulation 1143/2014 on invasive alien species;
- Convention on Wetlands of International Importance ('Ramsar convention');
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the 'Habitats Regulations');
- Wildlife and Countryside Act 1981 (as amended) (the 'WCA');
- Wildlife and Natural Environment (Scotland) Act 2011 (as amended) (the 'WANE Act');
- Nature Conservation (Scotland) Act 2004 (as amended);
- Wildlife and Natural Environment (Scotland) Act 2011 (as amended);
- Scottish Planning Policy (SPP) 2014;
- Argyll & Bute Local Development Plan 2 (LDP2);
- Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003;
- Argyll and Bute Local Biodiversity Action Plan (LBAP);
- Wildlife & Natural Environment (Scotland) Act 2011 (as amended) (WANE Act).
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition (CIEEM, 2016);
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR);
- Water Environment and Water Services (Scotland) Act 2003 ('WEWS Act').

2. Methods

2.1 Desk Study

The desk study assessed data obtained from the Scottish Environment Protection Agency (SEPA), NatureScot (formerly Scottish Natural Heritage, SNH) and online sources to assess the distribution of protected aquatic species and INNS within 2.5 km of the Development Site.

It is an offence in Scotland to spread any non-native species in the wild under the WANE Act, and consequently all species of UK concern, such as those identified on Schedule 9 of the WCA (although this no longer legally applies in Scotland) and those considered species of European Union (EU) concern under the EU Invasive Alien Species Regulation, have been collated and reported.

The information has subsequently been used when considering the potential environmental impacts of the Development and was also used to inform the survey scope.

2.2 Survey Sites

Survey sites (Table 1) were selected according to the proximity of waterbodies to areas of proposed works, such as watercourse crossings, intake/outfall location, and shoreline constructions. A total of 19 sites were surveyed (Table 1 Balliemeanoch Aquatic Survey Sites). The survey sites comprised two brackish sites on Loch Fyne, four freshwater loch sites, and 13 running water sites on various watercourses, as detailed in Table 1 Balliemeanoch Aquatic Survey Sites). Sites BL-14 and BL-16 were the only brackish sites to be surveyed in 2023 as the third brackish site, BL-15 (located at NN 08202 07116), was removed from survey scope due to a lack of access and proximity to BL-14. Data collected from surveys at BL-14 was deemed sufficient to represent the aquatic ecology of the immediate area.

Previous field survey data from site visits in 2019 is beyond of the three-year validity guidance window for ecological surveys (CIEEM, 2019). However, results from previous surveys in 2019 and 2021 have been included within the baseline report to present previous findings within the project in relation to the current suite of surveys, and the results of 2019 surveys are considered valid as described in Section 2.4 Macrophyte Survey. The latest macroinvertebrate and fish surveys were completed between 25th to 29th September 2023, with a further suite of macroinvertebrate and new macrophyte surveys scheduled for spring and summer 2024.

No FWPM habitat surveys or aquatic macrophyte surveys were completed within the 2023/2024 round of surveys as the 2019 surveys were extensive and the results conclusive. Furthermore, assessment during walkover surveys completed during the 2023 surveys found the physical characteristics of the watercourses had changed little, if any, during the intervening years, and as such the 2019 FWPM habitat survey results can still be used with confidence.

Table 1. Balliemeanoch Aquatic Survey Sites

Site ID	Watercourse Name	Grid Reference	Year	Macrophyte	Macroinvertebrate	Fish	INNS	eDNA
BL-01	Allt Criche (trib. of Erralich Water)	NN 08167 12302	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-
BL-02	Erralich Water	NN 07790 11867	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-
BL-03	Allt Blarghour	NN 02880 13037	2019	A	A	-	-	-
			2023	A	A	-	-	-
BL-04	Buinne Dhubh (Allt Beolich)	NN 03197 15552	2019	✓	✓	-	-	-
			2021	-	-	A	-	-
			2023	-	✓	A	-	-

Site ID	Watercourse Name	Grid Reference	Year	Macrophyte	Macroinvertebrate	Fish	INNS	eDNA
BL-05	Allt Beolich	NN 01347 15431	2019	✓	✓	-	-	-
			2023	-	✓	-	-	-
BL-06	Unnamed (direct into Loch Awe)	NN 01175 15660	2019	-	✓	-	-	-
			2021	-	✓	-	-	-
BL-07	Allt a' Chrosaid River Aray	NN 01127 16082	2019	✓	✓	-	-	-
			2021	-	-	A	-	-
			2023	-	✓	A	-	-
BL-14	Loch Fyne Wharf (Brackish site)	NN 08537 07116	2019	✓	-	-	-	-
			2023	-	✓	-	-	-
BL-16	Loch Fyne (Brackish site)	NN 11301 09358	2019	✓	-	-	-	-
			2023	A	A	-	-	-
BL-17	Allt a' Gheataidh (outfall into Loch Awe)	NN 00960 16289	2019	✓	✓	-	-	-
			2023	-	✓	-	-	-
BL-18	Loch Awe	NN 00683 15657	2019	✓	✓	-	✓	-
			2021	-	-	-	-	✓
			2023	-	✓	-	✓	✓
BL-19	Loch Awe	NN 07693 26840	2019	✓	✓	-	✓	-
			2021	-	-	-	-	✓
			2023	-	✓	-	✓	✓
BL-20	Lochan Airigh	NN 04278 16416	2019	✓	✓	-	-	-
			2023	-	✓	-	-	-
BL-21	Lochan Breac-liath	NN 03430 16457	2019	✓	✓	-	-	-
			2023	-	✓	-	-	-
BL-22	River Aray	NN 09062 18945	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-
BL-23	Unnamed (trib. of River Aray)	NN 09795 19225	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-
BL-24	Unnamed (tributary of Achan River)	NN 07687 19480	2019	✓	✓	-	-	-
			2021	-	✓	-	-	-
BL-25	Unnamed (tributary of Keppochan River)	NN 06895 19355	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-
BL-26	Unnamed (tributary of Allt na Cuile Riabhaiche)	NN 05988 18950	2019	✓	✓	-	-	-
			2021	-	-	✓	-	-
			2023	-	✓	✓	-	-

A - Surveys were aborted due to health and safety concerns, either watercourses were in spate, storm conditions or unsafe to enter

The brackish sites were surveyed as they are within the proposed Marine Facility area of the Development. The purpose of the 2019 surveys was to provide general site descriptions and inform further ecological surveys of

these sites if required at a later date. A secondary survey to BL-14 occurred in 2023, and is scheduled for a survey in spring 2024. No safe access was found for BL-16 during surveys in 2019 or 2023.

2.3 FWPM Habitat Assessment

FWPM habitat potential was assessed in 2019 to identify areas of optimal habitat as defined by Hastie *et al*. (2000, 2003) within the boundary of the Development. At each site, FWPM habitat potential was also assessed over a 100 m downstream stretch. Key habitat requirements include riverbed substrate diversity and stability, high water quality and the presence of host fish (salmon and trout). Pockets of clean sand, stabilised by boulders and cobbles in moderate- to fast-flowing waters create optimal microhabitats for FWPM (Hastie *et al*., 2000, 2003). No further surveys were recommended from the previous surveys.

2.4 Macrophyte Survey

Macrophyte surveys were completed in 2019. Further macrophyte surveys were not considered necessary as little physical change was exhibited to the watercourses present within the Development and there was shown to be an extremely limited macrophyte community in the water bodies surveyed. Therefore, in combination with desk study data, it is considered that previous survey results remain valid.

The survey methodology undertaken varied depending on the type of watercourse. The macrophyte survey of flowing watercourses followed the method outlined in the UKTAG River Assessment Method (Macrophytes and Phytobenthos) for use with LEAFPACS2 (WFD-UKTAG, 2014), which conforms to BS EN 14184:2014 Water quality - Guidance for the surveying of aquatic macrophytes in running waters.

The survey was made by walking within the channel of each watercourse along a 100 m transect, where safely accessible. Any inaccessible areas were bypassed as necessary before re-entering the channel at the next available access point. A list of all macrophytes encountered was made and their relative abundance was recorded using Taxon Cover Values (TCV), detailed below (Table 2).

Table 2. Taxon Cover Values (TCV) and their associated percentage cover

TCV	Percentage cover for the macrophyte species
C1	<0.1%
C2	0.1 to 1%
C3	1 to 2.5%
C4	2.5 to 5%
C5	5 to 10%
C6	10 to 25%
C7	25 to 50%
C8	50 to 75%
C9	>75%

The macrophyte surveys of BL-20 and BL-21 (Lochan Airigh and Lochan Breac-liath respectively) were based on the PSYM (Predictive SYstem for Multimetrics) pond survey methodology (Freshwater Habitats Trust, formerly Pond Action, 2002). The survey was undertaken by walking the perimeter of these waterbodies and recording all wetland plants present within their outer edge (defined as the upper level where water stands in winter). Deeper water areas were sampled by grapnel, thrown from shallow water. This method was developed to provide a method for assessing the biological quality of still waters in England and Wales. Due to the location, the PSYM metrics could not be calculated, however the survey methodology remains valid. The relative abundance of each taxon present was recorded using the DAFOR scale.

- D = Dominant (greater than 75% total cover);

- A = Abundant (51 to 75% total cover);
- F = Frequent (26 to 50% total cover);
- O = Occasional (11 to 25% total cover; and
- R = Rare (1 to 10% total cover).

If a taxon appears to be intermediate between two categories, it is generally assigned to the lower category.

Macrophyte surveys at the brackish sites were undertaken along 100 m parallel transects at the potential construction sites on the shores of Loch Awe. The strandline was inspected for macrophytes and plant fragments, with records collected of any macrophytes encountered.

All non-native species adjacent and within the watercourses were also recorded as part of the assessment in order to record the extent of any INNS species, if present, at the survey sites.

2.5 Aquatic Macroinvertebrate Survey

Macroinvertebrate samples were collected during each optimal survey period for autumn 2019, autumn 2023, and further surveys are proposed for spring 2024.

Aquatic macroinvertebrate sampling was undertaken by two suitably experienced aquatic ecologists to assess the biological quality of the surveyed waterbodies. Macroinvertebrate samples were taken using a standard Freshwater Biological Association (FBA) pattern pond net (mesh size: 1 mm) in line aquatic macroinvertebrate sampling procedures standardised by the Environment Agency (Environment Agency, 2017) and used by regulatory authorities across the UK. These sampling procedures also conform to BS EN ISO 10870:2012 Water Quality – Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters. The instream habitats were ‘kick sampled’ where practicable, or ‘sweep sampled’, for three minutes followed by a one minute hand search of larger substrates. The collected samples were subsequently preserved in Industrial Methylated Spirits (IMS) prior to laboratory processing.

Analysis of Aquatic Macroinvertebrate Samples

Each of the samples collected was sorted and analysed in a laboratory setting by suitably trained and experienced aquatic ecologists. Lists of the aquatic macroinvertebrate taxa present were produced in line with Environment Agency guidance (Environment Agency, 2014). The aquatic macroinvertebrate samples were analysed to ‘mixed taxon level’ using stereo-microscopes. Most groups were identified to species level (where practicable), except for the following:

- amber snail (Succineidae) were identified to family;
- pea mussels (Sphaeriidae) were identified to genus/genus-group;
- worms (Oligochaeta) were identified to order;
- mites were identified to Hydracarina or Oribatei ;
- truefly larvae, which were identified to the maximum resolution possible;
- springtails (Collembola) which were identified to order; and
- immature or damaged specimens, which were identified to the maximum resolution possible on a case-by-case basis.

The survey data was then used to calculate metrics that can be used to inform an assessment of relative nature conservation value, habitat condition and general degradation as detailed below.

Community Conservation Index (CCI)

A Community Conservation Index (CCI) (Chadd & Extence, 2004) was calculated for each sample as detailed in Annex B Community Conservation Index (CCI). The CCI classifies many groups of aquatic macroinvertebrates according to their scarcity and nature conservation value in England (and is also relevant to Scotland) as understood at the time that the classification was developed. Species scores range from 1 to 10, with 1 being Very Common and 10 being Endangered. Since its initial publication, in some cases the references used in the CCI classification to define scarcity and value have been superseded by more recent assessments. Due to this,

the author has provided AECOM with updated species scores to take account of this new information (Chadd, *pers. comm.*, 2018). These updated scores have been used within this assessment.

Whalley, Hawkes, Paisley & Trigg (WHPT)

The aquatic macroinvertebrate data were analysed to generate the Whalley, Hawkes, Paisley & Trigg (WHPT) score Average Score Per Taxon (ASPT), and Number of scoring taxa (NTAXA) values, which provides an indication of the ecological quality in the watercourse (WFD-UKTAG, 2021). This assigns numerical value to taxa according to their sensitivity to organic pollution. The average of the values for each taxon in a sample, known as ASPT is a stable and reliable index of organic pollution. Therefore, these assessments can indicate to what extent an aquatic macroinvertebrate community is exposed to organic pollution (further information is provided in Annex C Whalley, Hawkes, Paisley & Trigg (WHPT) Metric). It is important to note that these indices can vary between geological regions and habitat types. Ditches for example are unable to support many of the high-scoring taxa associated with fast flowing habitats. Therefore, the resultant metrics should be reviewed with an awareness of their potential limitations, and the reach-specific context, as described in this report.

The WHPT method has been primarily designed to respond to organic pollution, however it is suitable for monitoring other types of impact and is used for assessing the WFD classification parameter “General degradation” (WFD-UKTAG, 2021).

Proportion of Sediment-sensitive Invertebrates (PSI)

Calculations were undertaken to determine the proportion of sediment sensitive macroinvertebrates present using the Proportion of Sediment-sensitive Invertebrates (PSI) index (Extence *et al*., 2013). Using this approach, individual taxa of aquatic macroinvertebrate are assigned a Fine Sediment Sensitivity Rating (FSSR) ranging from A to D, as detailed in Annex D Proportion of Sediment-sensitive Invertebrates (PSI). The PSI score for each aquatic macroinvertebrate sample was derived from individual species scores and abundances. The derived PSI score corresponds to the percentage of fine sediment-sensitive taxa present in a sample and ranges from 0 to 100, where low scores correspond to watercourses with high fine sediment cover. The PSI score therefore provides an indication of the extent to which watercourses are influenced by fine sediments, and therefore by inference the potential sensitivity of the associated aquatic macroinvertebrate community to changes in silt load and deposition.

Lotic-invertebrate Index for Flow Evaluation (LIFE)

Lotic-invertebrate Index for Flow Evaluation (LIFE) scores were calculated (Extence *et al*., 1999). This is an index that links benthic macroinvertebrate data to flow regimes prevailing in UK waters. Flow scores have been allocated to various macroinvertebrates based on species/family abundance and ecological association with different flows, as detailed in Annex E Lotic-Invertebrate Index of Flow Evaluation (LIFE). The overall LIFE score for a Reach is calculated as the sum of the individual scores divided by the number of scoring species/families. LIFE scores increase with current velocity, scores <6.00 generally indicating sluggish or still water conditions and score >7.5 indicate fast flows. LIFE allows the mean flow preference of invertebrates colonising a reach to be determined so that effect of habitat changes such as sediment accumulation can be monitored.

River Invertebrate Classification Tool (RICT)

The resultant WHPT-ASPT and NTAXA values and environmental data collected were processed through the River Invertebrate Classification Tool version 3 (RICT) web application, available on the Freshwater Biological Association website[1].

RICT predicts the WHPT-ASPT and NTAXA scores for the surveyed locations based on the site location, altitude, alkalinity, slope, discharge category, distance from source, channel dimensions and substrate composition. The predicted scores are then compared to actual scores and the output is an Ecological Quality Ratio (EQR). The EQR can be translated into a Water Framework Directive (WFD) classification (High, Good, Moderate, Poor, or Bad). Alkalinity data should be obtained from monthly analysis of samples from each over a period of at least one year, whereas here, alkalinity was based on the average of one sample collected during the survey visit, which is only reflective of singular point in time.

2.6 Fish Habitat Assessment

Fish habitat assessments were completed in 2019 at 15 sites to establish suitability for electric fish surveys. At each site, fish spawning habitat potential was assessed over a 100 m downstream stretch of the watercourse.

[1] https://www.fba.org.uk/rivpacs-and-rict/river-invertebrate-classification-tool

Assessed key aquatic features included channel dimensions, mesohabitat coverage, habitat features, substrate composition, accessibility for migratory species and potential spawning areas for salmonids. These were subsequently analysed following SEPA's Guidance for applicants on supporting information requirements for hydropower applications (SEPA, 2005). The degree of suitable passage was also considered, as natural or artificial barriers may impact passage of salmonids upstream on surveyed waterbodies.

Further habitat surveys in 2023 and 2024 were not deemed necessary as the watercourses themselves exhibited little physical change across the years, thus the previous habitat survey results can still be used with confidence.

2.7 Fish Surveys

A total of eight sites were selected for electric fishing surveys together with two sites on Loch Awe for eDNA survey (Table 3 Balliemeanoch fish survey sites). Site selection was further informed by the fish surveys completed in 2021.

Table 3. Balliemeanoch fish survey sites

Site Reference	Waterbody name	Central Site NGR	Method 2021	Method 2023
BL-01	Allt Criche (trib. of Erralich Water)	NN 08167 12302	Time delineated (6 minute), semi-quantitative	3-run semi-quantitative†
BL-02	Erralich Water	NN 07790 11867	Time delineated (6 minute), semi-quantitative	3-run semi-quantitative†
BL-04	Buinne Dhubh (Allt Beolich)	NN 03197 15552	No survey - unsuitable conditions	No survey - unsuitable conditions
BL-07	Allt a' Chrosaid	NN 01127 16082	No survey - unsuitable conditions	No survey - unsuitable conditions
BL-22	River Aray	NN 09062 18945	3-run semi-quantitative†	3-run semi-quantitative†
BL-23	Unnamed (trib. of River Aray)	NN 09795 19225	3-run semi-quantitative†	Time delineated (6 minute), semi-quantitative
BL-25	Unnamed (trib. of Keppochan River)	NN 06895 19355	Time delineated (6 minute), semi-quantitative	3-run semi-quantitative†
BL-26	Unnamed (trib. of Allt na Cuile Riabhaiche)	NN 05988 18950	Time delineated (6 minute), semi-quantitative	Time delineated (6 minute), semi-quantitative
BL-18	Loch Awe inlet/outlet location	NN 00683 15657	N/A	eDNA
BL-19	Loch Awe outflow to River Awe	NN 07693 26840	N/A	eDNA

† - Although 3 runs were completed, downstream stop nets were only used as upstream points were either unsafe or unsuitable for using a stop net. Where possible, natural barriers were used upstream instead, with run locations slightly altered to accommodate.

Electric Fishing

Electric fishing surveys were undertaken following a derivation of the standard electric fishing practice for operators and equipment, as detailed in the Environment Agency Code of Practice and Electric Fishing Equipment Annex A and B, Issue II regulations revision (Beaumont et al., 2002). Electric fishing was conducted by fully trained fisheries scientists following the EA Operational Instruction 993_08, Electric fishing operations (2019) and in accordance with the Scottish Fisheries Coordination Centre protocols (SFCC, 2021).

Semi-quantitative 3-run surveys require three runs of depletive electric fishing to give a good indication of population densities of species present. Where suitable, these surveys were undertaken by assessing the fish population within a 100 m^2 reach isolated using cross channel stop nets, fishing in an upstream direction. These surveys were considered semi-quantitative due to sub-optimal electric fishing conditions which caused some fish within the 100 m^2 river reach to be observed but not captured.

As weather and flow conditions did not allow semi-quantitative three-run surveys at all sites, time delineated surveys were undertaken where possible. Time delineated surveys provide an index of abundance; catch per unit of effort (time). This method was advantageous to use as an alternative to the three-run method, as it facilitated a larger number of sites to be sampled in a short time frame when weather and flow conditions allowed. Operatives electric fished the watercourse in an upstream direction for 6 minutes. The number of fish caught during this time is regarded as an index of abundance; catch per unit effort (time).

Following capture, the fish were placed within fish holding tanks before being identified and measured then safely released immediately downstream. Any eels caught were kept in a separate tank to other fish species as they secrete mucus which can clog the gills of other fish. Holding tank dissolved oxygen was continuously monitored and maintained at optimal conditions using an aerator.

Fish eDNA Survey

Water samples were obtained and filtered at two sites; the first eDNA site was sampled at the River Awe outflow from Loch Awe; and the second eDNA site was collected on the east bank of Loch Awe. Approximately 1.5 - 2 L of water from each site was filtered and subsequently extracted by Nature Metrics using a commercial DNA extraction kit with a protocol modified to increase DNA yields. Fish eDNA survey commenced in Autumn 2023, and is proposed to continue seasonally for 12 months, i.e., until Summer 2024. This methodology was requested by stakeholders through consultation (refer to Chapter 9: Aquatic Ecology).

2.8 Limitations

The aim of a desk study is to help characterise the baseline context and provide valuable background information that would not be captured by a single site survey alone. Information obtained by desk study is dependent upon local recorders and organisations having submitted records for the area of interest. As such, a lack of records for a species does not necessarily mean that the habitats or species do not occur in the study area. Likewise, the record of a species does not automatically mean that these still occur within the area of interest or are relevant in the context of the Development.

All sites were in spate at the time of the surveys in 2023, and as such not all areas of the watercourse could be surveyed safely. Consequently, some meso- or micro-habitats within the watercourse may not have been representatively surveyed for both the fish and macroinvertebrate surveys.

During the autumn 2023 survey period, continuous storm conditions presented limitations to fish surveys. These conditions likely reduced the presence of salmonids within the watercourses and diminished the overall quality of electric fish surveys in 2023. Consequently, the 2023 survey results may not be representative of the community present under typical conditions, with lower counts or lack of taxa that are normally present.

Semi-quantitative 3-run electric fishing surveys could only be completed at two of the sites: BL-22 and BL-23. Where this was not possible semi-quantitative timed delineated surveys were carried out for six minutes (BL-01, BL-02, BL-25, BL-26).

However, although three runs were completed at most of the survey sites, it was unsafe to deploy two stop nets within the watercourses. Stop nets are used to isolate an area of river and restrict fish movement upstream and downstream of the survey site. This ensures an accurate snapshot of present taxa and ensures almost all individuals are caught. Where two stop nets are not used, some individuals may either escape upstream out of the range of the electric fishing gear or float past the surveyors and be missed. During 2019 and 2023 electric fishing surveys, downstream stop nets were primarily used as upstream survey points were either unsafe or unsuitable for using a stop net. Where possible, natural barriers were used instead and run locations were slightly altered. This was to avoid collapsed banks, water that was too deep or recently felled woody debris within the watercourses from the storm present during the autumn 2023 surveys.

Additionally, two sites (BL-04 and BL-07) could not be completed due to the torrential rain, which made site conditions unsafe for performing any fish surveys, and sites BL03 (all years) and BL16 (2023) could not be surveyed for macrophytes and macroinvertebrates due to site access restrictions. This is not considered a significant limitation due to the comparable nature of all watercourses within the site boundary, and therefore appropriate assumptions can be made about notable species and biological quality.

Although some surveys were completed in sub-optimal conditions, the data collected between 2019 and 2023 is considered comprehensive and appropriate to inform a robust impact assessment.

3. Results

3.1 Desk Study

Invasive Non-Native Species (INNS)

Recent INNS records for the Development and surrounding area were obtained from SEPA and the Argyll Biological Records Centre (ABRC). Records found within the past ten years, are presented in Table 4 Previous INNS records in Balliemeanoch area.

The following terrestrial and riparian INNS species were recorded within 2.5 km of the scheme:

- Japanese knotweed *Reynoutria japonica* was recorded in 2012 on the opposite bank of Loch Awe, near Inverinan, approximately 1.4 km from the proposed access track nearest to Balliemeanoch Farm.
- New Zealand willowherb *Epilobium brunnescens* was also recorded, approximately 2.3 km southeast of the headpond area in 2017.
- American skunk cabbage *Lysichiton americanus* is listed as an Invasive Alien Species of (European) Union concern. The species was identified during a survey of the River Shira, which runs east of the Development Site into Loch Fyne and is outside the red line boundary.

Aquatic INNS records were also previously reported within the area of the scheme. Records from 2016 provided evidence for the presence of:

- Canadian pondweed *Elodea canadensis* in Loch Awe, approximately 600 m from where the Balliemeanoch Farm access track option meets the shore.
- Nuttall's waterweed *Elodea nuttallii* was recorded along the northern shore of Loch Awe.
- New Zealand pigmyweed *Crassula helmsii* in Loch Awe.

Older historic records, from over 12 years ago, of the New Zealand Mud Snail *Potamapyrgus antipodarum* had been recorded in several locations within the boundary of the Development.

Table 4. Previous INNS records in Balliemeanoch area

Common name	Species	Location	Code	Date recorded
Japanese knotweed	*Reynoutra japonica*	Balliemeanoch	M	2012
New Zealand willowherb	*Epilobium brunnescens*	Glen Aray	U	2017
American skunk cabbage	*Lysichiton americanus*	River Shira	U	2018
Canadian pondweed	*Elodea canadensis*	Loch Awe (South)	M	2016
Nuttall's waterweed	*Elodea nuttallii*	Loch Awe (North)	U	2016
New Zealand pigmyweed	*Crassula helmsii*	Loch Awe	U	2016

Location codes: Multiple locations (M) or unspecified (U). Source: SEPA survey database and local records.

Macrophytes

Records of common aquatic plants were returned in the desk study. Records of common water-moss *Fontinalis antipyretica* and long-beaked water feather-moss *Platyhypidium riparioides* from 2013 showed these species as present in the Allt a' Chrosaid. An additional 2017 record of common water-moss was returned from east of the Site, on a tributary of the River Aray. A single record of bog pondweed *Potamogeton polygonifolius* (2017) was returned from Drimfern, approximately 2.5 km east of the Development.

Online sources also returned older historic records. These included the presence of red pondweed *Potamogeton alpinus*, curled pondweed *P. crispus*, bright-leaved pondweed *P. gramineus* x *perfoliatus* = *P. x nitens*, broad-leaved pondweed *P. natans* and perfoliate pondweed *P. perfoliatus* in Loch Awe. Common water-moss *Fontinalis antipyretica var. gracilis* was also on Mullach Nam Moaol in 1981, approximately 2.2 km east of the headpond area.

Aquatic Macroinvertebrates

A range of aquatic invertebrate taxa records (2005–2011) were provided by SEPA. However, no records of rare or protected species were returned within the study area. The only notable SEPA records available were historic accounts of the naturalised non-native New Zealand mud snail.

Several species of mayfly, cased caddisfly, dragonfly and damselfly (which have aquatic juvenile life stages) were recorded near Inverinan, on the opposite bank of Loch Awe. However, most were considered common and widespread. Additional records from 2012 identified the damselfly *Calopteryx virgo*, which are found within the Argyll and Bute region, with little occurrence throughout the rest of Scotland.

Freshwater Pearl Mussel (FWPM)

No historical records of FWPM in the wider Balliemeanoch area (between Loch Awe and Loch Fyne) were available from NatureScot. A targeted FWPM survey of the Allt Blarghour watercourse was undertaken in 2009 in advance of a proposed hydro-scheme, but the results were negative. No mussels were found in either the lower reach (road bridge to Loch Awe inlet at NM 995 134) or the upper reach of Allt Blarghour (1.5 km downstream of NN 018 130), and a lack of suitable FWPM habitat was noted in this watercourse (Iain Sime, pers. comm.).

Fish

Online sources returned historic individual commercially available records of European eel *Anguila anguila*, Atlantic salmon, brown/sea trout *Salmo trutta*, pike *Esox lucius* and perch *Perca fluviatilis*, all from the year 2002. The location of all these records was given as NN01, the 10 km OS grid square within which the site is located.

Additional older records from 1988 of Arctic char *Salvelinus alpinus*, brook lamprey *Lampetra planeri*, 3-spined stickleback *Gasterosteus aculeatus*, minnow *Phoxinus phoxinus* and rainbow trout *Oncorhynchus mykiss* were returned from the same 10 km OS grid square within and around Loch Awe. In 1985 salmon and trout also were recorded in Loch Awe, near Inverinan.

More recently, 12 resident fish species were recorded in Loch Awe during gill-netting and fish eDNA surveys carried out by SEPA in 2011 and 2016, respectively (Table 5 Fish species recorded in Loch Awe – SEPA gill-netting and eDNA surveys). These are all native species, except for rainbow trout. There are no known wild self-sustaining populations of rainbow trout in Scotland, so this is considered likely a record of escaped stocked fish or farmed fish.

Table 5. Fish species recorded in Loch Awe – SEPA gill-netting and eDNA surveys

Common name	Species	Gill Net (2011)	eDNA (2016)
Arctic char	*Salvelinus alpinus*	✓	✓
Atlantic salmon	*Salmo salar*	-	✓
Brown/sea trout	*Salmo trutta*	✓	✓
European eel	*Anguilla anguilla*	✓	✓
Lamprey	*Lampetra sp.*	-	✓
Minnow	*Phoxinus phoxinus*	✓	✓
Perch	*Perca fluviatilis*	✓	✓
Pike	*Esox lucius*	✓	✓
Rainbow trout	*Oncorhynchus mykiss*	✓	✓
Roach	*Rutilus rutilus*	✓	✓
3-spined Stickleback	*Gasterosteus aculeatus*	-	✓

Common name	Species	Gill Net (2011)	eDNA (2016)
Stone loach	*Barbatula barbatula*	-	✓

Source: SEPA survey database (exact locations unavailable)

3.2 Field Survey

BL-01 Allt Criche (tributary of Erralich Water)

The surveyed reach ran through a shallow, wooded gorge (Fig. 1a-b). The small channel (width (W) = 3 m, depth (D) = 0.4 m) was well shaded by mature broadleaved trees and scrub vegetation. Previous surveys at the site recorded that the riverbed was dominated by cobbles and pebbles and woody debris (Fig. 1a). Variable flow patterns and small patches of stable gravels for spawning were observed throughout during macroinvertebrate surveys but became a torrent during fish surveys the following day (Fig. 1a-b).

A few, small patches of potential sub-optimal FWPM habitat were apparent in places, but the riverbed substrates were generally too coarse and unstable for mussels. No evidence of FWPM (live mussels or shells) was found during the 2019 survey.

Five species of macrophytes were recorded along the survey section in 2019. No rare or notable species were recorded. The assemblage comprised of the aquatic bryophytes, common water-moss *Fontinalis antipyretica,* yellow fringed moss *Racomitrium aciculare*, compressed flapwort *Nardia compressa* with the marginal species lesser spearwort *Ranunculus flammula* and jointed rush *Juncus articulatus*. The community coverage was approximately 13 % of the channel.

During the 2019 macroinvertebrate surveys, a moderate diversity was recorded within the aquatic macroinvertebrate community (25 taxa). The biological quality of this site was very good (ASPT: 7.3; NTAXA: 17) with several pollution sensitive taxa recorded, indicating that the site is not impacted by organic pollution. The site has a **moderate conservation value** (CCI; 8.1) with most species recorded being of very common and common status (as defined by the CCI). The only exception was the stonefly *Protonemura meyeri.* Although initally considered to be Regionally Notable by the CCI (conservation score: 6), the increases in the recorded range of the stonefly (Macadam, 2015) has resulted in an updated assessment of Local Status (conservation score five) (Chadd pers comms, 2018).

The biological quality of the autumn 2023 macroinvertebrate community was very good (ASPT: 7.0; NTAXA: 21), with a higher diversity (28 taxa) than the 2019 survey. The macroinvertebrate community present reflected a minimally sedimented/unsedimented substrate, indicated by a PSI score of 88.24. Most species present were highly sensitive to reduced flows (LIFE: 8.79) and are pollution sensitive, demonstrated through high numbers of caseless caddisflies (*Philopotamus montanus* and *Hydropsyche pellucidula*) and numerous stonefly species (including *Perlodes mortoni* and *Siphonoperla torrentium*) comprising much of the community. Additionally present were mayflies, including *Rhithrogena semicolorata* which are adapted to faster flows with dorsally flattened bodies and legs for gripping the substrate. The conservation value of BL-01 was of **moderate conservation value** (CCI: 8.2). The majority of the species recorded were very common to frequent status, with the stonefly *Protonemura meyeri* being the only exception with a conservation score of locally notable (conservation score five).

Spring macroinvertebrate surveys are scheduled for completion in 2024.

The fish survey completed in 2021 consisted of a single 6-minute run carried out over a 20 m length of watercourse. Two trout were caught, measuring 68 mm and 158 mm. Three other fish were seen and not caught but were considered most likely to also be trout. The water temperature recorded was 9.8 °C and conductivity measured 30.79 μScm^{-1}.

In 2023 electric fish surveys were completed while the watercourse was in spate and torrential flows,.A total of three runs were completed, with only a downstream stop net. The upstream conditions prevented a stop net from being placed due to fallen trees and high amounts of wooden debris. During fish surveys, a total of seven trout parr (Figure 1d.) were recorded, ranging in fork lengths from 62 mm to 70 mm, alongside one salmon parr (Figure 1c.) measuring 107 mm. The water temperature recorded was 11.2°C and conductivity measured 31.3 μScm^{-1}.

No non-native species were recorded at the site during all surveys.

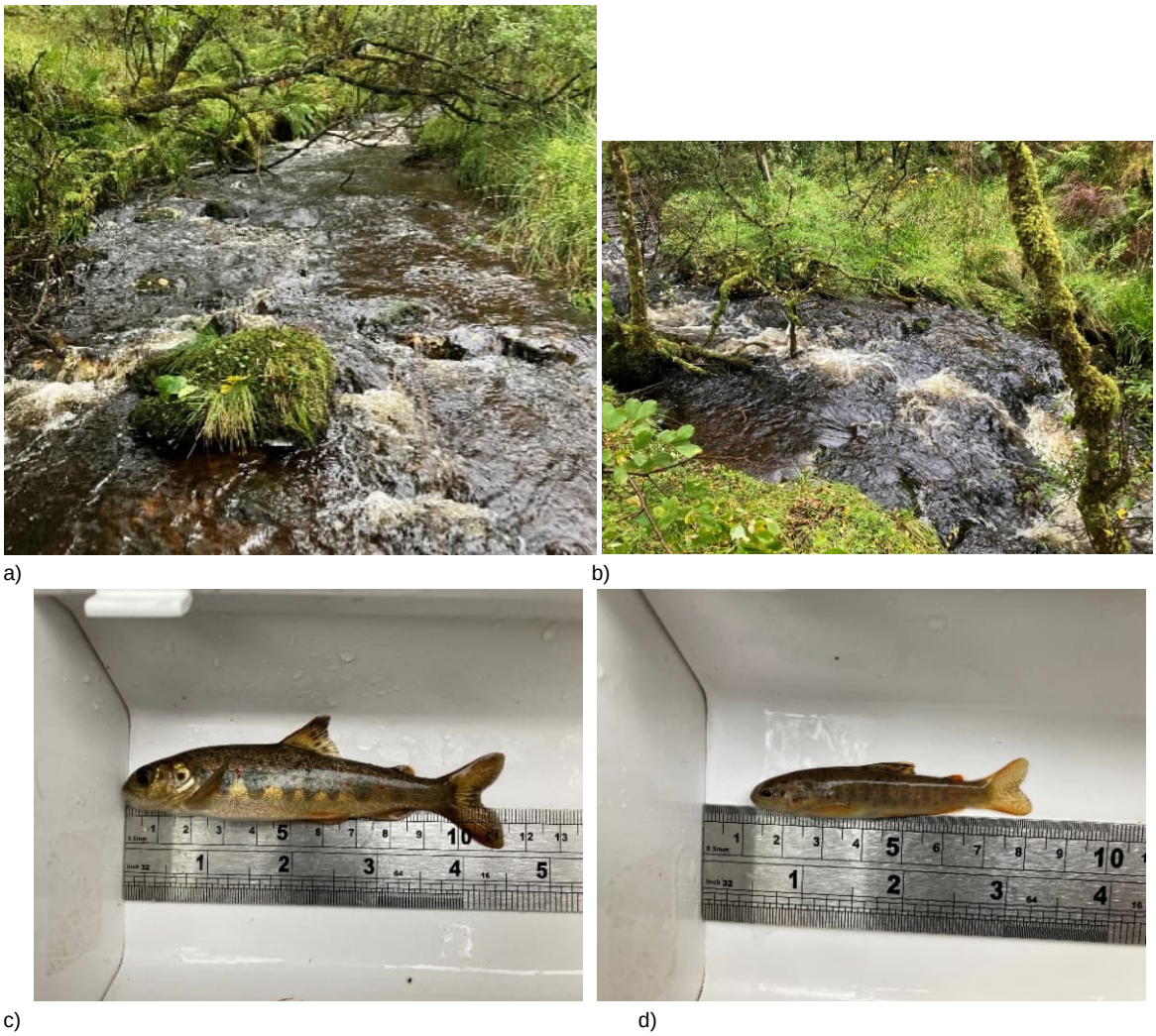


Figure 1. Site BL-01 Allt Criche **(tributary of** Erralich Water**) and Atlantic salmon parr**

BL-02 Erralich Water

The surveyed reach ran through a gentle sloping valley in a conifer plantation, with some scrub and semi-improved pasture. The channel (W = 10 m, D = 0.2 m) was bound by moderate-steep grassy banks (H = 1–3 m, S = 50–70 ^{o}). The channel was straight, possibly resulting from historical modifications associated with construction of a track bridge upstream of the survey point. Variable flow patterns (generally riffle) were observed in 2019. The riverbed featured a variety of substrates (dominated by boulders and cobbles) (Fig. 2a-c), with Isolated pockets of suitable spawning habitat for salmonids were observed.

Small patches of sub-optimal FWPM habitat were also noted (boulder-stabilised coarse sand deposits) during the 2019 survey. No fish or evidence of mussels were seen during the survey.

Three species of macrophytes were recorded in 2019 along the survey section. No rare or notable species were recorded. The assemblage was solely comprised of the aquatic bryophytes with common water-moss, yellow fringed moss and compressed flapwort recorded, none of which are notable or invasive non-native. The community coverage was approximately 20 % of the channel.

A low diversity was recorded within the aquatic macroinvertebrate community (12 taxa) for the autumn 2019 surveys, suggesting a restricted or generally homogenous habitat. The biological quality of this site was very good (ASPT: 7.5, NTAXA, 8) with a number of pollution sensitive taxa recorded, demonstrating the site is not influenced by organic pollution. The site had a **fairly high conservation value** (CCI: 10) with the majority of the species recorded being of very common to frequent status (as defined by the CCI). The only exception was the Locally Notable (conservation score five) stonefly *P. meyeri*.

The autumn macroinvertebrate community in 2023 indicated generally good water quality (ASPT: 7.7; NTAXA: 10). A higher diversity community (14 taxa) was present compared to that recorded in autumn 2019. The community present reflected a minimally sedimented/unsedimented substrate, as indicated by a PSI score of 100.00. The community sampled is highly sensitive to reduced flows (LIFE: 8.80) and comprised of numerous pollution-sensitive species, including mayfly species (e.g., *Baetis rhodani / atlanticus*, *R. semicolorata* and Leptophlebiidae), which accounted for greater than half of all identified specimens, and caseless caddisflies (*Rhyacophila dorsalis, Polycentropus flavomaculatus* and *H. pellucidula*). The autumn 2023 sample attained a CCI score of 10.0, reflecting a **fairly high conservation status**. Whilst the majority of the species recorded were very common to frequent status (as defined by the CCI), the Locally Notable (CCI species score five) stonefly *P. meyeri* was also recorded.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

For electric fishing surveys in 2021, a single 6-minute run was carried out over a 25 m length of watercourse and no fish were caught. Two other fish were seen and not caught but were considered likely to be trout. The water temperature recorded was 9.3 °C and conductivity measured 18.83 µScm^{-1}.

During 2023, three runs were completed with the use of a downstream stop net, as upstream was unsuitable for the net due to depth and torrential flows. A total of three trout parr (Figure 1d.) were found during the fish survey, measuring between 72 mm to 162 mm in fork length. Deep pool comprised 20% of the survey reach and a further 15% was accounted for by shallow pools; the remaining habitat was classified as run. All individuals found during the survey were from the downstream stop net. The water temperature recorded was 10.7 °C and conductivity measured 22.4 µScm^{-1}.

No non-native species were identified at this site during all surveys.

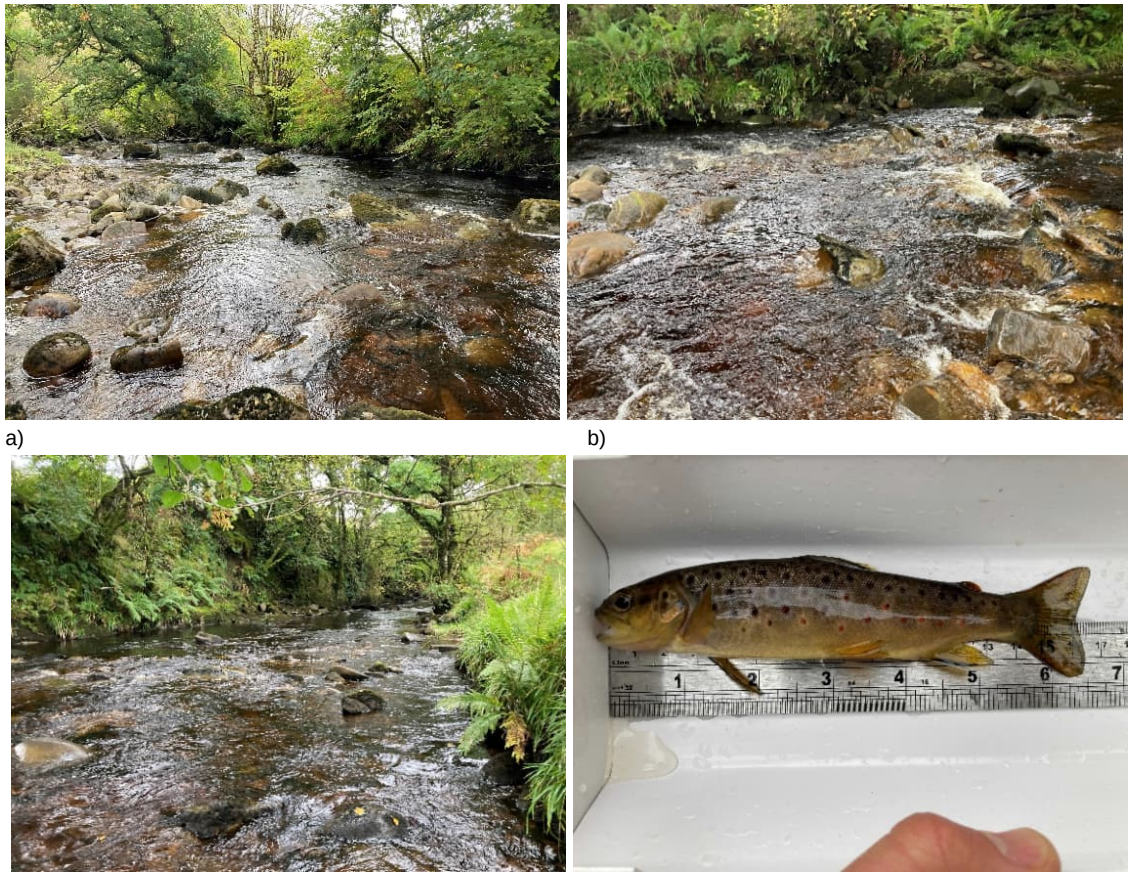


Figure 2. Site BL-02 Erralich Water

BL-03 Allt Blarghour

Site BL-03 was not surveyed in September 2019 and September 2023 due to access issues.

BL-04 Buinne Dhubh (Allt Beochlich)

The surveyed reach formed the main channel inflow to the reservoir Buinne Dhubh (W = 5 m, D = 0.4 m). The previous survey in 2019 recorded the downstream site to have banks vegetated downstream, which appear to flood when the reservoir basin is full. Muddy banks may indicate regular flooding (H = 1.5 m, S = 30–60 º; Fig. 3a-b). The downstream riverbed structure was recorded as very similar to that observed further upstream (100–200 m) from where the 2023 macroinvertebrate sample was collected. Clean gravel deposits dominate the mostly unstable riverbed. There was sub-optimal salmonid spawning habitat, but no shading of the channel (Fig. 4a-b). A significant waterfall (Height 4 m) downstream, at NN 04048 16081, would present a natural barrier to fish movement upstream. Below the surveyed section, a reservoir sluice/dam at NN 02884 15425 (H = 2 m) also forms a barrier to fish migration.

Small pockets of sub-optimal FWPM habitat were also noted (semi-stable, coarse sand and gravel deposits). No fish or evidence of mussels (shells) were observed during the 2019 survey.

Seven species of macrophytes were recorded, these were all present on the large banks which supported inundation vegetation. These include common water moss, jointed rush, lesser spearwort, intermediate water starwort *Callitriche hamulata*, marsh horsetail *Equisetum palustre*, water pepper *Persicaria hydropiper* and cuckoo flower *Cardamine pratensis*.

A low diversity (16 taxa) was recorded within the aquatic macroinvertebrate community surveyed in 2019. The biological quality of this site was very good (ASPT: 6.0, NTAXA: 10) with a number of pollution sensitive taxa recorded, suggesting that the site is not affected by organic pollution. The site had a **fairly high conservation value** (CCI; 5.5) with all of the species recorded being of very common to occasional status as defined by the CCI.

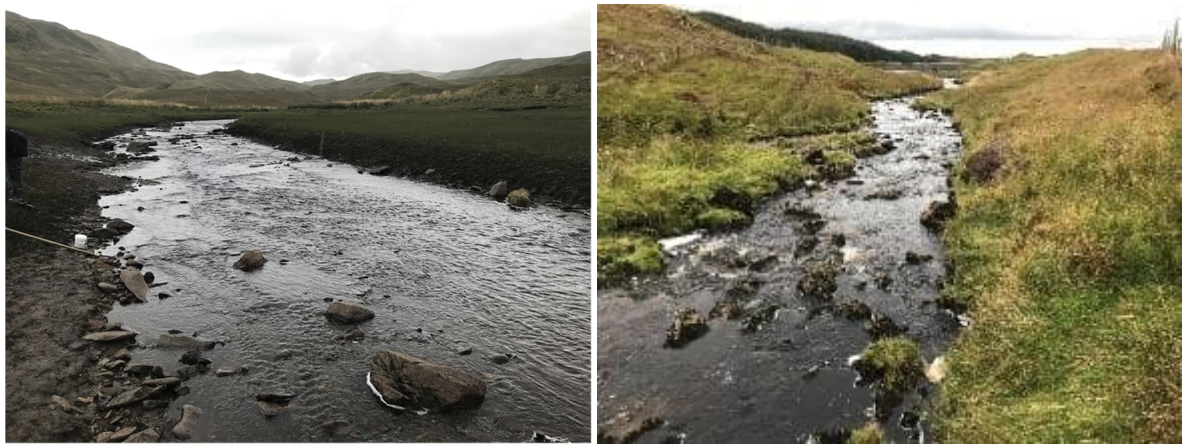
The autumn 2023 macroinvertebrate sample was taken slightly upstream (at NN 03398 15655), due to heavy rain and unsafe conditions toward the confluence of headwater river into the reservoir. The upstream sampling point was predominantly boulders and cobbles (Fig. 5a-b), within a channel (W = 4 m, D = 0.4 m) similar to that reported downstream near the reservoir. Torrents dominated the habitat due to heavy rain at the time of survey. Safe entry was found near an agricultural bridge near a section of pools, boulders and torrents where the macroinvertebrate sample was also collected (Fig. 4b).

The biological quality of this site, in autumn 2023, was very good (ASPT: 8.3; NTAXA: 12) across a moderately diverse community (19 taxa). The community reflected a substrate that was minimally sedimented/unsedimented (PSI: 92.31) and was pollution-sensitive, exhibited by dominance of the community by mayfly taxa (e.g., *B. rhodani/atlanticus*, *Ecdyonorus* sp. and Leptophlebiidae). Several species of stoneflies (including *Isoperla grammatica* and *S. torrentium*) and riffle beetles (e.g. *Elmis aenea* and *Limnius volkmari*) characteristic of higher flow habitats were also present, indicating at the community reliance on faster flows and thus high sensitivity to flow reduction. This is further indicated by the high LIFE score of 8.36 attained by the autumn 2023 sample. The site had a **moderate conservation value** with a CCI score of 9.4 as most species being of very common to frequent status as defined by the CCI. The Locally notable stonefly *P. meyeri* was also present.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

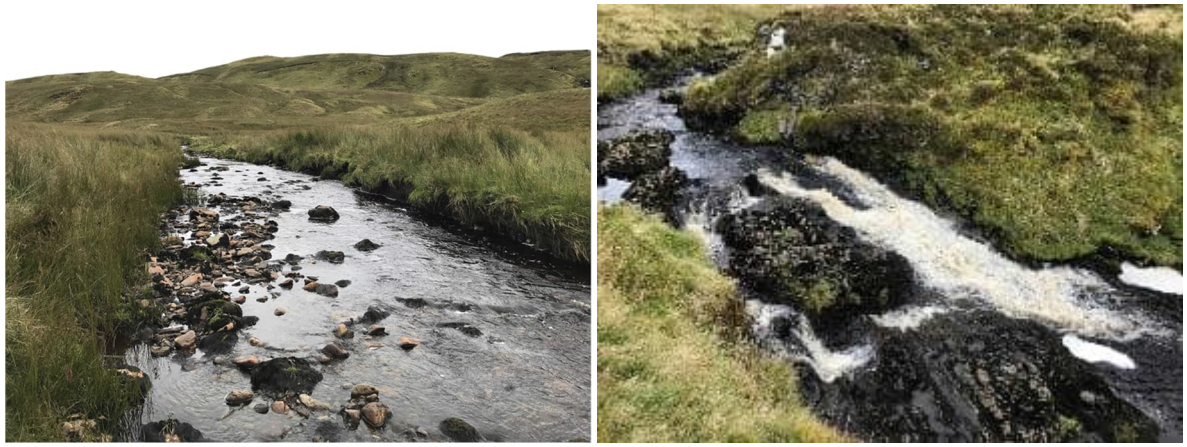
Electric fish surveys could not be completed in 2021 due to the channel being in spate. Similarly further fish surveys could not be completed in 2023 due to a persistent storm during the survey period, with torrential rain.

No non-native species were recorded at this site during any surveys.



a) b)

Figure 3. Site BL-04 Buinne Dhubh (Allt Beolich) in 2019



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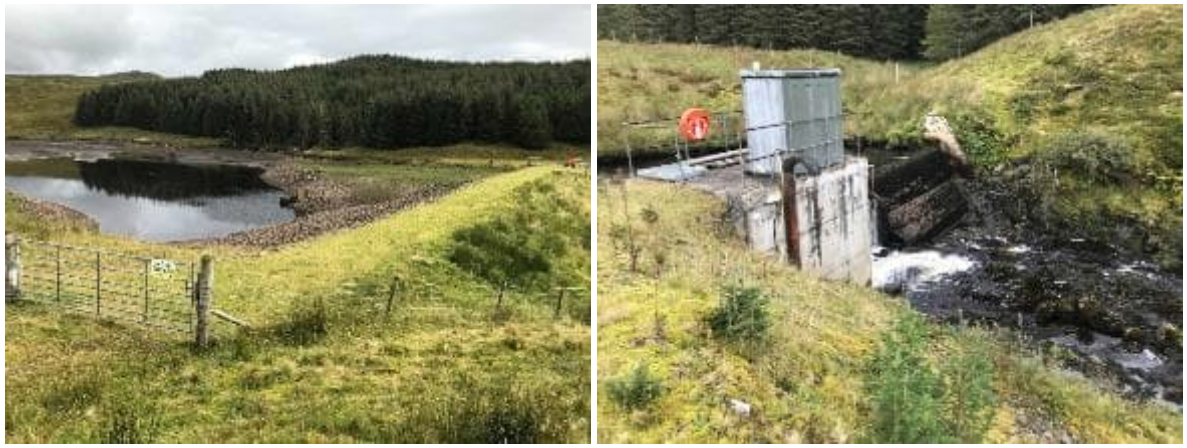
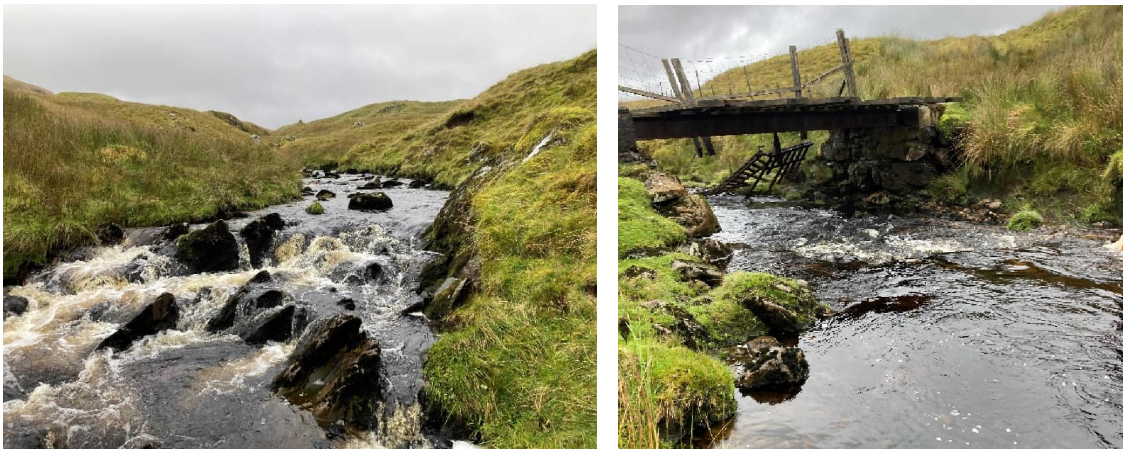


c) d)

Figure 4. Buinne Dhubb (Allt Beolich) features on watercourse



a) b)

Figure 5. Site BL-04 Buinne Dhubh (Allt Beolich) upstream sampling point in 2023

BL-05 Allt Beolich

The Allt Beolich watercourse at site BL-05 ran through a steep, wooded rocky gorge with fast-flowing water (Figure 5a-b), which was not previously accessed due to health and safety considerations in 2019. However, an alternative route to the survey point was found to access the watercourse in 2023 and the previously used 2019 alternative location Site BL-05(b) (located *c.* 100 m upstream of BL-05) was not visited during the 2023 round of surveys. Comparison to 2019 data should be treated with caution. Slight variation in location and mesohabitat proportions may have minor influences on results, although both locations are within close proximity.

The watercourse at BL-05 ran through a deep bedrock gorge (W= 5 m, D= 0.4 m) largely covered in boulders in large woody debris, through heavily shaded deciduous woodland with extensive moss growth.

Similarly, in 2019, at BL-05(b), the watercourse was dominated by bedrock and boulder substrates and generally fast-flowing waters (Fig. 6a). Complex flow patterns were observed. Small patches of suitable spawning gravels for salmon and trout were seen in slower locations. Trout fry were identified during this survey. Above this section, a dam (H = 3 m) and waterfall (H = 3 m) at NN 02464 15148 form effective barriers to fish movement further upstream (Fig. 6b).

Further downstream, a significant waterfall, registered as impassable barrier, was identified on the SEPA Obstacles to Fish Migration[2] map layer, explaining the absence of migratory fish above this point.

The coarse, mobile substrates and high flows observed at this site appeared unsuitable for FWPM. No evidence of FWPM was recorded in the 2019 surveys.

Although much of the channel at BL-05(b) could not be accessed due to safety reasons in 2019, the macrophyte community appeared to be limited to common water moss, a liverwort *Pelia* sp., compressed flapwort, rusty feather-moss *Sciuro-hypnum plumosum* with jointed rush. No rare or notable species were recorded.

A high diversity was recorded within the aquatic macroinvertebrate community (33 taxa) sampled at BL-05(b) in autumn 2019. The biological quality of this site was very good (ASPT: 7.1; NTAXA: 23) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **fairly high conservation value** (CCI: 12.0) with the majority of the species recorded being of very common to occasional status. The only exceptions were the stoneflies *Protonemura praecox* and *P. meyeri* which are defined as of local status (conservation score 5).

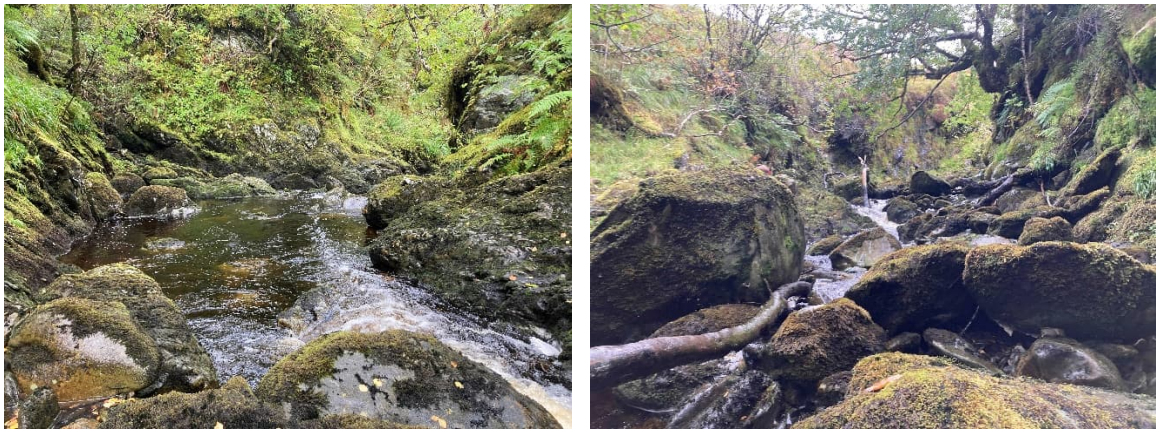
During autumn 2023 surveys at BL-05, a lower diversity community (17 taxa) was present, with a biological quality of very good (ASPT: 7.4; NTAXA: 14). The community present indicated a minimally

[2] https://map.environment.gov.scot/sewebmap/

sedimented/unsedimented substrate (PSI 90.48) and a high sensitivity to reduced flows (LIFE: 8.60). A CCI score of 10.0 indicated a **fairly high conservation value**, with the Locally notable (conservation score 5) stonefly *P. meyeri* was present, and remaining taxa with common to frequent status.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

No non-native species were recorded at either survey location during any surveys.



a) b)

Figure 6. Site BL-05 *Allt Beolich*

BL-06 Unnamed (direct into Loch Awe)

The surveyed reach formed a small, upland burn flowing directly through rough pasture into Loch Awe (Fig. 7a-b). The watercourse was moderately fast-flowing, running down a steep slope along a very shallow vegetated channel (W= 0.2 m and D= 0.05 m). The surveyed section had a culverted section under a farm access track, and was considerably modified/impacted, primarily from intermittent livestock poaching. Small patches of gravel were present in the channel; however, it was too shallow (D <0.05 m) for fish spawning to occur. No fish were seen during the survey, and it is unlikely to support species with many natural barriers along its course through the agricultural landscape it resides within.

No suitable FWPM habitat was observed (lack of stable substrates) during the 2019 surveys.

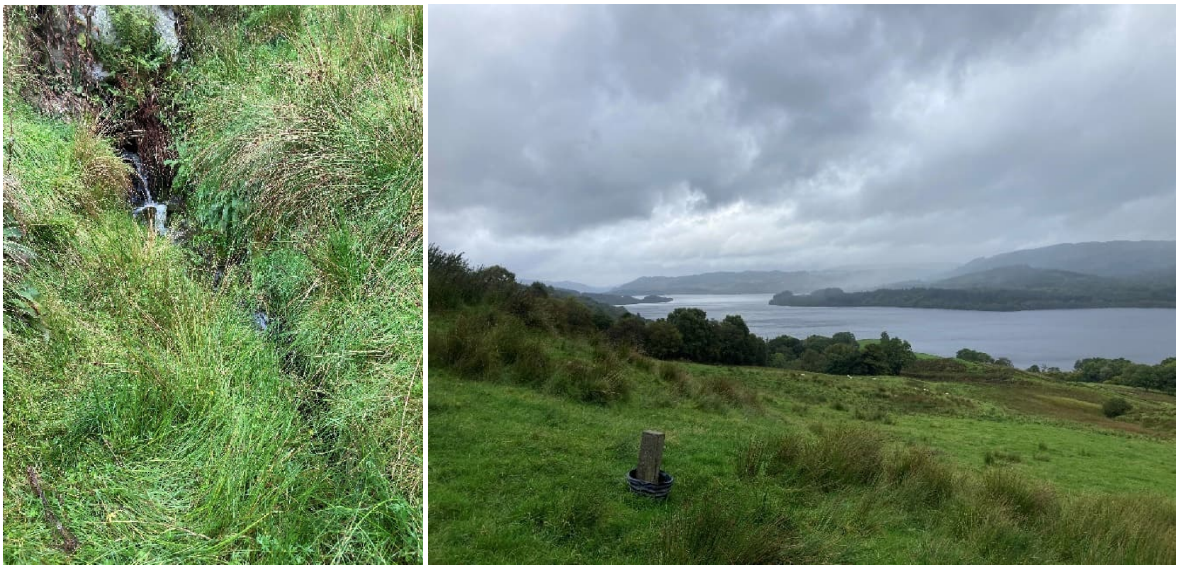
Four species of macrophytes were recorded along the survey section in 2019. No rare or notable species were recorded. The assemblage comprised common water-moss, lesser spearwort, jointed rush and water forget-me-not *Myosotis scorpioides*. The community coverage was approximately 12 % of the channel.

In 2019, high diversity was recorded within the aquatic macroinvertebrate community (21 taxa). The biological quality of this site was good (ASPT: 5.1, NTAXA, 17) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **fairly high conservation value** (CCI: 12.0) with the majority of the species recorded being of very common to occasional status. The only exception was the caddisfly *Limnephilus bipunctatus*, which is defined as of Locally notable status (conservation score 5).

The autumn 2023 macroinvertebrate community present at the site had a biological quality of very good (ASPT: 5.4; NTAXA: 20). The community was more diverse (26 taxa) and primarily composed of snails, beetles and caddisflies. The community reflected a moderately sedimented substrate (PSI: 41.67) and a moderate sensitivity to reduced flows (LIFE: 7.09). The community was also of **moderate conservation value** (CCI: 5.3), with all taxa present, defined by the CCI, as common to frequent status.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

No non-native species were recorded at this site. However, in previous surveys from 2019, a single non-native species was recorded; the New Zealand mud snail. This species was first introduced to the UK in 1852 and is now naturalised, widespread and common in many areas (Seddon *et al*., 2014).



a) b)

Figure 7. Site BL-06 Unnamed (direct into *Loch Awe*)

BL-07 Allt a' Chrosaid

The surveyed reach of the Allt a' Chrosaid ran through a rocky, wooded gorge, featuring fast-flowing sections with numerous cascades, steps and minor falls (H = 0.5–1 m) characterising the channel (W = 3 m, D = 0.35 m) (Fig. 8a-b). Previous surveys recorded a significant waterfall (H = 3 m) at NN 01092 16070 as a barrier to fish movement upstream. However, suitable flows and gravel deposits below the falls indicated potential salmon and trout spawning habitat downstream are also present, although were not assessed again during the 2023 surveys. The survey section was marked by a culvert under a farm track and a water torrent over boulders upstream under deciduous trees (Fig. 8a-b).

Small patches of sub-optimal FWPM habitat were recorded in places (semi-stable, coarse sand and gravel deposits). No fish or evidence of mussels (shells) were seen during the 2019 survey.

Four species of macrophytes were recorded along the survey section in 2019. No rare or notable species were recorded. The assemblage comprised common water-moss, lesser spearwort, common haircap moss *Polytrichum commune* and a liverwort *Pellia* sp. The community coverage was approximately 11 % of the channel.

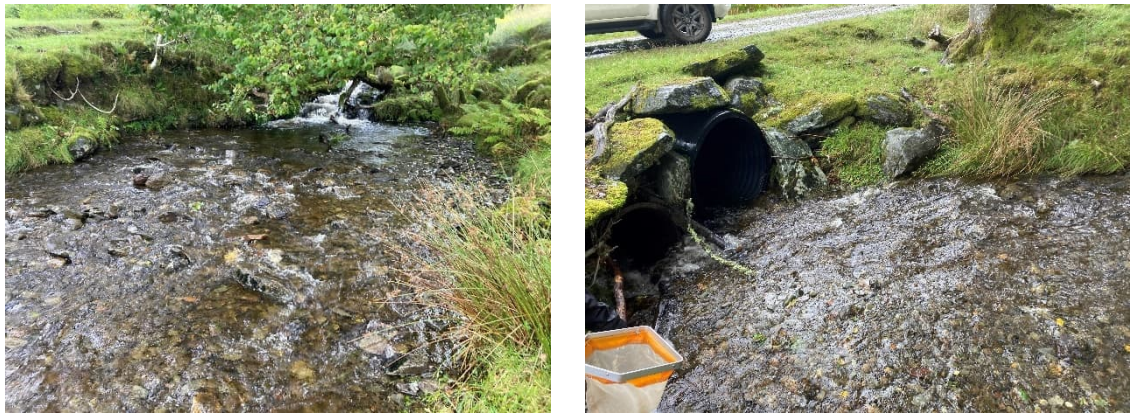
A high diversity was recorded within the aquatic macroinvertebrate community (32 taxa) during 2019. The biological quality of this site was very good (ASPT: 7, NTAXA, 19) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **fairly high conservation value** (CCI: 11.9) with the majority of the species recorded being of very common to occasional status. The only exceptions were the stoneflies *P. praecox* and *P. meyeri* are defined as Locally notable (conservation score 5).

The biological quality of the autumn macroinvertebrate community present in 2023 was very good (ASPT: 7.9; NTAXA: 19), with a slightly lower diversity (26 taxa). The community reflected a minimally sedimented/unsedimented substrate (PSI: 91.89) and was of high sensitivity to reduced flows (LIFE: 8.53). This was reflected by the community largely being composed of caseless caddisfly (e.g., *H. pellucidula, Hydropsyche siltalai*), stoneflies (e.g., *P. mortoni, I. grammatica, S. torrentium*) and mayflies (e.g., *R. semicolorata*, *Ecdyonorus* sp.), taxa which are adapted to survive and exploit the increased velocity evident in the stream. The site also had a **moderate conservation value** with a CCI of 9.4, with most species common to frequent status defined by the CCI. However, the Locally notable (conservation score 5) stonefly *P. meyeri* was also present.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

Electric fish surveys were not attempted in 2021 due to the channel being in spate and torrential rain prevented further surveys in 2023.

No non-native species were recorded during any surveys at the Allt a' Chrosaid site.



a) b)

Figure 8. Site BL-07 *Allt a' Chrosaid*

BL-14 Loch Fyne Wharf (Brackish site)

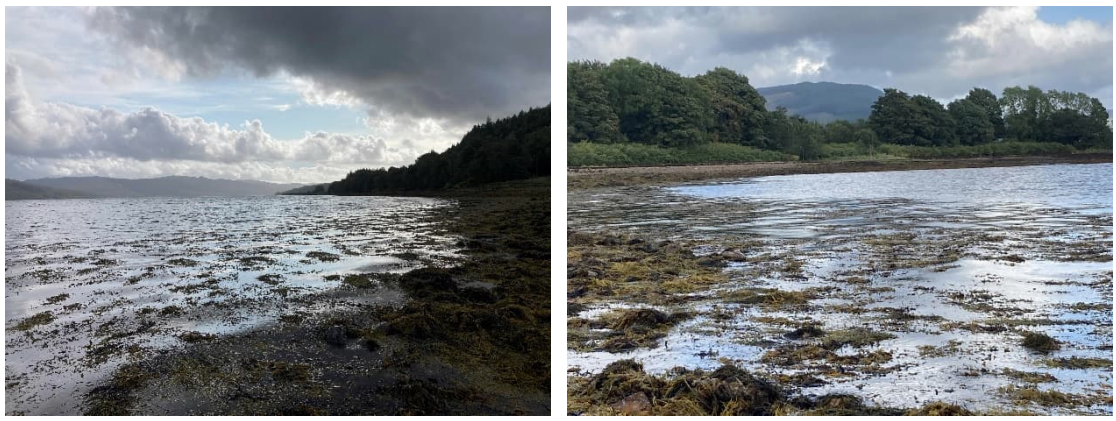
A short section (100 m) of Loch Fyne shoreline was surveyed as part of the brackish zone, with gentle-sloping tidal zone (Fig. 9a-b), dominated by brown seaweed species (*Ascophyllum nodosum* and *Fucus* spp.). Pebble dominated the shore substrate, with some cobbles and boulders scattered throughout. Above high-water mark (HWM) near the artificial wall for the road above, dense scrub vegetation included large stands of the INNS species Japanese knotweed (Fig. 9c) and Himalayan balsam (Fig. 9d).

No macroinvertebrate sample was taken at this site in 2019.

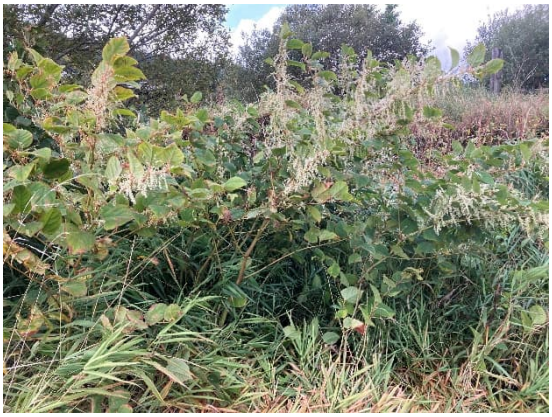
The autumn macroinvertebrate community present in 2023 had a moderate (ASPT: 3.6; NTAXA: 5) biological quality with **moderate conservation value** (CCI: 7.5). It had one of the lowest recorded diversities of the surveyed sites, however this is likely due to it being a brackish environment and was therefore dominated by salinity tolerant macroinvertebrates, such as the shrimp *Gammarus duebeni*, and the Atlantic ditch shrimp *Palaemonetes varians*. All species present were of common to occasional status species, as defined by their respective CCI scores.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

No non-native macroinvertebrates were found during surveys. However, INNS macrophyte species were recorded, with the presence of Himalayan balsam and Japanese knotweed along the shoreline.



a) b)



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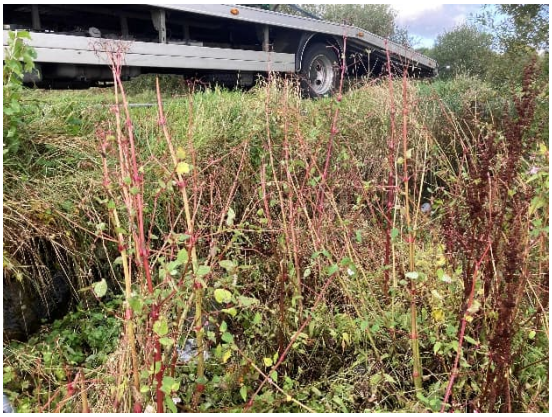


d)

Figure 9. Site BL-14 *Loch Fyne* Wharf

BL-16 Loch Fyne (Brackish site)

The site BL-16 was not surveyed in September 2019 and 2023, owing to unsafe access and poor weather conditions.

BL-17 Allt a' Gheataidh (outfall into Loch Awe)

This surveyed watercourse consisted of a small stream/drainage ditch (W = 0.5 m, D = 0.1 m) from a field upstream and flowing through a short, shaded stretch (50 m) of broadleaved woodland (Fig. 10a-d). The channel runs under a road bridge (B840), which divides the two riparian habits. The channel is heavily modified, particularly in the field upstream. During surveys the watercourse was in spate with burst banks and a wetted width greater than 4 m. No suitable spawning habitat for salmonids was found. No fish were seen during the survey.

No suitable FWPM habitat was observed at this site in 2019 due to the lack of clean substrates.

Seven species of macrophytes were recorded along the survey section in 2019. No rare or notable species were recorded. The assemblage comprised of lesser spearwort, joined rush, common reed *Phragmites australis,* yellow flag iris *Iris pseudacorus,* fool's-water-cress *Helosciadium nodiflorum,* hemlock water dropwort *Oenanthe crocata* and water mint *Mentha aquatica.*

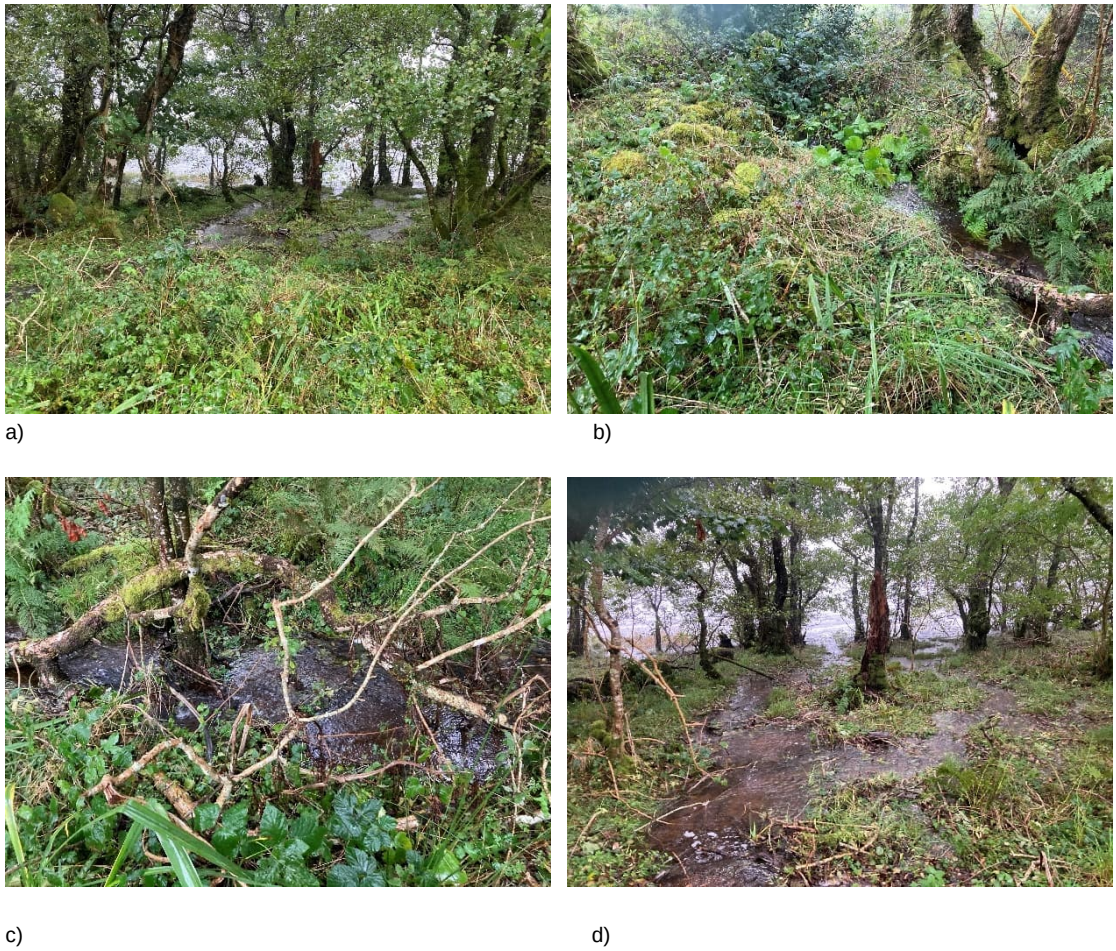
A moderate diversity was recorded within the aquatic macroinvertebrate community (26 taxa) in 2019. The biological quality of this site was good (ASPT: 4.7, NTAXA, 16) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **moderate conservation value** (CCI: 6.0). All of the species recorded were of very common to occasional status (as defined by the CCI).

During the autumn surveys in 2023, the biological quality of the macroinvertebrate community was moderate (ASPT: 5.0; NTAXA: 14). The community was of similar diversity (16 taxa) to previous years. The higher presence of snails and oligochaeta worms indicated a sedimented substrate (PSI: 35.00) and a low sensitivity to reduced flows (LIFE: 6.33). Beetles and caddisflies (e.g. *Micropterna lateralis, Beraea maurus* and *Crunoecia irrorata*) were also present within the sample and indicated areas of faster flows and better water quality were present across the matrix of mesohabitats present at BL-17. The site was of **moderate conservation** value (CCI: 5.6), with all species of common to frequent status species, as defined by their respective CCI scores

Spring macroinvertebrate surveys are scheduled for completion in 2024.

Fish surveys could not be completed due to spate conditions and torrential rains during visits to the site in 2021 and 2023 respectively.

The non-native but non-invasive New Zealand mud snail was recorded within the sample from this site. No other non-native species were recorded at the site during any surveys.



a) b)

c) d)

Figure 10. Site BL-17 *Allt a' Gheataidh* (outfall into Loch Awe)

BL-18 Loch Awe

A short section (100 m) of the Loch Awe shoreline was surveyed, centred on a small stone crop at NN 00684 165657 (Fig 11a-b). A gravel-pebble substrate dominated the site, with some cobbles and boulders present. No fish were seen during the survey, as water conditions were turbid and torrential rain and high winds produced lots of waves at the site.

In 2019, five species of macrophytes were recorded. The assemblage comprised common water moss *Fontinalis antipyretica*, shoreweed *Littorella uniflora*), jointed rush, lesser spearwort and alternate water-milfoil *Myriophyllum alterniflorum*. Filamentous green algae (*Enteromorpha*, *Ulva* spp.) were also present below the water line. No rare or notable species were recorded and the community present was considered typical of an oligotrophic lake.

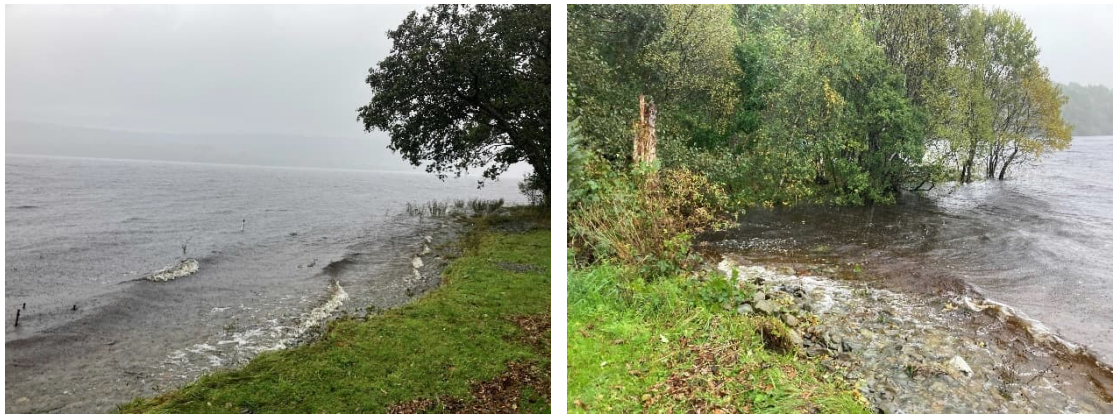
A high diversity was recorded within the aquatic macroinvertebrate community (32 taxa) was recorded in 2019. The biological quality of this site was good (ASPT: 5, NTAXA, 26) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site has a **moderate conservation value** (CCI: 6.8) with the species recorded being of very common to occasional status (as defined by the CCI).

The autumn 2023 macroinvertebrate community was of moderate (ASPT: 6.0; NTAXA: 13) biological quality at this site. The site exhibited a lower diversity (16 taxa) than the previous visit and was primarily composed of mayflies, stoneflies and aquatic beetles. The conservation score of the community was of **low conservation value** (CCI: 4.0), with most very common to common status species, defined by the CCI.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

Between Autumn 2023 and Summer 2024, fish eDNA sampling is being carried out seasonally and the results will be reported in an addendum report to this appendix. The first eDNA sample for this period was collected for analysis during the autumn 2023 surveys.

No non-native species were recorded at this site on Loch Awe during any surveys.



a) b)

Figure 11. Site BL-18 *Loch Awe*

BL-19 Loch Awe

The location for BL-19 was moved from its previous location (NN 00958 16912) to correspond with the fish eDNA sample site near the confluence of Loch Awe to the River Awe. The new sample point (NN 07695 26842) was located on a sand and gravel shore adjacent to the Cruachan Dam Visitor Centre, below a gabion protected bank (Fig. 12a-d).

Previously in 2019, six species of macrophytes were recorded. The assemblage comprised common water moss, shoreweed, alternate water-milfoil, jointed rush, lesser spearwort and an INNS waterweed *Elodea* sp. Filamentous green algae (unidentified) were also present below the water line. No rare species were recorded and the community present was considered typical of an oligotrophic lake.

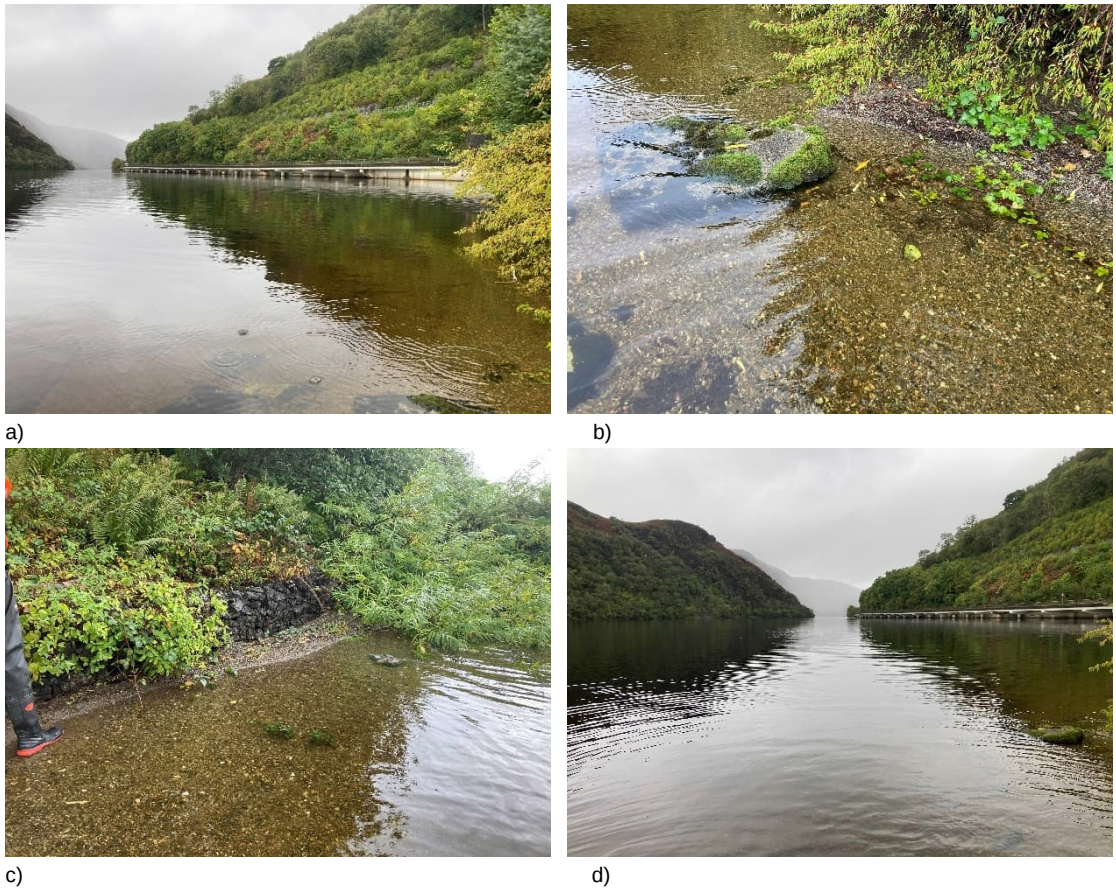
A high diversity was recorded within the aquatic macroinvertebrate community (46 taxa) in 2019. The biological quality of this site was very good (ASPT: 5.9, NTAXA, 26) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **moderate conservation value** (CCI: 6.6) with all of the species recorded being of very common to occasional status (as defined by the CCI).

The macroinvertebrate community present during autumn of 2023 was of moderate biological quality (ASPT: 3.0; NTAXA: 4). This site had the lowest level of diversity among sites with only three taxa identified. The **very high conservation value** (CCI: 80.0), due to the presence of the Rare RDB3 status Dytiscidae beetle *Oreodytes davisii*, with a conservation score of eight. The non-native and non-invasive *Crangonyx floridanus/pseudogracilis* was recorded within the sample with four individuals. No other non-native or invasive species were recorded during surveys.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

Between Autumn 2023 and Summer 2024, fish eDNA sampling is being carried out seasonally at BL-19 and the results will be reported in an addendum report to this appendix. The first eDNA sample was collected for analysis during the autumn 2023 surveys.

Previous surveys in 2019 also found *C. pseudogracilis/floridanus* at the original survey location on Loch Awe, in addition to a small fragment of waterweed *(Elodea* sp.) which was present within the strandline. Although it was not possible to identify the species, all species within this genus are non-native in Scotland.



a) b) c) d)

Figure 12. Site BL-19 *Loch Awe*

BL-20 Lochan Airigh

The shore of the small loch and a 100 m section of the outlet stream were surveyed (Fig. 13a-d) in 2019. The latter dropped steeply into a glen below (Fig. 13b). A variety of substrates and (step-pool) flow patterns were observed. However, the channel was very narrow and shallow (W = 0.3 m D = 0.1 m) and no suitable fish spawning habitat was observed. No fish were seen in the loch or stream during the survey, although trout *Salmo trutta* were previously observed in the loch.

No suitable FWPM habitat was observed in 2019 at this site due to unstable substrate.

In 2019, nine macrophytes were recorded within the loch with the assemblage consisting of shoreweed, alternate water-milfoil, lesser spearwort, joined rush, bog pondweed *Potamogeton polygonifolius*, red pondweed *Potamogeton alpinus*, water lobelia *Lobelia dortmanna*, water horsetail *Equisetum fluviatile* and common water moss. No rare or notable species were recorded and the community present was considered typical of an oligotrophic lake.

A moderate diversity was recorded within the aquatic macroinvertebrate community (21 taxa) during 2019 surveys. The biological quality of this site was very good (ASPT: 6.3, NTAXA, 15) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site has a **very high conservation status** (CCI: 15) with the majority of the taxa recorded being of very common to occasional status (as defined by the CCI). Two species are of Locally Notable status, the freshwater amphipod *Gammarus lacustris* and the diving beetle *Acilius sulcatus;* this beetle is typical of steep-sided pools and may occur in deep and clear water if fish are absent (Foster & Friday, 2011). The most notable species present was a diving beetle *Agabus arcticus*, which is regarded as Regionally Notable (conservation score 6), however, it has no statutory protection. This species inhabits permanent montane lakes and is widespread across Scotland including its major islands (Foster & Friday, 2011).

Further macroinvertebrate surveys at this site could not be completed in September 2023, owing to access issues and storm conditions.

No non-native species were recorded during any surveys at Lochan Airigh .

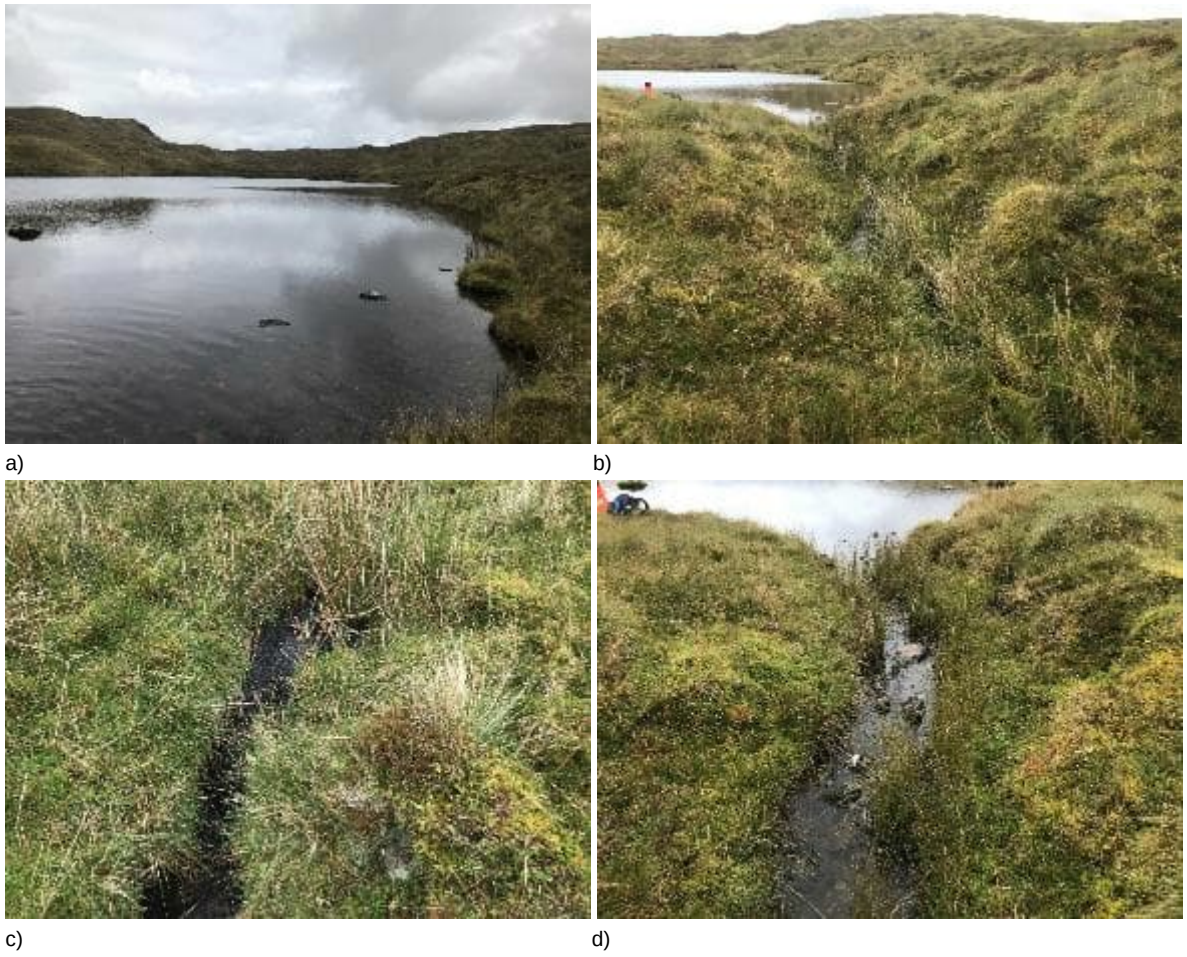


Figure 13. Site BL-20 *Lochan Airigh*

BL-21 Lochan Breac-liath

The shore of Lochan Breac-liath and a 100 m section of the outlet stream were surveyed (Fig. 14 a-d) in 2019. The latter formed a deep-cut, rocky channel with undercut and eroding peat banks (H = 1 m) (Fig. 14 c-d). A variety of substrates and (step-pool) flow patterns were observed. However, the channel was very narrow and shallow (W = 0.3 m, D = 0.1 m) and no suitable spawning habitat was observed. Minnow were identified in the loch, with other fish observed jumping, potentially brown Trout, but no fish were seen in the stream during the survey.

No suitable FWPM habitat was observed at this site due to a lack of suitable substrate during 2019.

Six species were recorded within the small loch during macrophyte surveys in 2019. The assemblage consisted of shoreweed, jointed rush, bog pondweed, water lobelia, bulbous rush *Juncus bulbosus*, floating bur-reed *Sparganium angustifolium* and common water moss. No rare or notable species were recorded and the community present was considered typical of an oligotrophic lake.

A moderate diversity was recorded within the aquatic macroinvertebrate community (22 taxa) in 2019. The biological quality of this site was very good (ASPT: 6.8, NTAXA, 12) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **High conservation status** (CCI: 7) with all the taxa recorded being of very common to occasional status.

Further macroinvertebrate surveys at this site could not be completed in September 2023, owing to access issues and storm conditions.

No non-native species were recorded during any surveys at Lochan Breac-liath.

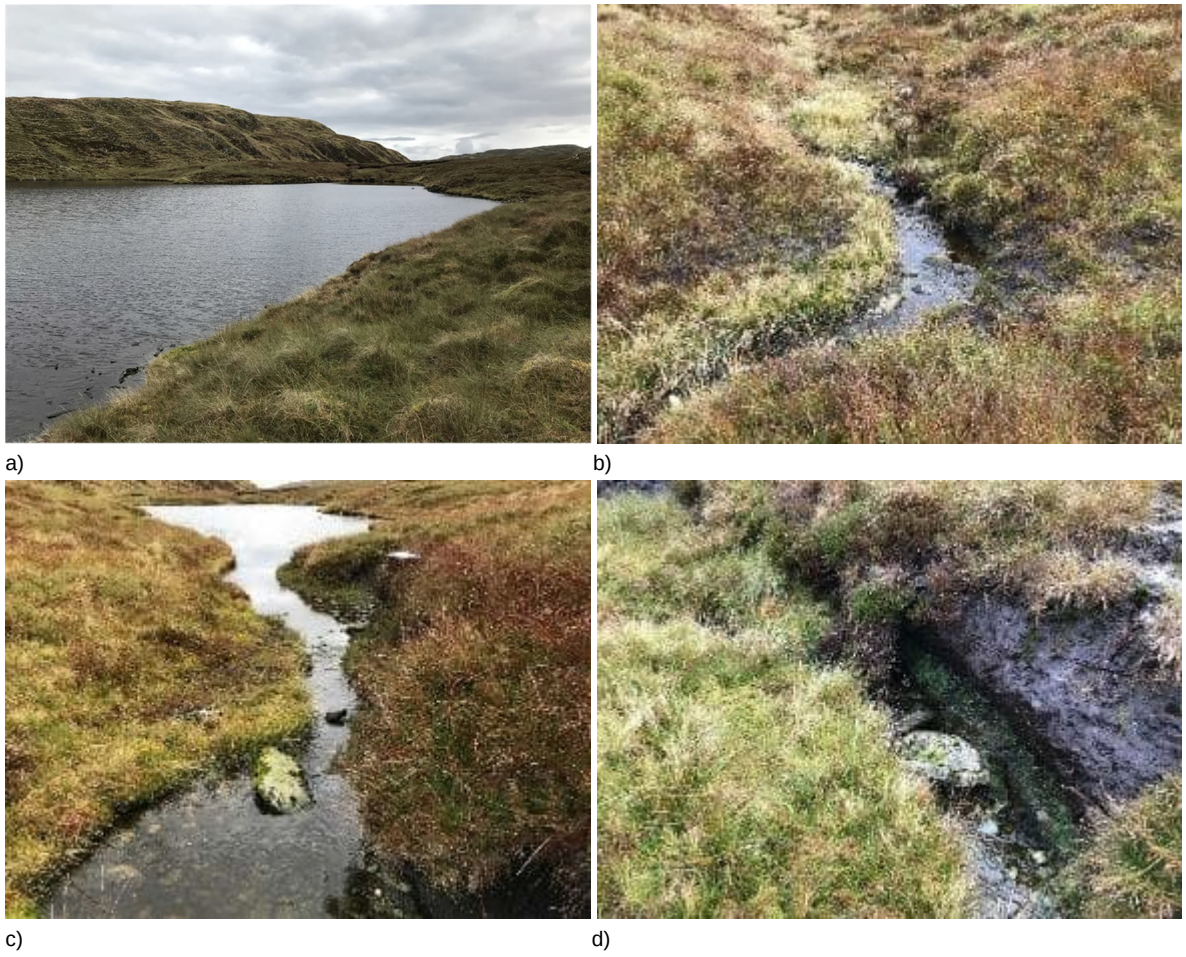


Figure 14. Site BL-21 *Lochan Breac-liath*

BL-22 River Aray

The River Aray water level was in spate during surveys. This reach of the watercourse forms a deep-cut channel (W = 2 m, D = 0.5 m) with undercut peat banks, running through an open marshy area within a conifer plantation (Fig. 15a-b). Rushes (*Juncus* sp.) and tussock grass (*Deschampsia sp.*) and other emergent vegetation were predominant along the 5 m stretch (Fig. 15a-b). Previous surveys in 2019 identified variable (riffle-step-pool) flows and small gravel patches (A <0.5 m^2) which could have offered some potential trout spawning habitat. However, during the surveys in autumn 2023, water conditions were turbid and torrential. There were many areas of collapsed banks throughout the channel, with fragments larger than 0.5 m^3 from prior storm conditions. This led to channel widening, loss of pools and faster flows throughout channel.

Small patches of potential, but sub-optimal, FWPM habitat (moderately stable patches of gravel) were observed in 2019. No evidence of mussels or shells were seen during the survey.

Macrophyte surveys in 2019 identified a total of 10 macrophytes. The higher plant assemblage consisted of shoreweed, jointed rush, floating bur-reed, lesser spearwort, water horsetail, bulbous rush and broad-leaved pondweed *Potamogeton natans*. The bryophytes present were common water-moss, compressed flapwort and drab brook-moss *Hygrohypnum luridum*. No rare or notable species were recorded and the community coverage was approximately 13 % of the channel.

The macroinvertebrate sample in autumn 2019 had high diversity within the identified aquatic macroinvertebrate community (40 taxa). The biological quality of this site was very good (ASPT: 6.6, NTAXA, 25) with a number of

pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site had a **high conservation status** (CCI: 8.6) with the majority of the taxa recorded being of very common and common status, as defined by their CCI values. Only two species of Locally notable status were present, the alderfly *Sialis fuliginosa* and the stonefly *P. meyeri*.

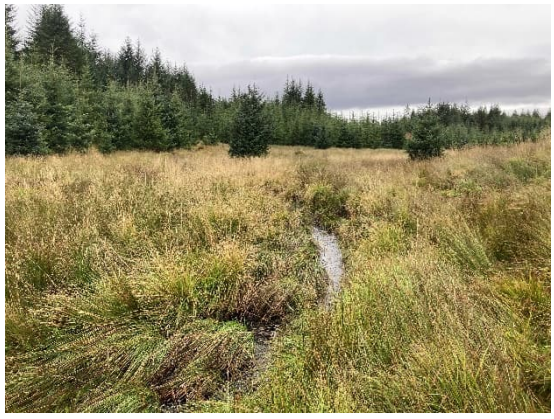
During macroinvertebrate surveys at BL-22, the autumn community present was of very good (ASPT: 7.0; NTAXA: 18) biological quality and consisted of 24 taxa. This community reflected the slightly sedimented (PSI: 78.57) substrate conditions, indicated in part by the presence of the snail *Ampullaceana balthica* and true fly larvae (including non-biting midges Orthocladiinae). A high sensitivity to reduced flows was also exhibited by the dominant presence of taxa adapted to faster flowing watercourses, such as stoneflies, riffle beetles and caddisfly species (e.g. *R. dorsalis, P. flavomaculatus* and *Silo pallipes*). The **moderate conservation value** (CCI: 9.3), with most common to frequent status species, defined by the CCI. However, the Locally notable stonefly *P. meyeri*, and alderfly *S. fuliginosa* were persistent in their presence at the site.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

In 2021, electric fishing surveys consisted of three 100 m runs with a total of 22 brown trout caught, measuring between 62 – 205 mm. Previously, the watercourse was on average 1.5 m wide and 50 cm deep. The substrate comprised of cobbles, pebbles, gravel, silt, and some boulders. The predominant habitat present was run with some slower marginal areas of flow. The water temperature recorded was 10 °C and conductivity measured 26.02 µScm^{-1}.

During the 2023 electric fishing surveys, the riverbanks had collapsed into much of the channel, forming a matrix of torrenting flows throughout the survey reach. Therefore, no stop nets were used as the conditions were unsafe from potentially unsecure fragments of bank in the channel and collapsible bank tops. Deep pools totalled 30 % of the survey reach with run habitat comprising over 60 % of available habitat. During fish surveys, a total of three trout parr were recorded at the site, with fork lengths measuring from 65 mm to 127 mm (Fig 15c-d). The water temperature recorded was 10.7 °C and conductivity measured 25.40 µScm^{-1}.

No non-native species were recorded during any surveys in the River Aray.



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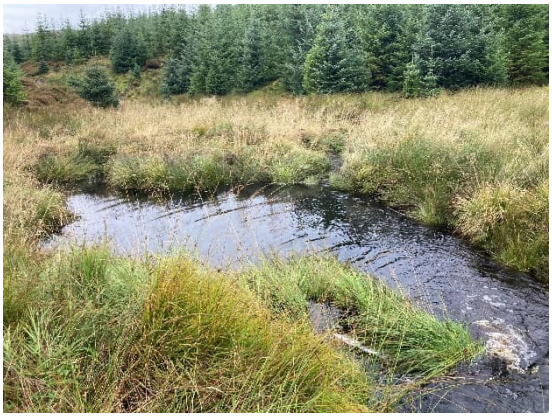

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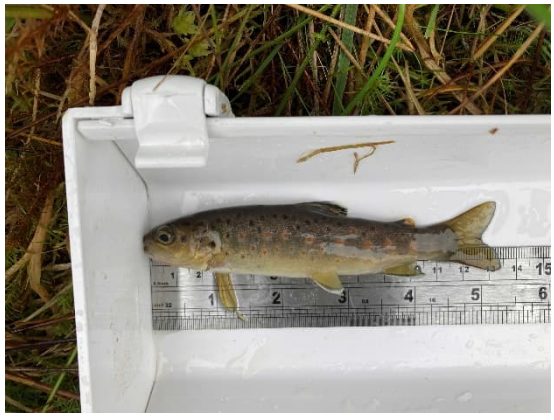

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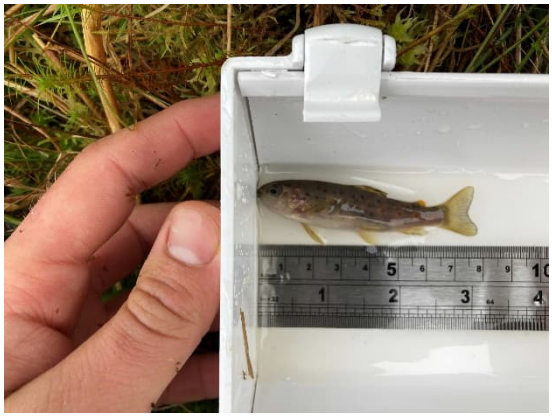


d)

Figure 15. Site BL-22 *River Aray*

BL-23 Unnamed (tributary of River Aray)

The site ran through an open, clear-felled area adjacent to a conifer plantation (Fig. 16a-b). The channel (W = 0.3 m, D = 0.4 m) had deep-cut banks (H = 0.5–0.75 m) with a large amount of woody debris and emergent reeds and sedges along the margins (Fig. 16a-b).Previous surveys had identified patches of gravel (A <0.5 m^2) for potential trout spawning habitat 100 m downstream in the tributary, although the flows were generally too low and a culvert under the forestry access track may prove to be impassable barriers to fish migrating upstream unless in spate. No fish were seen during the survey.

No suitable FWPM habitat, due to the unstable nature of the substrate, was observed at this site during the 2019 surveys.

In 2019, three macrophytes were recorded: jointed rush, lesser spearwort, and compressed flapwort. No rare or notable species were recorded and the community coverage was approximately 5% of the channel.

A low diversity was recorded within the 2019 aquatic macroinvertebrate community (26 taxa). The biological quality of this site was very good (ASPT: 6.6, NTAXA, 15) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site has a **moderate conservation status** (CCI: 6) with all of the taxa recorded being of very common and occasional status (as defined by the CCI).

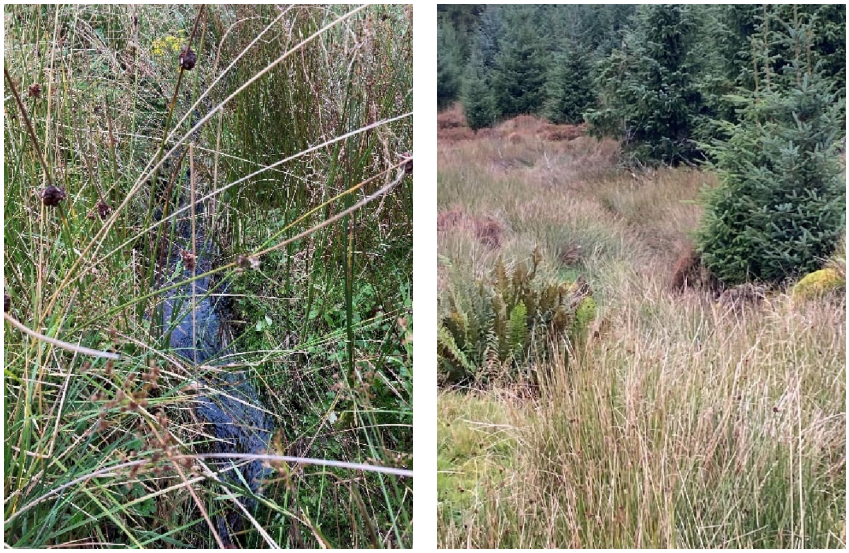
The macroinvertebrate community present during autumn 2023 was of very good biological quality (ASPT: 6.6; NTAXA: 21). The community suggested the substrate was moderately sedimented (PSI: 58.62), indicated by the considerable presence of true fly larvae (e.g., non-biting midges Orthocladiinae and Tanypodinae, and Limoniidae), snails (*Galba truncatula*), and Oligochaeta worms. The community present was also of high sensitivity to reduced flows (LIFE: 7.69). This was demonstrated by the numerous stonefly taxa inhabiting the watercourse, alongside caddisfly larvae that prefer faster flowing habitats (e.g. *Plectrocnemia conspersa, Micropterna sequax* and *Sericostoma personatum*). The **fairly high conservation value** (CCI: 12.3), was largely due to the presence of the Locally notable stonefly *P. meyeri* with a conservation score of 5. The dragonfly larvae *Cordulegaster boltonii* and diving beetle *Agabus guttatus*, were both also present with occasional conservation scores of 4. The remaining species identified were of frequent to very common status, as defined by their respective CCI values.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

During 2021, electric fish surveys consisted of three 100 m runs, with no fish caught. The watercourse was previously on average 70 cm wide and 50 cm deep. The substrate comprised of organic matter and silt with some cobbles. The habitats present were predominantly run and glide. The water temperature recorded was 9 °C and conductivity measured 25.7 μScm^{-1}.

No fish were found during electric fish surveys in 2023, as access was highly limited due to collapsed banks and dense vegetation growth, which prevented egress along most of the watercourse. Due to channel constrictions, the use of the anode for the electric fishing was also affected as it was difficult to keep within the wetted channel. The water temperature recorded was 11.0 °C and conductivity measured 24.3 μScm^{-1}.

No non-native species were recorded during any surveys at this site.



a) b)

Figure 16. Site BL-23 Unnamed (tributary of *River Aray*)

BL-24 Unnamed (tributary of Achan River)

Site BL-24 was not surveyed in September 2019 and 2023 owing to access constraints.

BL-25 Unnamed (tributary of Keppochan River)

This tributary of the Keppochan River ran through a shallow, rocky gorge in a mature conifer plantation (Fig. 17a-b). The stream was in spate during the survey, with very fast flows observed (W = 3 m, D = 0.45 m). The riverbed was bedrock-boulder dominant, with some patches of course, mobile substrates (cobbles/pebbles/gravel) in slower areas, forming isolated pockets of potential trout and salmon spawning habitat in places. However, these may be too unstable to support spawning, given the channel runs over a very steep bedrock slope.

No suitable FWPM habitat was observed at this site and there was no evidence of mussels (shells) were seen. It was noted that the riverbed substrates appeared too unstable during the 2019 surveys..

Macrophyte surveys completed in 2019 identified six bryophyte species, however there was an absence of higher plants. These were recorded as the liverwort *Pellia* sp., common water-moss, compressed flapwort, common haircup, yellow fringed moss, and flagellate feather-moss *Hyocomium armoricum*. No rare or notable species were recorded and the community coverage was approximately 15% of the channel.

A low diversity was recorded within the aquatic macroinvertebrate community (15 taxa) in 2019. The biological quality of this site was very good (ASPT: 7.1, NTAXA, 13) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site has a **fairly high conservation value** (CCI: 11.7) with the majority of the species recorded being of very common to frequent status (as defined by the CCI). The only exception was the Locally Notable stonefly *Protonemura meyeri,*

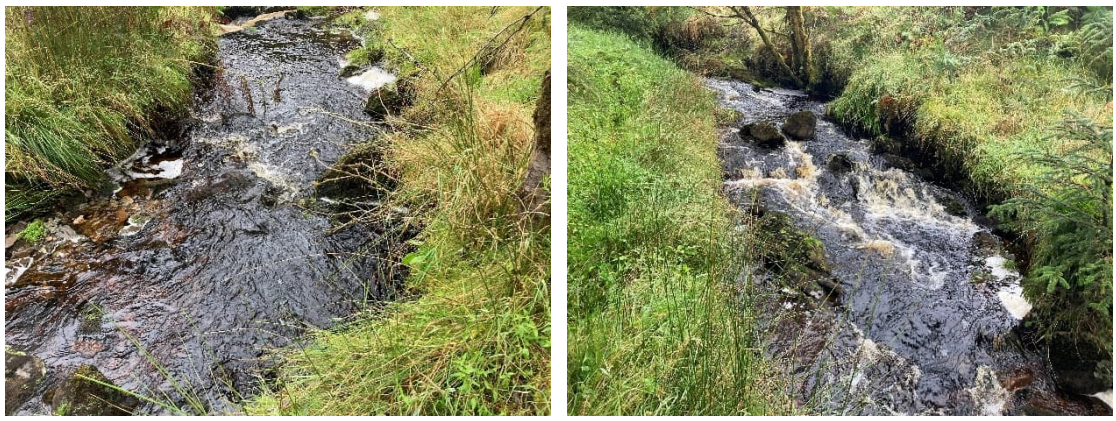
The macroinvertebrate community in autumn 2023 had a very good biological quality (ASPT: 7.4; NTAXA: 13). The substrate within the River Aray was minimally sedimented/unsedimented as indicated by a PSI score of 90.48. The community present was of high sensitivity to reduced flows (LIFE: 7.55). This was evident by the presence of mayfly, stonefly and caseless caddisfly taxa which are adapted to faster flows within a watercourse. The site was of **moderate conservation value** (CCI: 9.3), with most species of common to very frequent status, as defined by their respective CCI scores. The only exception was the Locally Notable stonefly *P. meyeri*, which was present with 34 specimens.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

Electric fish surveys in 2021 consisted of a single 6-minute run at the site which was performed over 40 m of watercourse. No fish were caught. The water temperature recorded was 9.6 °C and conductivity measured 23.19 μScm^{-1}.

The electric fish surveys in 2023 also found no fish. Only a downstream stop net was used, as upstream of the survey reach was a culvert from under a forestry access track which discharged on a small waterfall feature, forming a natural barrier to fish migration upstream. The water temperature recorded was 9.6 °C and conductivity measured 23.19 µScm^{-1}.

No non-native species were recorded, during any surveys on the unnamed tributary of the Keppochan River.



a) b)

Figure 17. Site BL-25 Unnamed (tributary of *Keppochan River*)

BL-26 Unnamed (tributary of Allt na Cuile Riabhaiche)

This reach of the tributary stream (Allt na Cuile Riabhaiche) dropped down a shallow, rocky gorge in a mature conifer forest (Fig. 18a-d). The watercourse was generally characterised by fast-flowing waters and a bedrock-boulder dominated riverbed with some coarse, mobile substrates (cobble, pebble, gravel) with undercut earth banks (H = 0.5 m) (Fig. 19b-c). The surveyed section (W = 2 m, D = 0.35 m) featured numerous steps and cascades forming potential obstacles to fish migration. A deep gorge section with high, rocky banks (H = 3–4 m) and a waterfall (H = 3 m) at the upper end of the section (NN 06635 18965) formed a complete barrier to fish migration (Fig. 19b). Isolated pockets of potential spawning habitats for salmon and trout (stable, clean gravel deposits in fast-flowing water) were observed below the waterfall. No fish were seen during the survey.

Further downstream, a significant waterfall registered as impassable barrier on the Keppochan River was identified on the SEPA Obstacles to Fish Migration map layer[2], explaining the absence of migratory fish above this point.

No suitable FWPM habitat and no evidence of mussels (shells) was observed at this site durignt he 2019 surveys. The riverbed substrates were considered to be too coarse and unstable to support mussels.

Four macrophytes were recorded at the site and included compressed flapwort, a liverwort *Pellia* sp., common water-moss and blinks *Montia fontana*. No rare or notable species were recorded and the community coverage was approximately 30% of the channel.

A low diversity was recorded within the 2019 aquatic macroinvertebrate community (15 taxa). The biological quality of this site was very good (ASPT: 5.9, NTAXA, 11) with a number of pollution sensitive taxa recorded, suggesting that the site is not impacted by organic pollution. The site has a **fairly high conservation value** (CCI: 10.0) with the majority of the species recorded being of very common to frequent status. The only exception was the Locally notable stonefly *P. meyeri.*

The autumn 2023 macroinvertebrate community present was of good biological quality (ASPT: 7.1; NTAXA: 13) with moderate diversity (16 taxa). The macroinvertebrate community present within the tributary reflected a minimally sedimented/unsedimented substrate, as evidenced by a PSI score of 90.48. The community also exhibited a moderate sensitivity to reduced flows (LIFE: 7.22). This was evidenced by the presence of taxa preferring various flow types. Taxa that are adapted to faster flows, such as stoneflies (e.g. *I. grammatica* and *S. torrentium*), riffle beetles (e.g. *E. aenea*) were dominant within the sampled community. However, additional taxa that are adapted to slower flows, the marsh beetle Scirtidae, which is more frequently associated with stagnant waters. The **moderate conservation value** (CCI: 9.3), due to the presence the Locally notable stonefly *P.*

meyeri, with a CCI score of 5. The remaining identified species were of common to very common status, as classed by their respective CCI scores.

Spring macroinvertebrate surveys are scheduled for completion in 2024.

During the 2021 electric fish surveys a single 6-minute run was performed over 35 m of watercourse. No fish were caught. The water temperature recorded was 9.2 °C and conductivity measured 19.3 µScm^{-1}.

Further surveys in 2023, similarly also identified no fish within the watercourse. However, this is most likely due to high flow rates (>1.5 m/sec), with over 35% of the surveyed reach recorded as torrents, and low levels of pooling across less than 20% of the reach. Torrential rain and storm conditions had previously caused a spike in water levels of the channel to over 1.25 m, which was visible on the banks the following day. The water temperature recorded was 9.9°C and conductivity measured 17.8 µScm^{-1}.

No non-native species were recorded during any surveys at the site.

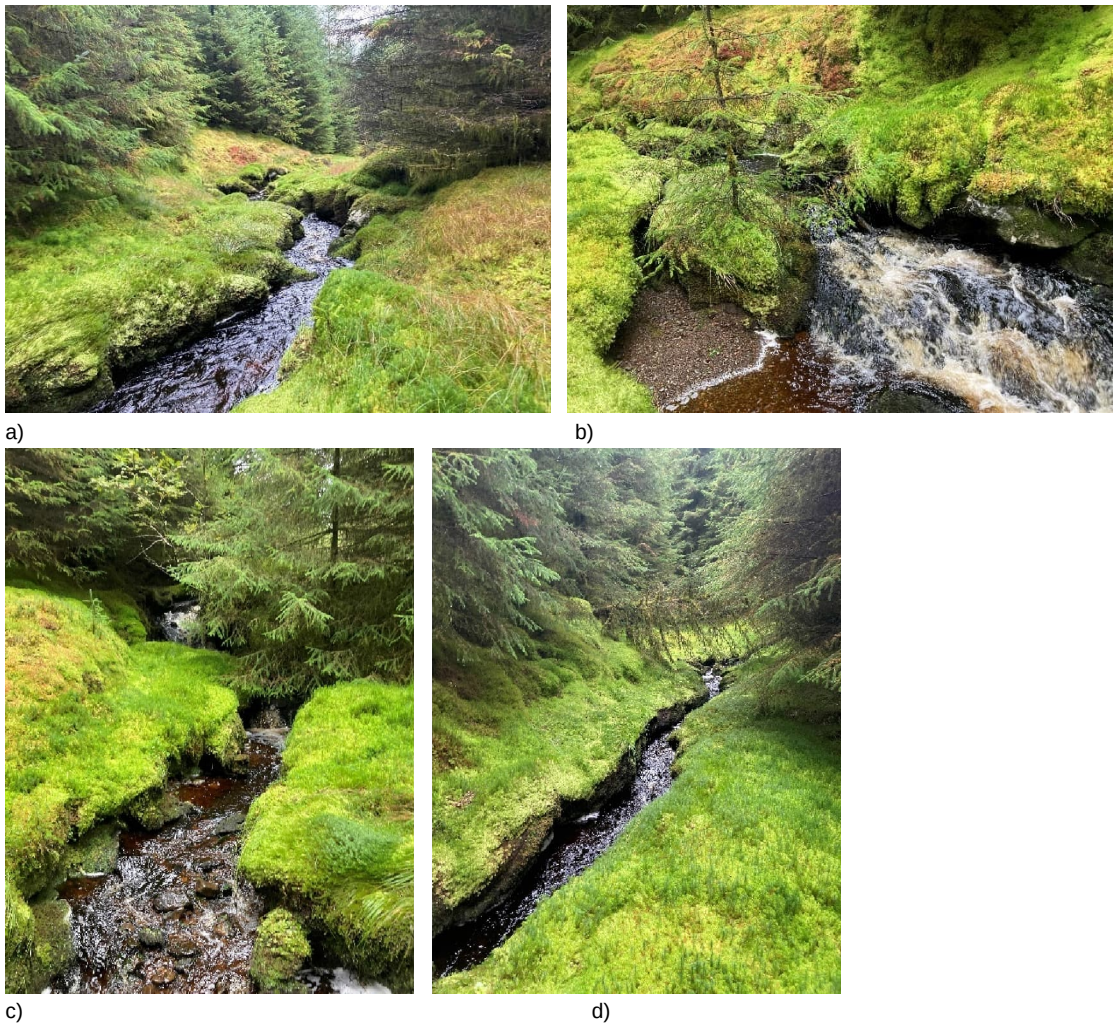


Figure 18. Site BL-26 Unnamed (tributary of *Allt na Cuile Riabhaiche*)

3.3 Biological Metrics

Macrophytes

The full list of macrophyte taxa and marginal species recorded during surveys can be found in Annex F Macrophyte taxa . River Macrophyte Nutrient Index (RMNI), number of macrophyte taxa (NTAXA), Number of Functional Groups (NFG) and cover of filamentous green algae (ALG), observed and predicted scores for each survey reach are detailed in Table 6 LEAFPACS2 metrics for macrophyte surveys conducted in 2019. The table also includes the overall Ecological Quality Ratio (EQR) and WFD class for each survey reach.

Table 6. LEAFPACS2 metrics for macrophyte surveys conducted in 2019

Site ID	RMNI	NTAXA	NFG	ALG	EQR	WFD class
BL-01	3.42	3	3	0	0.99	High
BL-02	3.30	2	2	0	0.83	High
BL-04	5.41	1	1	0	0.50	Moderate
BL-05	-	-	-	-	-	N/A
BL-06	5.00	1	1	0	0.52	Moderate
BL-07	5.07	1	1	0	0.47	Moderate
BL-17	6.23	2	1	0	0.36	Poor
BL-22	3.35	6	5	0	0.98	High
BL-23	2.07	1	1	0	0.84	High
BL-25	3.38	2	2	0	0.72	Good
BL-26	4.08	2	2	0	0.63	Good

The macrophyte data for BL-05 could not be processed for LEAFPACS as only presence data was collected for macrophyte taxa, rather than taxon cover values.

The minimum requirement for LEAFPACS2 classification is three scoring macrophyte taxa. Only two sites (BL-01 and BL-22) achieved this threshold in 2019. Consequently, for all other sites results are considered to be indicative only and should be treated with caution.

Four sites (BL-01, BL-02, BL-22 and BL-23) all attained a High WFD classification, while a further two sites (BL-25 and BL-26) attained a Good WFD classification, demonstrating the macrophyte communities present were not impacted by either nutrient enrichment, alterations in river flow and/or modifications to morphological conditions. A further three sites (BL-04, BL-06 and BL-07) were all classified as having a Moderate WFD status. These sites were likely impacted by nutrient enrichment, changes to flow and/or channel modification. Further impacts to BL-17, on the confluence of an outfall to Loch Awe, were evident as it attained a WFD classification of Poor status.

Macroinvertebrates

A summary of the macroinvertebrate biological metrics calculated for each site, are presented in Table 7 Macroinvertebrate biotic index results, below, for the autumn 2023 survey season. The full lists of aquatic macroinvertebrate taxa can be found in Annex G Macroinvertebrate taxa .

Table 7. Macroinvertebrate biotic index results

Site Reference	Season	CCI (Conservation value)	PSI and interpretation	LIFE and interpretation to reduced flows	WHPT-ASPT	WHPT-NTAXA
BL-01	Autumn 2023	8.2 - Moderate	88.24 - Minimally sedimented/unsedimented	8.79 – High sensitivity	6.95	21
BL-02	Autumn 2023	10.0 – Fairly high	94.12 - Minimally sedimented/unsedimented[†]	8.80 – High sensitivity	7.70	10

Site Reference	Season	CCI (Conservation value)	PSI and interpretation	LIFE and interpretation to reduced flows	WHPT-ASPT	WHPT-NTAXA
BL-04	Autumn 2023	9.4 – Moderate	92.31 – Minimally sedimented/unsedimented	8.36 - High sensitivity	8.32	12
BL-05	Autumn 2023	10.0 – Fairly high	90.48 – Minimally sedimented/unsedimented	8.60 - High sensitivity	7.44	14
BL-06	Autumn 2023	5.3 - Moderate	28.57 - Sedimented†	9.00 - High sensitivity †	5.40	20
BL-07	Autumn 2023	9.4 - Moderate	91.89 – Minimally sedimented/unsedimented	8.53 - High sensitivity	7.90	19
BL-14	Autumn 2023	7.5 - Moderate	28.57 – Sedimented†	9.00 - High sensitivity †	3.13	4
BL-17	Autumn 2023	5.6 - Moderate	35.00 - Sedimented†	6.33 - Low sensitivity †	4.97	14
BL-18	Autumn 2023	4.0 - Low	87.50 – Minimally sedimented/unsedimented	7.40 - High sensitivity †	6.02	13
BL-19	Autumn 2023	80.0 – Very high	0.00 – Heavily sedimented†	6.00 - Low sensitivity †	3.97	3
BL-20	Autumn 2023	A	A	A	A	A
BL-21	Autumn 2023	A	A	A	A	A
BL-22	Autumn 2023	9.3 - Moderate	78.57 – Slightly sedimented	7.89 - High sensitivity	7.03	18
BL-23	Autumn 2023	12.3 – Fairly high	58.62 – Moderately sedimented	7.69 – High sensitivity	6.59	21
BL-25	Autumn 2023	9.3 - Moderate	90.48 - Minimally sedimented/unsedimented	7.55 - High sensitivity †	7.42	13
BL-26	Autumn 2023	9.3 - Moderate	90.48 - Minimally sedimented/unsedimented	7.22 - Moderate sensitivity †	7.13	13

† - Lack of scoring species which may have artificially increased scores, therefore family value has been used

A – Surveys aborted so no sample was collected for analysis

Table 8 RICT indices for Autumn 2023 and Spring 2024 macroinvertebrate surveys, displays the Ecological Quality Ratio (EQR) and WFD macroinvertebrate status for the WHPT ASPT and NTAXA indices for each survey location, as well as the most probable WFD status based on the combination of the modelled distributions for each of ASPT and NTAXA across all classes, termed MINTA (Minimum of NTAXA and ASPT EQRs). Brackish sites (BL-14) and loch sites (BL-18, BL-19, BL-20 and BL-21) were removed from analysis as RICT was developed for communities within running watercourses.

For the interest of this report, the previous survey season of autumn 2019 was analysed but was not included within the overall WFD class (MINTA) for 2023 due to the gap between the two sets of data.

Table 8. RICT indices for Autumn 2023 and Spring 2024 macroinvertebrate surveys

Site ID	NTAXA EOR		ASPT EOR		
	Autumn 2019	Autumn 2023	Autumn 2019	Autumn 2023	Overall WFD class (MINTA) for 2023 and 2024
BL-01	0.97(H)	1.18(H)	0.98(H)	0.94(G)	Good††
BL-02	0.58(M)	0.70 (M)	0.98(H)	1.01(H)	Good††
BL-04	0.63(M)	0.74(G)	0.82(M)	1.11(H)	Good††
BL-05	1.42(H)	0.91(H)	0.94(G)	0.98(H)	Good††
BL-06	1.09(H)	1.26(H)	0.85(M)	0.90(G)	Good††
BL-07	1.19(H)	1.19(H)	0.93(G)	1.04(H)	High††

BL-17	1.02(H)	0.91(H)	0.71(P)	0.75(M)	Moderate††
BL-22	1.53(H)	1.13(H)	0.90(G)	0.95(G)	Good††
BL-23	1.02(H)	1.38(H)	0.89(G)	0.89(G)	Good††
BL-25	0.91(H)	0.91(H)	0.94(G)	0.98(H)	Good††
BL-26	0.76(H)	0.88(H)	0.80(M)	0.95(H)	Good††

EQRs are valued as High (H), Good (G), Moderate (M), Poor (P), and Bad (B)

†† - Value currently based off autumn 2023 result only and is not reflective of overall score, which will be updated following the spring 2024 macroinvertebrate sample analyses

One site, BL-07, attained a High overall classification while majority of the remaining sites were classified as having a Good overall WFD class. The only other expectation was BL-17, which was the lowest classified site from Autumn 2023, with a Moderate classification.

Official WFD classifications are based on combined spring and autumn macroinvertebrate survey data, whereas currently the RICT analysis is based solely on autumn season data. Alkalinity data should be obtained from monthly analysis of samples from each over a period of at least one year, whereas here, only one sample was taken during the survey period. Therefore, classifications presented here based on only one alkalinity measurement are indicative of point-in-time classification only.

3.4 Fish eDNA

Two sites on Loch Awe were identified for fish eDNA sampling locations in 2023. These were BL-18 which was situated on the eastern shoreline and BL-19 was located at the confluence of Loch Awe with the River Awe to the Northwest.

The eDNA analysis for both BL-18 and BL-19 for the 2024 period, is yet to be completed and will be reported upon as an addendum alongside spring survey results at a later stage.

BL-18

In 2021, four fish species were detected in the eDNA sample (Table 9 Results of eDNA surveys for fish species) with minnow *Phoxinus phoxinus* accounting for the highest percentage of sequence reads (60.9%). Brown trout, a species of note, accounted for the second highest sequence reads (26.4%).

In 2023, a total of six fish species were recorded from the eDNA survey (Table 9 Results of eDNA surveys for fish species). A high percentage of Minnow sequence reads (30.8%) persisted, although the species of note, Brown trout, was also present with the highest recorded sequence reads (61.7%) within the sample.

BL-19

In 2021, seven fish species were detected in the eDNA sample (Table 9 Results of eDNA surveys for fish species). with rainbow trout *Oncorhynchus mykiss* accounting for the highest percentage of sequence reads (38.2%). Species of note recorded include brown trout (0.5%), European eel (3.9%) and Atlantic salmon (0.2%).

In 2023, nine fish species were detected within the eDNA sample (Table 9 Results of eDNA surveys for fish species). Similar to the prior survey, rainbow trout were the recorded with the highest percentage of sequence reads (54.7%). Other species of note within the sample included brown trout (2.2%) and European eel (2.2%). Atlantic Salmon was not detected within the sample during the 2023 survey.

Table 9. Results of eDNA surveys for fish species

Common name	Scientific name	BL-18		BL-19	
		2021	2023	2021	2023
European Eel	*Anguilla anguilla*	-	-	✓	✓
Carp	*Cyprinus carpio*	✓	-	-	-
Chub	*Squalius cephalus*	-	✓*	-	✓*
Stone Loach	*Barbatula barbatula*	-	-	-	✓*

Common name	Scientific name	BL-18		BL-19	
		2021	2023	2021	2023
Northern Pike	*Esox lucius*	-	-	-	✓
Minnow	*Phoxinus phoxinus*	✓	✓	✓	✓
Roach	*Rutilus rutilus*	-	✓	✓	✓
Perch	*Perca fluiviatus*	✓	✓	✓	✓
Rainbow trout	*Oncorhynchus mykiss*	-	-	✓	-
Atlantic salmon	*Salmo salar*	-	-	✓	-
Rainbow Trout	*Oncorhynchus mykiss*	-	-	-	✓
Sea/Brown trout	*Salmo trutta*	✓	✓	✓	✓

* eDNA analysis suggest low support for taxonomic identification as it is based on fewer than three matches to sequences in the reference database, and/or limited geographic occurrence records for the taxon.

4. Discussion and Recommendations

4.1 FWPM Habitat

No optimal riverbed FWPM habitat (boulder-stabilised deposits of clean sand) was observed at any of the surveyed sites. However, potential sub-optimal habitats (small patches of coarse sands and gravels) that may support small numbers of adult mussels, were noted at sites BL-01, BL-02, BL-04, BL-07, BL-22.

No evidence of FWPM (mussels, shells) was found at any site, and no historical records were found in the proposed Development area during the desk study.

No further FWPM surveys of the surveyed watercourses mentioned in this report are considered necessary, based on the results of the surveys undertaken.

4.2 Macrophytes

No protected or notable macrophyte species were identified in the desk study.

Flowing Water Habitats (BL-01, 02, 04, 05, 06, 07, 17, 22, 23, 25 and 26)

No rare or notable species were recorded within any of the survey sites. The sites surveyed are on small oligotrophic headwater streams and supported typical macrophyte communities characterised by bryophytes with higher plants limited and generally confined to the margins.

These macrophyte communities are considered typical of upland watercourses in this part of Scotland. The steep gradients, resulting high velocity flow conditions, and unstable substrates does not allow the development of extensive or diverse stands of macrophytes, while bryophytes, which are able to cope with these conditions, dominate. Although there was a slight increase in the diversity of vascular plants within sites with less dynamic flow conditions (such as BL- 17 and BL-22), the sites were still relatively species poor.

Similar macrophyte communities are likely to be very common across the wider landscape and therefore the macrophyte communities encountered are considered to be of negligible nature conservation value.

Loch Awe (BL18 and BL19)

No rare or notable species were recorded within either of the survey sites. The current WFD status for aquatic macrophytes and phytobenthos (diatoms) in Loch Awe is ‘Moderate’ and ‘High’ (Cycle 2: 2016) respectively. The communities surveyed were species poor and the species present are typical of a large oligotrophic lake.

The macrophyte community was similar at both sites and does not indicate that the potential intake and outfall locations are a particularly sensitive area for macrophytes. The communities present are likely to occur in numerous other locations within Loch Awe and in other similar lochs within the local area. As such, macrophyte community is of no greater than negligible nature conservation value.

Lochan Airigh (BL-20) and Lochan Breac-liath (BL-21)

No rare or notable species were recorded within either lochan. The communities surveyed were species poor and typical of oligotrophic lakes.

The macrophyte community was similar at both sites and the communities present are likely to occur in numerous other locations in similar lochs within the local area. As such, macrophyte community is of no greater than negligible nature conservation value.

4.3 Aquatic Macroinvertebrates

No notable or protected species were identified during the desk study.

The most notable species recorded during the 2019 surveys, was the diving beetle *Agabus arcticus* (conservation score: 6, but not listed in the Coleoptera Red Data Book RDB) in BL-20 Lochan Airigh. This is not a SBL species, is not rare and is widespread through Scotland, but its distribution is limited by its specific habitat requirements (montane lakes). However, in the local context, these habitats are fairly common and as such it can be expected to occur wherever there are comparable habitats. The most notable species recorded within 2023 communities

were found on the shore of Loch Awe (BL-19), which had the highest conservation score due to the presence of the Rare RDB3 diving beetle *Oreodytes davisii* (conservation score: 8 – listed as Near Threatened in the RDB). All other aquatic macroinvertebrate recorded were common and typical of the habitats present. None were threatened or legally protected. On this basis, there are no other species considered greater than negligible nature conservation value.

Within the flowing water sites (BL-01, BL-02, BL-04, BL-05, BL-06, BL-07, BL-17, BL-22, BL-23, BL-25 and BL-26) the communities are considered typical of fast-flowing upland watercourses comprising a range of mayfly, stonefly, caddisfly, truefly and beetle taxa. Although the watercourses are classified as moderate to fairly high conservation value in terms of the CCI, non are considered to be notably diverse or unique (in a local context). It is likely that similar macroinvertebrate communities are common across the wider landscape and therefore the macroinvertebrate communities present are considered no greater than of negligible nature conservation value.

Stonefly presence was extensive among the sites with two Locally notable species present, as classified by their CCI score. The stonefly *Protonemura meyeri* was widespread among the Balliemeanoch sites, being found at 10 sites (BL-01, BL-02, BL-04, BL-05, BL-07, BL-22, BL-23, BL-24, BL-25 and BL-26). An additional two records of the Locally Notable *Protonemura praecox* was also found on the hillside of Loch Awe at BL-05 and BL-07 – this species is listed as Least Concern in the Plecoptera RDB.

Most caddisflies identified were of common or lower conservation status with the exception of Locally Notable caddisfly *Limnephilus bipunctatus*, which was found within the community at BL-06 – this species is listed as Least Concern in the RDB. A singular species of alderfly was recorded from macroinvertebrate samples and was later identified as the Locally Notable (CCI) *Sialis fuliginosa* – this species is not listed in the RDB.

Communities were generally of high sensitivity to reduced flow, most likely due to the nature of faster flows down highland headwater rivers and streams. The sites BL-19 and BL-17 had a low sensitivity to reduced flows, but this was due to the present communities being adapted to slower or no flows of the loch shores. Presence of notable species resulted in moderate conservation value or higher for all sites, except for BL-18 which was of low conservation value. Similarly with sedimentation levels, higher sedimentation was present at Loch shore sites BL-17 and BL-19, in addition to slower flowing sites through forestry land where earth banks and tree removal was present, such as BL-23.

The sites, BL-18 and BL-19 on the banks of Loch Awe are both defined by the CCI to have a moderate conservation value in 2019, dropping to low conservation value and the latter increasing to fairly high conservation values respectively in 2023. However, it should be noted that the sampling location change may influence results. The communities present on the loch shores are considered typical of these habitats and are likely to occur in numerous other locations in other similar lochs within the local area. As such, aquatic macroinvertebrate community is considered no greater than of negligible nature conservation value.

Lochan Airigh (BL-20) is defined by the CCI as having a very high conservation status (CCI: 15), which was the highest across the sites surveyed in 2019. However, as only eleven species were recorded the presence of a few taxa of moderate conservation importance (*Gammarus lacustris, Acilius sulcatus:* both conservation score five, and *Agabus arcticus* conservation score six). It is therefore likely that the highlighted taxa of conservation value are also present in the wider landscape, and as such the community is of negligible nature conservation value. The community present is considered fairly typical and is likely to occur in numerous other locations in other similar lochs within the local area. As such, aquatic macroinvertebrate community is considered to be of no greater than negligible nature conservation value.

The communities of macroinvertebrates found within the samples are indicative of the wider landscape. All sites surveyed were of Good or Very good biological quality with the exception of BL-19, which was of Poor quality with generally lower diversity than other sites. The WHPT scores indicate that the watercourses are not significantly impacted by organic pollution and/or other pollution sources. It is therefore it is important that pollution prevention measures are instated during construction works, such as temporary silt fencing, SuDs features and attenuation ponds to maintain the baseline condition of these watercourses.

There was a low presence of non-native and non-invasives within macroinvertebrate community samples with small numbers of New Zealand mud snail was found at BL-06 and BL-17, and the amphipod *Crangonyx pseudogracillis/floridanus* was found at BL-19.

Three dragonfly species are listed in the Argyll and Bute Local BAP 2010 - 2015, the white-faced darter *Leucorrhinia dubia*, the brilliant emerald *Somatochlora metallica* and the Azure hawker, *Aeshna caerulea*.

However, none of these species were recorded during the aquatic invertebrate surveys the desk study, or during the adult dragonflies and damselflies surveys (Appendix 6.5: Butterfly, Dragonfly and Damselfly Survey Report, Volume 5). As such, it is considered unlikely that these species occur within the Site.

4.4 Fish

Three fish species likely or known to be present in Loch Awe (Atlantic salmon, sea lamprey and river lamprey) are listed as LBAP priority species (Argyll and Bute LBAP, JNCC. 2007). All three fish species are Scottish Biodiversity List species and UK Biodiveristy Action Plan species[3]. It is also an objective in the LBAP to remove stream crossing obstacles to fish migration. European eel is also recorded in Loch Awe, being a SBL species and afforded protection under the Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008. However, eel screening guidance for England and Wales does not apply in Scotland, and this would be resolved through the CAR licence discussed below.

Both river lamprey and Atlantic salmon (protected in freshwater only) are listed in Annex II of the Habitats Directive and in the Conservation (Natural Habitats, &c.) Regulations 1994[4] (as amended). The Salmon and Freshwater Fisheries Act also affords protection to fish and their habitats, including spawning habitats.

Works in Loch Awe (and other watercourses) will require a Controlled Activities Regulations (CAR) licence application to SEPA before the works can proceed.

Under the CAR licence the works in Loch Awe may be restricted as to the timing of their completion, in order to avoid the salmon migratory season when salmon and other migratory species (eel, lamprey, sea trout) will be moving through Loch Awe. The CAR licence is likely to limit construction works in Loch Awe to between July and October. Screening requirements for the inlet/outlet structure would also be agreed through the CAR licence.

Fish Habitat

Fish habitat surveys identified habitat with the potential to support breeding populations of species identified within the desk study. Subsequently, these surveys helped to evaluate likely impacts to the minor watercourses and the shoreline of Loch Awe and Loch Fyne, while informing follow up electric fishing surveys in 2021 and 2023

Potential salmonid spawning habitat was observed at the following sites: BL-01, BL-02, BL-22, BL-23. Live juvenile trout (parr) were found in BL-01, confirming its suitability to support this species. It is also possible that salmon and sea trout utilise some of these watercourses. Small patches (<1 m^2) of suitable salmonid spawning habitat were also noted at BL-04, BL-07, BL-25, BL-26. However, fish migration to these sites may be prevented or generally restricted by the steep gradients and numerous natural and artificial obstacles (waterfalls and dams) observed on these watercourses. The field observations were corroborated by the SEPA *Obstacles to Fish Migration* map layer, explaining the absence of migratory fish at these sites.

Some sites could potentially support small numbers of European eel. However, as previously mentioned, fish movements upstream at sites BL-04, BL-07, BL-25, BL-26 appear to be severely restricted or prevented by natural and artificial obstacles, thus rendering them unavailable to colonise by migratory fish.

The sections of watercourses surveyed indicated prevalent moderate-steep gradients and a lack of suitable riverbed substrates (stable fine sand deposits) observed, required to support nursery habitats for lamprey ammocoetes (larvae). However, it should be noted that lamprey have previously been recorded in the general area, indicating that small areas of potentially suitable lamprey habitat (not observed during the present survey) may be present in the Development Site.

The water bodies (lochs) surveyed had suitable trout habitat: BL-18, BL-19, BL-10, BL-21. Trout are confirmed in BL-20 through desk study records. Minnows were identified in BL-18, BL-19 and BL-21 during the surveys.

Electric fishing surveys at BL-01, BL-02, BL-22 and BL-23 are recommended to inform the impact assessment by establishing the fish species present and the potential for these species to spawn at those locations, potentially salmonid species (Atlantic salmon and brown/sea trout), lamprey species and European eel. Similar surveys of

[3] UK Biodiversity Action Plan - List of UK BAP Priority Fish Species (excluding purely marine species) 2007. Available at: https://data.jncc.gov.uk/data/98fb6dab-13ae-470d-884b-7816afce42d4/UKBAP-priority-fish.pdf (accessed November 2023)
[4] Conservation (Natural Habitats, &c.) Regulations 1994. Available at: https://www.legislation.gov.uk/uksi/1994/2716/contents/made (accessed November 2023)

BL-04, BL-07, BL-25, BL-26 would also provide useful data if these sites are to be affected by the Development, but they are considered to be less important in terms of potential fish spawning habitat.

Electric fishing

Brown trout were recorded at three of the eight sites that were electric fished in 2021 and 2023: BL-01, BL-02 and BL-22. Juvenile trout captured included both fry 0+ and parr 1+ year classes. This confirms that active spawning is occurring in and around the locations where fish were caught. During previous aquatic walkover surveys potential Atlantic salmon (BL-02) and trout (BL-01, BL-02, BL-22) spawning habitat was observed at all three sites. Trout were found at BL-01, BL-02, and BL-22, while Atlantic Salmon was only recorded at BL-01. No impassable barriers to migration were recorded during walkover surveys or on SEPA Obstacles to Fish Migration map[1] downstream of these three sites. It is therefore possible that Atlantic salmon and sea trout, as well as European eel and lamprey, could utilise the sites.

No fish were caught at sites BL-23, BL-25, and BL-26 during both survey years (steps and cascades forming potential obstacles to fish migration. A deep gorge section with high, rocky banks (H = 3–4 m) and a waterfall (H = 3 m) at the upper end of the section (NN 06635 18965) formed a complete barrier to fish migration, Isolated pockets of potential spawning habitats for salmon and trout (stable, clean gravel deposits in fast-flowing water) were observed below the waterfall). In the aquatic walkover surveys, small patches (<0.5 m^2) of potential salmonid spawning habitat were noted at BL-25 and BL-26, however fish migration to these sites may be restricted by steep gradients (BL-25) or naturally formed steps and cascades (BL-26). The SEPA *Obstacles to Fish Migration* map[5] also identified a natural impassable barrier to fish passage downstream of the survey site at BL-25. It is therefore unlikely that migratory salmonids, European eel, or lamprey *spp*. would be present at this site.

Site BL-04, during both 2021and 2023, was not surveyed due to the watercourse being in spate and storm conditions respectively. Small patches (<1 m^2) of potential suboptimal salmonid spawning habitat were noted during the aquatic walkover surveys at BL-04. The SEPA *Obstacles to Fish Migration* map[5] identified a natural impassable barrier to fish passage downstream of the survey site at BL-04. Walkover surveys also identified a 2 m high reservoir sluice/dam (NN 02884 15425) that also forms a potential barrier to migration downstream. It is therefore unlikely that Atlantic salmon, sea trout, European eel, or lamprey would be present at this site, however it may be possible that resident trout populations could inhabit the area.

Similarly, Site BL-07 was also not surveyed during either year, due to the watercourse being in spate and storm conditions. Walkover surveys indicated potential Atlantic salmon and trout spawning habitat, however the site was characterised by numerous cascades, steps, and minor falls (height = 0.5 - 1 m), with a significant waterfall (height = 3 m) forming a barrier to fish movement upstream. Nonetheless, it may be possible for Atlantic salmon, sea/brown trout, European eel, and lamprey to utilise this site and further evaluation would require a full passability assessment.

4.5 eDNA

Previous eDNA results from Loch Awe, in 2021, indicate the presence of three protected fish species; European eel (IUCN Critically Endangered, UKBAP and Scottish Biodiversity List (SBL) Priority Species), brown/sea trout (UKBAP and SBL Priority Species) and Atlantic salmon (IUCN Endangered in the UK; Annex II Habitats Directive, UKBAP, and SBL Priority Species).

Arctic charr *Savelinus alpinus* (UKBAP species), pike *Esox lucius*, Lamprey *lampetra* sp, and three-spined stickleback *Gasterosteus aculeatus,* were not detected by eDNA survey but are known to be present in Loch Awe (SEPA survey database). Sea lamprey and river lamprey are a listed species on Annex II of the Habitats Directive and are UKBAP and LBAP priority species (Argyll and Bute LBAP, JNCC. 2007).

The presence of carp at the BL-18 site is unexpected and is likely the result of introduction as a sport fish. Carp are not native to oligotrophic lochs in Scotland and are known to mobilise phosphorous bound within sediment, potentially bringing about undesirable changes within the macrophyte and algal community (Fisher *et al.* 2016).

Non-native rainbow trout gave the highest percentage of sequence reads at the BL-19 site. This is likely due to the proximity of the sampling site to the fish farm, from which numerous escapes have been documented in the past.

[5] https://map.environment.gov.scot/sewebmap/

4.6 Invasive Non-Native Species

Canadian pondweed has been recorded to the west of the red line boundary in Loch Awe, and therefore there is the potential for this species to occur within and beyond the Development, particularly during the construction phase, and notably along the shore of Loch Awe.

INNS macrophytes identified found recent records of Japanese knotweed, American skunk cabbage and New Zealand willowherb within the immediate boundary of the Development. Within the wider area, New Zealand pigmyweed and Nuttall's waterweed were also identified.

The Wildlife and Countryside Act 1981 (as amended by the Wildlife and Natural Environment (Scotland) Act 2012[6]), is a preventative measure to control the spread of such species. This covers the INNS macrophytes present from the desk study. Together the referenced legislation makes it an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild. If transported off site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990[7]). The legislation also makes in an offense to release, or allow to escape, listed species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

No INNS macroinvertebrates were identified within the desk study, except for historic records of the non-native but naturalised New Zealand mud snail.

During any works, caution is necessary within the proposed boundary of the Development and within the wider landscape, to help prevent the transport of INNS into areas unestablished by INNS. Biosecurity measures should be implemented throughout the construction of the Development.

Five INNS were recorded across a number of sample locations during field surveys:

- Canadian pondweed or Nuttall's waterweed *Elodea* sp. within Loch Awe (BL-19);
- Japanese knotweed (on the shores of Loch Fyne BL-14); and
- Himalayan balsam (on the shores of Loch Fyne BL-14).
- the New Zealand mud snail, within BL-06 and BL-17;
- the crustacean, Crangonyx *pseudogracilis*/*floridanus* within Loch Awe (BL-19)

Although only recorded within one of the Loch Awe sites, Canadian pondweed has previously been recorded in the desk study. Therefore, this species has potential to occur in close proximity to both sampling locations (BL-18 and BL-19) and throughout Loch Awe.

Although only recorded from a few of the waterbodies, both the New Zealand mud snail and *C. pseudogracilis*/*floridanus* are naturalised non-native species and it is possible that they occur in a greater number of waterbodies than has been recorded (given the stated limitations of biological recording).

Japanese knotweed is a highly invasive perennial plant that spreads and persists via an underground rhizome network up to 7 m from visible above ground plants. Spread is solely by vegetative means and tiny fragments of rhizome can produce new plants. Rhizome fragments spread in contaminated soil attached to vehicles, equipment and footwear. Himalayan balsam is an annual plant that spreads and persists via seed and is capable of projectile dispersal of seeds up to 7 m from flowering plants. Therefore, there is a risk of spread via machinery and personnel.

As such with the desk study INNS, the Wildlife and Natural Environment (Scotland) Act 2012[8]) makes it an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild. If transported off site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate

[6] Wildlife and Natural Environment (Scotland) Act 2012. Available at: https://www.legislation.gov.uk/asp/2011/6/contents/enacted (accessed November 2023)
[7] Environmental Protection Act 1990, c. 43. Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (accessed November 2023)
[8] Wildlife and Natural Environment (Scotland) Act 2012. Available at: https://www.legislation.gov.uk/asp/2011/6/contents/enacted (accessed November 2023)

establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990[9]). The legislation also makes in an offense to release, or allow to escape, listed species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

There was a low presence of non-native species within macroinvertebrate community samples, collected in 2019 and 2023, with small numbers of New Zealand mud snail was found at BL-06 and BL-17, and the amphipod *Crangonyx pseudogracillis/floridanus* was found at BL-19. These species have the potential to be transported within water pumping or alterations to watercourses. Although these species are non-native, they are not listed in statutory legislation but best practice biosecurity measures should be implemented to prevent their spread.

As such, it is recommended that best practice biosecurity measures are implemented for all works within and near all waterbodies, as outlined within Appendix 3.1 Outline CEMP (Volume 5 Appendices). These mitigation measures should be detailed in an INNS risk assessment or Construction Environmental Management Plan (CEMP) for the Development produced by the appointed contractor.

4.7 Brackish Sites

The proposed Development includes potential brackish sites that may be impacted if certain transport route options are selected (BL-14 and BL-16). Only one of these sites (BL-14) was visited briefly during the scoping survey and general observations were noted. One option being considered is to construct a wharf at one of these sites on Loch Fyne, near Inverary. This would be a permanent structure, or temporary with permanent foundations, and would involve considerable disruption to seabed and shore sediments (e.g., installation of coffer dams, breakwater, pilings, slipway etc).

Impacts to Loch Fyne are assessed in Chapter 8: Marine Ecology (Volume 2 Main Report).

[9] Environmental Protection Act 1990, c. 43. Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (accessed November 2023)

5. Potential Impacts to Aquatic Ecology from the Development

Impacts of the Development are assessed within the EIA (Chapter 7 Aquatic Ecology, Volume 2 Main Report).

The following potential impacts to macrophytes, macroinvertebrates and fish may arise from the Development during construction, operation, and decommissioning:

- Fish may become entrained through or impinged on the water intake screens;
- The intake and outfall may attract fish resulting in disruption to migratory routes and potentially preventing the completion of lifecycles for species such as Atlantic salmon, sea trout, European eel, and lamprey;
- The use of culverts for temporary or permanent watercourse crossings may impact riverine mesohabitats and fish migration;
- Direct mortality or physical injury of fish and macroinvertebrates through construction, piling and de-watering activities;
- Mortality from de-watering activities;
- Exposure to harmful chemicals within aquatic environment during different stages the Developments lifecycle;
- Alterations in water quality from site drainage during construction and operation;
- Increased surface run-off and erosion from tracks accessing site, causing alterations to watercourse sedimentation levels, potentially smothering macroinvertebrate and macrophyte communities, in addition to gravel beds associated with fish spawning;
- Changes in water levels within Loch Awe may cause undesirable changes in fish passage and the availability of spawning habitat for species such as Arctic charr which rely on suitable gravels and depths within the loch to spawn;
- Changes in water levels in watercourses within the Development's boundary may also cause undesirable changes to flows, which could impact macroinvertebrate communities sensitive to variable flows, in addition to macrophyte assemblages;
- Transfer of INNS during de-watering and substrate excavation, transporting materials on or off the site and operational processes.

5.1 Mitigation

The following measures could be implemented to mitigate potential impacts to macrophytes, macroinvertebrates and fish as a result of the Development:

- Intake screens, including approach velocities and bar spacing, should be designed according to best practice guidance and agreed through the CAR licence to avoid fish becoming impinged or entrained;
- Outfalls should be screened according to best practice guidelines and located in an area of minimal impact where possible. Timings of discharges should be considered in line with migratory periods for key species and life stages;
- Culverts should follow SEPA best practice for culvert design and allow continued fish passage during construction;
- A 'soft start' to piling works could be used to deter fish from the immediate area where physical injury may occur;
- Periods and methods of operation should be optimised to consider critical spawning periods for key species and life stages such as Atlantic salmon, brown/sea trout and Arctic charr. Construction should avoid critical migratory periods for key species and life stages, such as late spring and early summer for salmonid smolt migration; late autumn or winter for adult salmonid migration;

- Fish rescues should be undertaken before any de-watering activities;
- Utilising sediment bags or similar filtration methods when de-watering;
- Employing water quality best practice during construction, including SUDs, settlement ponds, temporary ditches, and other drainage features;
- Use of silt curtains or equivalent and spoil management, including dust screens and vehicle washing facilities should be implemented to minimise dust, siltation, runoff, and subsequent contamination of waterbodies;
- Utilising silt fences or wattles and logs to prevent sheet erosion and reduce siltation of watercourses in the immediate vicinity of construction;
- Best practice biosecurity measures should be implemented and adhered to throughout construction, operation, and decommissioning.

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Annex A Site maps

Figures A1 – A4. Aquatic survey sites

Annex B Community Conservation Index (CCI)

The Community Conservation Index (Chadd & Extence, 2004) allows a classification of the nature conservation value associated with a macroinvertebrate community. The CCI score for one sample is derived from individual Conservation Scores (CS), assigned to some species of aquatic macroinvertebrates and relating closely to the available published Red Data Books (Bratton, 1990, 1991; Shirt, 1987). Conservation Scores assigned to individual species vary from 1 to 10, as detailed on the Table B1 below. The derived CCI scores generally vary from 0 to > 20, as detailed in the Table B2 below. The Table B2 below provides a guide to interpreting CCI scores.

Table B1: Conservation Scores from the Community Conservation Index (from Chadd & Extence, 2004)

Conservation Score	Relation to Red Data Books
10	RDB1 (Endangered)
9	RDB2 (Vulnerable)
8	RDB3 (Rare)
7	Notable (but not RDB status)
6	Regionally notable
5	Local
4	Occasional (species not in categories 10-5, which occur in up to 10% of all samples from similar habitats)
3	Frequent (species not in categories 10-5, which occur in up to >10-25% of all samples from similar habitats)
2	Common (species not in categories 10-5, which occur in up to >25-50% of all samples from similar habitats)
1	Very common (species not in categories 10-5, which occur in up to >50-100 % of all samples from similar habitats)

Table B2: General guide to CCI scores (from Chadd & Extence, 2004)

CCI Score	Description	Interpretation
0 to 5.0	Sites supporting only common species and/or community of low taxon richness	Low conservation value
> 5.0 to 10.0	Sites supporting at least one species of restricted distribution and/or a community of moderate taxon richness	Moderate conservation value
> 10.0 to 15.0	Sites supporting at least one uncommon species, or several species of restricted distribution and/or a community of high taxon richness	Fairly high conservation value
> 15.0 to 20.0	Sites supporting several uncommon species, at least one of which may be nationally rare and/or a community of high taxon richness	High conservation value
> 20.0	Sites supporting several rarities, including species of national importance and/or a community of very high taxon richness	Very high conservation value

Annex C Whalley, Hawkes, Paisley & Trigg (WHPT) Metric

There are approximately 4,000 species of aquatic macroinvertebrates in the British Isles. To simplify the analysis of the samples and the data we do not identify individual species but only the major types (taxa), mostly at the family taxonomic level. A key piece of information is the number of different taxa at a site. A fall in the number of taxa indicates ecological damage, including pollution (organic, toxic and physical pollution such as siltation, and damage to habitats or the river channel).

The WHPT scoring system (WFD-UKTAG, 2021) is based upon the sensitivity of macroinvertebrate families to organic pollution. It replaces the Biological Monitoring Working Party (BMWP) system (Hawkes, 1997) previously used in the UK.

The WHPT system assigns a numerical value to about 100 different taxa (known as the WHPT-scoring taxa) according to their sensitivity to organic pollution. In addition to the presence of macroinvertebrate taxa at a sampling site, as in the BMWP scoring system, the WHPT system also uses another type of information, this being the abundances of different scoring taxa.

Taxa abundances are classified in four categories (Class 1: 1 to 10 individuals, Class 2: 11 to 100 individuals, Class 3: 101 to 1,000 individuals, and Class 4: > 1,000 individuals). A score (Pressure Sensitivity Scores (PSs) is then assigned to each taxa, depending of the taxa sensitivity and abundances recorded.

The total WHPT score for a sample corresponds to the sum of PSs of scoring taxa recorded. The Average Score Per Taxon (ASPT) values are calculated as the Sum PSs divided by the number of scoring taxa (NTAXA). As such, three metrics are calculated:

- WHPT score
- NTAXA
- ASPT

Some animals are more susceptible to organic pollution than others, and the presence of sensitive species indicates good water quality. This fact is taken into account by the WHPT metrics.

The most useful way of summarising the biological data was found to be one that combined the number of taxa and the ASPT. The best quality is indicated by a diverse variety of taxa, especially those that are sensitive to pollution. Poorer quality is indicated by a smaller than expected number of taxa, particularly those that are sensitive to pollution. Organic pollution sometimes encourages an increased abundance of the few taxa that can tolerate it. However, maximum achievable values will vary between geological regions. For example, pristine lowland streams in East Anglia will always score lower than pristine Welsh mountain streams because they are unable to support many of the high-scoring taxa associated with fast flowing habitat. WHPT scores and ASPT for different types watercourse are dependent on the quality and diversity of habitat, natural water chemistry (associated with geology, distance from source etc.), altitude, gradient, time of year the sample was taken and other factors.

Annex D Proportion of Sediment-sensitive Invertebrates (PSI)

The Proportion of Sediment-sensitive Invertebrates (PSI) index allows an assessment of the extent to which a waterbody is composed of, or covered by, fine sediments. This follows the method stated in Extence *et al*., 2013. Under this system, individual species of aquatic macroinvertebrates are assigned a Fine Sediment Sensitivity Rating (FSSR) as detailed in Table D1, and abundance rating based on LIFE scores as detailed in Table D2. The PSI score for the aquatic macroinvertebrate sample is then derived from the individual species scores and abundances, as detailed in Table D3. The PSI score corresponds to the percentage of fine sediment-sensitive taxa present in a sample and ranges from 0 to 100, with low scores corresponding to waterbodies with high fine sediment cover.

Table D1. Fine Sediment Sensitivity Rating (FSSR) groups used to derive PSI scores

FSSR group	Description
A	Highly sensitive
B	Moderately insensitive
C	Moderately insensitive
D	Highly insensitive

Table D2. Abundance categories used to derive PSI scores

FSSR group	Abundance			
	1-9	10-99	100-999	>999
A	2	3	4	5
B	2	3	4	5
C	1	2	3	4
D	1	2	3	4

Table D3. Interpretation of PSI scores

PSI	Description
81-100	Minimally sedimented
61-80	Slightly sedimented
41-60	Moderately sedimented
21-40	Sedimented
0-20	Heavily sedimented

Annex E Lotic-Invertebrate Index of Flow Evaluation (LIFE)

The Lotic-Invertebrate Index for Flow Evaluation (LIFE) provides an assessment of the impact of variable flows on benthic macroinvertebrate communities. Under the assessment, individual species of aquatic macroinvertebrates are assigned to a flow group varying from I to VI, as detailed on the Table E1 below. The LIFE score for a macroinvertebrate sample is then derived (mean of individual scores) from individual species scores and abundances, as detailed on the Table E3 below. LIFE scores for a macroinvertebrate sample ranges from 1 to 12, where highest scores describe communities adapted to rapid flows.

Table E1. Flow groups used to derive LIFE scores (from Extence *et al*., 1999)

LIFE score Group	Description	Mean current velocity
I	Taxa primarily associated with rapid flows	Typically > 100 $cm.s^{-1}$
II	Taxa primarily associated with moderate to fast flows	Typically 20 to 100 $cm.s^{-1}$
III	Taxa primarily associated with slow or sluggish flows	Typically < 20 $cm.s^{-1}$
IV	Taxa primarily associated with (usually slow) and standing waters	
V	Taxa primarily associated with standing waters	
VI	Taxa frequently associated with drying or drought impacted sites	

Table E2. Abundance categories used to derive LIFE scores (from Extence *et al*., 1999)

Abundance category	Description
A	1 to 9
B	10 to 99
C	100 to 999
D	1000 to 9999
E	> 10000

Table E3. A guide to interpreting LIFE scores (from Extence *et al*., 1999)

Flow groups	Abundance categories			
	A	B	C	D/E
I	9	10	11	12
II	8	9	10	11
III	7	7	7	7
IV	6	5	4	3
V	5	4	3	2
VI	4	3	2	1

Annex F Macrophyte taxa

Table F1. Macrophyte taxa present at running water sites during autumn 2019

Taxonomic Group	Common Name	Scientific Name	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-22	BL-23	BL-25	BL-26
Microalgae	Green algae sp.						C1						
Bryophyte	Common water moss	*Fontinalis antipyretica*	C5	C5	C3	P	C5	C6		C4		C5	C7
Bryophyte	Yellow fringed moss	*Racomitrium aciculare*	C3	C5								C3	
Bryophyte	Drab Brook-moss	*Hygrohypnum luridum*								C3			
Bryophyte	Flagellate feather-moss	*Hyocomium armoricum*										C3	
Bryophyte	Compressed Flapwort	*Nardia compressa*	C1	C3		P				C2	C3	C2	C3
Bryophyte	Rusty Feather-moss	*Sciuro-hypnum plumosum,*				P							
Bryophyte	Common haircup	*Polytrichum commune*						C2				C3	
Bryophyte	Liverwort	*Pellia* sp.				P		C1				C1	C1
Vascular Plant	Lesser spearwort	*Ranunculus flammula*	C1		C4		C2	C1	C1	C2	C3		
Vascular Plant	Joined rush	*Juncus articulatus*	C1		C4	P	C2		C1	C2	C2		
Vascular Plant	A water starwort	*Callitriche hamulate*			C4								
Vascular Plant	Marsh horsetail	*Equisetum palustre*			C7								
Vascular Plant	Water horsetail	*Equisetum fluviatile*								C2			
Vascular Plant	Water pepper	*Persicaria hydropiper*			C6								
Vascular Plant	Cuckoo flower	*Cardamine pratensis*			C1								
Vascular Plant	Water forget me not	*Myosotis scorpioides*					C1						
Vascular Plant	Common reed	*Phragmites australis*							C1				
Vascular Plant	Yellow iris	*Iris pseudacorus*							C1				
Vascular Plant	Fool's-water-cress	*Apium nodiflorum*							C1				
Vascular Plant	Hemlock water dropwort	*Oenanthe crocata*							C3				
Vascular Plant	Water Mint	*Menta aquatica*							C3				
Vascular Plant	Shoreweed	*Littorella uniflora*								C2			
Vascular Plant	Broad-leaved pondweed	*Potamogeton natans*								C2			
Vascular Plant	Bulbous rush	*Juncus bulbosus*								C2			
Vascular Plant	Narrow-leaved bur-reed	*Sparganium angustifolium*								C3			
Vascular Plant	Blinks	*Montia fontana*											C1
Total Number of taxa recorded			**5**	**3**	**7**	**5**	**4**	**4**	**7**	**10**	**3**	**6**	**4**
Total % cover of macrophytes			**13%**	**20%**	**50%**	**N/A**	**12%**	**11%**	**6%**	**13%**	**5%**	**15%**	**30%**
Total % cover of filamentous algae			**0%**	**0%**	**0%**	**N/A**	**<1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

C – Taxon cover value group as per UKTAG River Assessment Method Macrophytes and Phytobenthos (WFD-UKTAG, 2014) methodology

P – species present with no cover value assigned

Table F2. Macrophyte taxa present at Loch sites during autumn 2019

Taxonomic Group	Common Name	Latin Name	Lock Awe		Lochan Airigh	Lochan Breac-liath
			BL-18	BL-19	BL-20	BL-21
Microalgae	Green algae sp.		F	F		
Bryophyte	Common water moss	*Fontinalis antipyretica*	F	R	R	R
Vascular Plant	Lesser spearwort	*Ranunculus flammula*	O	O	R	
Vascular Plant	Joined rush	*Juncus articulatus*	R	O	O	R
Vascular Plant	Water horsetail	*Equisetum fluviatile*			R	
Vascular Plant	Shoreweed	*Littorella uniflora*	D	D	A	R
Vascular Plant	Alternate water-milfoil	*Myriophyllum alterniflorum*	O	O	R	
Vascular Plant	Waterweed	*Elodea sp.*		R		
Vascular Plant	Bog pondweed	*Potamogeton polygonifolius*			O	R
Vascular Plant	Red pondweed	*Potamogeton alpinus*			O	
Vascular Plant	Water lobelia	*Lobelia dortmanna*			A	R
Vascular Plant	Bulbous Rush	*Juncus bulbosus*				R
Vascular Plant	Narrow-leaved bur-reed	*Sparganium angustifolium*				R
Total Number of			7	6	9	7
Total % cover of			6%	N/A	N/A	N/A
Total % cover of			0%	N/A	N/A	N/A

NB: Cover values assigned as per DAFOR abundance scale

Annex G Macroinvertebrate taxa

Table G1. Macroinvertebrate taxa list resulting from autumn 2019 surveys

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Flatworms																	
Flatworms	Tricladida		2														
Planariidae	*Polycelis sp.*							1			8						
Planariidae	*Polycelis felina*	3				4	15	2		10	10						
Snails																	
Lymnaeidae	Lymnaeidae (juvenile / damaged)						60		6		1						
Lymnaeidae	*Radix / Ampullaceana sp.*										1						
Lymnaeidae	*Ampullaceana balthica*	1									1						
Hydrobiidae	*Potamopyrgus antipodarum*	1					1		1								
Physidae	*Physa fontinalis*	1								2	1						
Succineidae	Succineidae						4		4								
Planorbidae	*Bathyomphalus contortus*	2								7							
Limpets and mussels																	
Anyclidae	*Ancylius fluviatilis*	1	1	1							6	4	1	2			
Sphaeriidae	Sphaeriidae (juvenile / damaged)					1			15						8		
Sphaeriidae	*Pisidium/Euglesa/Odhneripisidium*						2		76	2	2	40					
Worms																	
Oligochaeta				2	1	2	30	8	57	20	35		7	6	1	5	1
Leeches																	
Glossiphoniidae	*Glossiphonia complanata*	1								1							
Glossiphoniidae	*Helobdella stagnalis*	1								9							
Erpobdellidae	*Erpobdella sp.*										1						
Erpobdellidae	*Erpobdella octoculata*	1								2	1						
Hirudinidae	*Haemopis sanguisuga*	4								1		1					
Mites																	
Hydracarina										2							
Oribatei	*Oribatei*													1	2		
Crustaceans																	

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Gammaridae	Gammaridae				1												
Gammaridae	*Gammarus sp.*										5						
Gammaridae	*Gammarus lacustris*	5										30					
Gammaridae	*Gammarus pulex*	1			3				4	30							
Crangonyctidae	*Crangonyx pseudogracilis/ floridanus*								8	20	6						
Asellidae	*Asellus aquaticus*	1								200	160						
Mayflies																	
Baetidae	Baetidae (juvenile / damaged)													1			
Baetidae	*Baetis sp.*			4				2						2		1	
Baetidae	*Baetis rhodani / atlanticus*		8	24	1	25	20	4								1	
Heptageniidae	Heptageniidae (juvenile / damaged)		3			2		2									
Heptageniidae	*Rhithrogena sp.*		7	32													
Heptageniidae	*Rhithrogena semicolorata*	2				2		23								1	
Heptageniidae	*Electrogena lateralis*	2				1											
Heptageniidae	*Ecdyonorus sp.*		5	2	1	4		3									
Leptophlebiidae	Leptophlebiidae (juvenile / damaged)				3								13		35		
Leptophlebiidae	*Leptophlebia sp.*					6											
Leptophlebiidae	*Leptophlebia vespertina*	3											28				
Leptophlebiidae	*Paraleptophlebia sp.*					1						18		1	2		
Ephemerellidae	*Serratella ignita*	1												1			
Ephemeridae	*Ephemera sp.*										4						
Ephemeridae	*Ephemera danica*	1								8	12						
Caenidae	Caenidae (juvenile / damaged)					1				1							
Caenidae	*Caenis sp.*								1		3						
Caenidae	*Caenis horaria*	1								1	2						
Caenidae	*Caenis luctuosa*	1									15						
Stoneflies																	
Plecoptera	Plecoptera sp													3			
Nemouridae	Nemouridae (juvenile / damaged)										1				1		
Nemouridae	*Protonemura sp.*		37	2				36						3			19
Nemouridae	*Protonemura praecox*	5				1		2									
Nemouridae	*Protonemura meyeri*	5	32	6		17		2						29		18	33
Nemouridae	*Amphinemura sp.*					1											
Nemouridae	*Nemoura sp.*									2	1	12		4	51		

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Leuctridae	*Leuctra sp.*				1	3		1						5	36		2
Leuctridae	*Leuctra fusca*	1						2		5	1			2		1	
Capniidae	*Capnia sp.*												1				
Perlodidae	Perlodidae (juvenile / damaged)		1										1	3	1		
Perlodidae	*Perlodes mortoni*	2				1										1	
Perlodidae	*Diura bicaudata*	3									1					2	
Perlidae	*Perla bipunctata*	3		1													
Chloroperlidae	*Chloroperla / Siphonoperla sp.*					1											
Chloroperlidae	*Siphonoperla torrentium*	1											2				
Chloroperlidae	*Chloroperla tripunctata*	4						3				1	3				
Damselflies																	
Coenagrionidae	Coenagrionidae (juvenile / damaged)												1	1			
Dragonflies																	
Cordulegasteridae	*Codulegaster boltonii*	4													2		
True bugs																	
Gerridae	*Gerris lacustris*	1													1		
Veliidae	Veliidae (nymph / damaged)													1			
Veliidae	*Velia caprai*	2													5		2
Corixidae	Corixidae (nymph / damaged)											1					
Corixidae	*Sigara sp.*											1					
Corixidae	*Sigara dorsalis*	1								4	1						
Beetles																	
Dytiscidae	Dytiscidae (larvae / damaged)						15		2						4		1
Dytiscidae	*Hydroporus sp.*								1								
Dytiscidae	*Hydroporus palustris*	1										4					
Dytiscidae	*Oerodytes sanmarkii*	1								2	10			1			
Dytiscidae	*Agabus arcticus*	6										2					
Dytiscidae	*Agabus guttatus*	4					2										
Dytiscidae	*Agabus paludosus*	1					2										
Dytiscidae	*Acilius sulcatus*	5										1					
Hydrophilidae	Hydrophilidae (larvae / damaged)													1	1		
Hydrophilidae	*Helophorus sp.*								1								
Hydrophilidae	*Helophorus brevipalpis*	1					4										
Hydrophilidae	*Anacaena globulus*	1							1						2		1

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Hydraenidae	*Hydraena gracilis*	1	5			3		3						9			
Scirtidae	Scirtidae (larvae / damaged)		18			1	4	19	4							9	
Elmidae	Elmidae (larvae / damaged)		1											2			
Elmidae	*Elmis aenea*	1	12	1	3	1	7	4						12		3	2
Elmidae	*Esolus parallelepipedus*	4			2	3											
Elmidae	*Limnius volckmari*	1	5	3	7	5		1		10				7			1
Elmidae	*Oulimnius sp.*				2					20	12	4	8	8			
Elmidae	*Oulimnius tuberculatus*	1										1		10			
Alderflies																	
Sialidae	Sialidae (juvenile / damaged)																
Sialidae	*Sialis fuliginosa*	5												2			
Caddisflies	Trichoptera					2									1		
Rhyacophilidae	*Rhyacophila dorsalis*	1		2		2		1						1			
Glossosomatidae	*Agapetus sp.*										3						
Glossosomatidae	*Agapetus fuscipes*	1								5	3						
Philopotamidae	*Philopotamus montanus*	2	4			16	1	6									
Polycentropodidae	Polycentropodidae (juvenile /damaged)				1								14	2			
Polycentropodidae	*Plectrocnemia sp.*												1				
Polycentropodidae	*Plectrocnemia conspersa*	2			1									1	20	1	2
Polycentropodidae	*Polycentropus sp.*										4		5		9		
Polycentropodidae	*Polycentropus flavomaculatus*	2			5	4				7	6	6	4	1			
Polycentropodidae	*Cyrnus trimaculatus*	3											1				
Hydropsychidae	*Hydropsyche sp.*		2					7									
Hydropsychidae	*Hydropsyche pellucidula*	1						1									
Hydropsychidae	*Hydropsyche angustipennis*	1						1									
Hydropsychidae	*Hydropsyche siltatai*	1	2			3								2			
Hydropsychidae	*Diplectrona felix*	4					2										
Hydroptilidae	*Hydroptila sp.*					2				1	4		2	5			
Hydroptilidae	*Oxyethira sp.*												1	1			
Phryganeidae	Phryganeidae (juvenile / damaged)									2		1					
Limnephilidae	Limnephilidae (juvenile / damaged)		5			1		9			10			5		2	2
Limnephilidae	*Limnephilus sp.*										6						
Limnephilidae	*Limnephilus bipunctatus*	5					1										
Limnephilidae	*Micropterna sp.*								2								

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Limnephilidae	*Micropterna lateralis*	2					6		7								
Beraeidae	*Beraea pullata*	4							58								
Beraeidae	*Beraea maurus*	3						1	50								
Leptoceridae	Leptoceridae (juvenile / damaged)												1				
Leptoceridae	*Cereclea sp.*										1						
Leptoceridae	*Athripsodes sp.*									1	4	1	1				
Leptoceridae	*Athripsodes cinereus*	1								1	4						
Leptoceridae	*Mystacides sp.*									15	9	9					
Leptoceridae	*Mystacides azurea*	2									3						
Goeridae	Goeridae (juvenile / damaged)													2			
Goeridae	*Silo sp.*		3														
Goeridae	*Silo pallipes*	1														4	
Lepidostomatidae	Lepidostomatidae (juvenile / damaged)										1						
Lepidostomatidae	*Lepidostoma hirtum*	1									3						
Sericostomatidae	Sericostomatidae (juvenile / damaged)										2	1					
Sericostomatidae	*Sericostoma personatum*	1	1							1	3	1					
Trueflies																	
Chironomidae	Chironomidae (damaged / pupea)				1	1			2	6	1			4	3		1
Chironomidae	Tanypodinae								2				3	1	19		
Chironomidae	Orthocladiinae		1				40	1	1		2		5	2	5		1
Chironomidae	Chironomini										3						
Chironomidae	Tanytarsini												8	1	2		
Chironomidae	Diamesinae										1						
Tipulidae	*Tipula sp.*		1				1	1		2				1			
Pediciidae	Pediciidae		1												2		2
Pediciidae	*Pedicia* sp.																2
Pediciidae	*Dicranota* sp.				1			1								3	
Limoniidae	Limoniidae														4		
Simuliidae	Simuliidae (damaged / juvenile)		2			1	1	9	5					5			
Simuliidae	*Simulium* sp.								7								
Simuliidae	*Simulium angustipes/velutinum*	4															
Simuliidae	*Simulium argyreatum*	3						1									
Simuliidae	*Simulium variegatum*	4				1											
Simuliidae	*Simulium argyreatum/variegatum*	4						2								3	

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-17	BL-18	BL-19	BL-20	BL-21	BL-22	BL-23	BL-25	BL-26
Psychodidae							2		5								
Empididae			5			1		7				1					
Ceratopogonidae									26						1		
Other Taxa																	
Collembola									1						1		
NTAXA (WHPT)			**17**	**8**	**10**	**23**	**17**	**19**	**16**	**26**	**26**	**15**	**12**	**25**	**15**	**13**	**11**
Number of non-scoring families (WHPT)			**1**	**0**	**0**	**0**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Total number of families			**18**	**8**	**10**	**23**	**18**	**19**	**18**	**28**	**27**	**16**	**12**	**26**	**17**	**13**	**11**
WHPT score			**123.3**	**60.3**	**60.2**	**163.9**	**87.0**	**133.7**	**75.7**	**131.0**	**152.1**	**94.2**	**81.0**	**164.5**	**98.9**	**92.2**	**64.4**
ASPT (WHPT)			**7.3**	**7.5**	**6.0**	**7.1**	**5.1**	**7.0**	**4.7**	**5.0**	**5.9**	**6.3**	**6.8**	**6.6**	**6.6**	**7.1**	**5.9**
CCI Score			**8.1**	**10.0**	**5.5**	**12.0**	**12.0**	**11.9**	**6.0**	**6.8**	**6.6**	**15.0**	**7.0**	**8.6**	**6.0**	**11.7**	**10.0**

Table G2. Macroinvertebrate taxa list resulting from autumn 2023 surveys

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-14	BL-17	BL-18	BL-19	BL-22	BL-23	BL-25	BL-26
Flatworms																
Planariidae	*Polycelis felina*	3					7									
Snails																
Lymnaeidae	Lymnaeidae (juvenile / damaged)						26			2	1					
Lymnaeidae	*Galba truncatula*	3					10							1		
Lymnaeidae	*Ampullaceana balthica*	1											1			
Hydrobiidae	*Potamopyrgus antipodarum*	1								8						
Succineidae	Succineidae						5			1						
Limpets and mussels																
Anyclidae	*Ancylus fluviatilis*	1			2			2			2					
Sphaeriidae	*Pisidium/Euglesa/Odhneripisidium*		1				1			13				1		
Worms																
Oligochaeta	Oligochaeta		1			1	8	16	25	32	3	1		2	1	3
Crustaceans																
Palaemonidae	*Palaemonetes varians*	1							1							
Gammaridae	*Gammarus duebeni*	4							15							
Gammaridae	*Gammarus pulex/fossarum agg.*	1	2													
Gammaridae	*Gammarus pulex*	1								1						
Crangonyctidae	*Crangonyx sp.*											4				
Asellidae	*Asellus aquaticus*	1								1						
Mayflies																
Baetidae	Baetidae (juvenile / damaged)		2	3	1	3		2			1				1	
Baetidae	*Baetis rhodani / atlanticus*		3	19	3	7	1				2				4	
Heptageniidae	Heptageniidae (juvenile / damaged)		1	16	2	2		7					1		5	
Heptageniidae	*Rhithrogena semicolorata*	2	1	14		2		1					1		10	
Heptageniidae	*Ecdyonorus sp.*		3	10	15	5		3					1			
Leptophlebiidae	Leptophlebiidae (juvenile / damaged)			1	2	2							2	64		

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-14	BL-17	BL-18	BL-19	BL-22	BL-23	BL-25	BL-26
Stoneflies																
Nemouridae	Nemouridae (juvenile / damaged)		2											120		
Nemouridae	*Protonemura sp.*				1											
Nemouridae	*Protonemura meyeri*	5	3	3	5	9		26					37	4	34	54
Nemouridae	*Amphinemura sp.*													1		
Nemouridae	*Nemoura sp.*						15									
Nemouridae	*Nemoura avicularis*	3											6			
Leuctridae	Leuctridae (juvenile / damaged)													60		
Leuctridae	*Leuctra sp.*		1		1						2				1	2
Leuctridae	*Leuctra fusca*	1				3		11			3		1	16		4
Perlodidae	Perlodidae (juvenile / damaged)							1								
Perlodidae	*Perlodes mortoni*	2	5	1	1	2		2			1		5			
Perlodidae	*Isoperla grammatica*	2		2	1			4						3	1	4
Perlidae	*Perla bipunctata*	3			1	2										
Chloroperlidae	*Siphonoperla torrentium*	1	2		1			3								1
Damselflies																
Coenagrionidae	*Pyrrhosoma nymphula*	3												2		
Calopterygidae	*Calopteryx splendens*	1											2			
Dragonflies																
Cordulegasteridae	*Cordulegaster boltonii*	4												1		
Beetles																
Dytiscidae	Dytiscidae (larvae / damaged)									1						
Dytiscidae	*Hydroporus sp.*													1		
Dytiscidae	*Oreodytes davisii*	8										1				
Dytiscidae	*Agabus didymus*	1					1									
Dytiscidae	*Agabus guttatus*	4												1		
Hydrophilidae	*Anacaena globulus*	1												3		
Hydraenidae	*Hydraena sp.*													1		
Hydraenidae	*Hydraena gracilis*	1									1		2		1	

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-14	BL-17	BL-18	BL-19	BL-22	BL-23	BL-25	BL-26
Dryopidae	Dryopidae (larvae / damaged)									5						
Dryopidae	*Dyops sp.*						1									
Scirtidae	Scirtidae (larvae / damaged)		12				24	16			3			8	5	1
Elmidae	*Elmis aenea*	1	2		2		1	2					9		9	9
Elmidae	*Limnius volckmari*	1	9	2	3	2		1			1		6			
Elmidae	*Oulimnius sp.*				1								3	3		
Elmidae	*Oulimnius tuberculatus*	1			1								5			
Alderflies																
Sialidae	Sialidae (juvenile / damaged)															
Sialidae	*Sialis fuliginosa*	5											1			
Caddisflies																
Rhyacophilidae	*Rhyacophila sp.*				1											
Rhyacophilidae	*Rhyacophila dorsalis*	1	1	1		1							1		1	
Glossosomatidae	*Agapetus sp.*		14													
Glossosomatidae	*Agapetus fuscipes*	1						2								
Philopotamidae	*Philopotamus montanus*	2	43					7			1					
Polycentropodidae	Polycentropodidae (juvenile / damaged)		1				3							13		
Polycentropodidae	*Plectrocnemia conspersa*	2					1			1				12		2
Polycentropodidae	*Polycentropus flavomaculatus*	2		1									3			
Hydropsychidae	*Hydropsyche sp.*		3													
Hydropsychidae	*Hydropsyche pellucidula*	1	5	1				12								
Hydropsychidae	*Hydropsyche siltalai*	1				3	2	10								
Hydroptilidae	*Hydroptila sp.*					1							2			
Limnephilidae	Limnephilidae (juvenile / damaged)		5					1		3			4	7		3
Limnephilidae	*Limnephilus lunatus*	1					1									
Limnephilidae	*Micropterna lateralis*	2								2						
Limnephilidae	*Micropterna sequax*	1					3							1		
Beraeidae	*Beraea maurus*	3					3	1		1						
Odontoceridae	*Odontocerum albicorne*	3						1								

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-14	BL-17	BL-18	BL-19	BL-22	BL-23	BL-25	BL-26
Goeridae	*Silo sp.*		4													4
Goeridae	*Silo pallipes*	1	3										3		1	2
Lepidostomatidae	*Crunoecia irrorata*	3						1		1						
Sericostomatidae	*Sericostoma personatum*	1												1		
Trueflies																
Chironomidae	Tanypodinae						1							14		
Chironomidae	Orthocladiinae		2				8		1	2	1		1	16		3
Chironomidae	Tanytarsini													2		
Chironomidae	Prodiamesinae															1
Tipulidae	Tipulidae						1	2			1				1	
Pediciidae	Pedicia sp.													2		
Pediciidae	Dicranota sp.		1	1	1	1	9	3			1		1		5	1
Limoniidae	Limoniidae													9		
Simuliidae	*Simulium* sp.		3			1	3	1					8	12	4	6
Psychodidae							6		1					5		
Ceratopogonidae							1									
Stratiomyidae	Stratiomyidae						1									
Sciomyzidae										1	1					
Other Taxa																
Mytilidae	*Mytilus sp.*								4							
Carcinidae	*Carcinus maenas*								1							
Nereididae	*Nereis diversicolor*								1							
NTAXA (WHPT)		**21**	**10**	**12**	**14**	**20**	**4**	**3**	**13**	**19**	**14**	**13**	**18**	**21**	**13**	**21**
Number of non-scoring families (WHPT)		**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
Total number of families		**21**	**10**	**12**	**14**	**21**	**8**	**3**	**13**	**19**	**15**	**13**	**18**	**22**	**13**	**21**
WHPT score		**146.0**	**77.0**	**99.8**	**104.1**	**107.9**	**12.5**	**11.9**	**96.5**	**150.1**	**69.6**	**78.3**	**126.6**	**138.4**	**92.7**	**146.0**
ASPT (WHPT)		**7.0**	**7.7**	**8.3**	**7.4**	**5.4**	**3.1**	**4.0**	**7.4**	**7.9**	**5.0**	**6.0**	**7.0**	**6.6**	**7.1**	**7.0**
CCI Score		**8.2**	**10.0**	**9.4**	**10.0**	**5.3**	**7.5**	**80.0**	**9.3**	**9.4**	**5.6**	**4.0**	**9.3**	**12.3**	**9.3**	**8.2**
Total Number of Species		**11**	**9**	**10**	**10**	**10**	**2**	**1**	**8**	**16**	**7**	**7**	**16**	**10**	**7**	**11**

Family	Species	CCI Score	BL-01	BL-02	BL-04	BL-05	BL-06	BL-07	BL-14	BL-17	BL-18	BL-19	BL-22	BL-23	BL-25	BL-26
Total Number of Taxa		**17**	**5**	**9**	**7**	**16**	**6**	**2**	**8**	**10**	**9**	**9**	**8**	**20**	**9**	**17**