Aberdunant Hall Holiday Park

Proposed Micro-Hydroelectric Power Generation Scheme

Environmental statement to accompany application to Natural Resources Wales for water impoundment and abstraction licences

29 March 2023

Contents

1. INTRODUCTION

1.1. Project Overview

The applicant is the owner and operator of Aberdunant Hall Holiday Park, a well-established park comprising a hotel and static cabins situated on a 53-hectare site located near Porthmadog in Gwynedd, North Wales (OS reference: SH 582417).

In response to rising energy costs, decreasing energy security and in line with the park's objective to become carbon neutral by using a range of renewable energy technologies to supply the park, Derwent Hydroelectric Power Limited (DHPL) have been commissioned to design a hydroelectric power (HEP) scheme for the site.

The site has numerous small streams that descend down steep banks and gather in the Afon Mûr-gwenyn. The project is a run of river scheme. Intake structures are proposed in three of these streams which will deliver water to a header chamber where it is combined and sent via a penstock pipe of approximately 940 metres to a turbine house and outfall located next to the river near the entrance to the holiday park.

Pre-application advice was sought from NRW and the advice received is attached at Appendix A.

Part of the application site is a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The key feature of these designations is the lesser horseshoe bat *Rhinolophus hipposideros*.

Although lower plants are not listed as a feature of the Aberdunant SAC Management Units, the land within the SSSI / SAC also provides a supporting habitat for the bats and in response to this the applicant has commissioned a specialist ecological survey to examine whether the scheme could have an unacceptable impact on the ecology of bryophytes which depend on the wet environment provided by the rivers and streams.

The operation of the scheme will be controlled according to the amount of water available to ensure that water always flows down the natural watercourses in sufficient quantities to protect their ecology and environments. The renewable electricity generated will be used on site, with any excess fed into the local distribution network serving the surrounding homes and businesses.

As part of the site is within an SAC the standard NRW categorisation would apply a Zone 1 abstraction regime. Given the results of the Bryophyte survey, and the specific characteristics of the streams and terrain in the area, this application seeks to move to a Zone 3 management regime. The reasons for this are detailed in this statement.

1.2. Climate change and positive environmental impact

Taking total protection of the natural environment as the ideal, it is inevitable that all development will have some cost in terms of its impact on the local environment. Negative environmental impact is normally weighed against the expected benefits of a proposed development. However, the need to take into account the impact of development proposals on the global environment is becoming abundantly clear, as evidence of man-made climate change accrues. The present proposal is unusual in that its overall environmental impact will be positive, as its purpose is the use of a totally renewable energy source which would displace fossil fuel electricity generation. The production of 100% renewable electricity could benefit both the holiday park but also a wider area by reducing carbon dioxide emissions in the order

of 21,350 kg every year, based on the 2022 average carbon intensity of 182gCO2/kWh[1]. North Wales is well suited to small and micro-hydro developments due to its terrain and weather and every scheme that comes forward increases its contribution to reducing green house gas emissions.

As with all developments, building some structures within watercourses and installing a pipe and powerhouse on/in the land will have some negative environmental effects, but these will be limited, mitigated to the greatest extent practical and mostly very short-term. Furthermore they must be set against the expected substantial and ongoing positive environmental impact. The net environmental impact of this proposed development is positive.

2. THE SITE

2.1. Existing layout and use

The site is accessed from the A498 road, 2km Northeast of Porthmadog. The entire site lies to the west of this road. The cabins and hotel are spread across the bottom and shallower sides of a valley with steep hillsides surrounding. Numerous streams / rivers descend the sides of the valley and gather in the Afon Mûr-gwenyn which exits the park flowing east under the A498 road to join the Afon Glaslyn. Much of the flatter areas and some of the valley sides are developed with tarmacked access roads for the cabins, but a significant proportion comprising the steeper valley sides is undeveloped and covered light woodland and brush. There is a tip site within the land, and apparent slate quarrying waste above one of the watercourses on the north-western boundary of the park.

At the eastern boundary next to the road the elevation of the river is about 2 metres AOD. At the western boundary of the park, the elevations of the watercourses are in excess of 130m AOD. As the streams come down steep sides of the valley they go down a number of waterfalls and chutes. The largest of these observed is on the Afon Mûr-gwenyn which comes down a waterfall in excess of 6 metres over two sections on the edge of the developed area of the park.

Within the park there are a number of man-made structures such as bridges and culverts that have redirected and altered the natural state of some of the watercourses.

There are no known current abstractions from the watercourses that are the subject of the application.

2.2. Conservation designations

Certain parts of the site are designated a Special Area of Conservation (SAC), part of the Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites SAC.

The SAC's component Site of Special Scientific Interest (SSSI) is called Aberdunant and covers 8.8ha land on the northwest corner of the within the park, comprising mainly wooded and steep valley sides, plus the entrance lodge next to the A498 road.

[1] Source: https://www.nationalgrideso.com/news/britains-electricity-explained-2022-review. 2022 was the second greenest year on record.

3. PROPOSED MICRO-HYDRO SCHEME

3.1. Basic Principles for Hydroelectric Power Generation

Hydroelectric power is a method for converting the potential energy in the mass of elevated water into electrical energy. Therefore the two key factors are how much water is available, and the distance that the water can fall downwards. The former is known as flow and the latter as head.

A high head scheme can be effective with a relatively low flow of water, as is proposed here. With a high head scheme, water is brought down from the higher elevation via a pipe, which allows the full pressure of the height of the water to be delivered to the turbine. Having passed through the turbine all of the water is returned to the natural watercourse. Hydropower is genuinely renewable since no fuel is used up. Even as a renewable technology it compares well with others because it makes little impression on its surrounding landscape, and because installations are long-lived.

All electricity generating installations use energy in their construction but compared with that 'energy in', hydropower typically produces the most 'energy out' of any technology. These factors combine to make a strong case for run-of-river hydro as the most environmentally benign way of generating electricity possible.

Hydropower developments have large upfront fixed costs and therefore are only viable in certain locations and under certain conditions. Currently there is no financial support available, unlike in the past (the Feed-In Tariff, and before that Renewable Obligation, etc) which increases the risk of investing in such schemes. Recent extreme weather events such as long dry periods, and conversely periods with much higher rainfall than average, do not help to underwrite the case for investing in hydropower.

3.2. Scheme layout

The proposed layout for the Aberdunant HEP scheme is illustrated on the Layout Plan that accompanies the application. Water is collected from three streams, labelled 'Far', 'Middle' and 'Near' in accordance to their distance to a proposed header chamber, via Coanda overspill screens. The 'Near' stream is the upper reaches of the Afon Mûr-gwenyn. Pipes of 200mm nominal bore bring the water to a header chamber where it is combined, and where it then enters a 250mm outside diameter penstock for transmission to the turbine house.

The penstock is about 940 metres in length and descends eastwards to the turbine house on the north side of the Afon Mûr-gwenyn next to the A498 road.

The turbine will drive a generator, which will be connected to the Holiday Park's existing electricity grid connection, located about 300 metres up the river.

3.3. Design considerations

The Afon Mûr-gwenyn and other streams in the area are small, flashy upland watercourses with very small catchment areas so in order to ensure some consistency of flow and for economic viability it is proposed to have intakes located within three watercourses.

The Near and Middle intakes are located near the land ownership boundary at the top of the park. The Far intake is located approximately 80 metres downstream from the boundary. This is because the potential extra head available further upstream is not usable in combination with water from the other intakes.

All intakes have the same quarter-height Coanda design, which has the dual benefits of providing ultra-fine screening of the water via apertures of 3mm and of enabling a low profile intake structure.

The structure forms a weir which is divided in the proportion of the permitted percentage take and the flow to be left in situ. In addition, a minimum residual ("Hands off") flow notch ensures that no water is abstracted below the protected flow rate.

We do not believe there to be fish present in any of the watercourses at the proposed intake locations, due to (1) the steep profiles of the watercourses both above and below the intake points, which include many waterfalls and chutes; (2) the small size of the watercourses, meaning that there is little water volume and limited connectivity during drier periods. Nonetheless we have adopted a conservative approach and in accordance with the pre-application guidance the intake structure design includes a plunge pool below the screen to accommodate downstream fish passage, and eel brushes for eel passage.

The header chamber allows some settlement i.e. for air bubbles to leave the water before it is taken into the penstock pipe. To achieve this fully would require a much larger tank, but for environmental and cost reasons a larger tank is not proposed.

The penstock pipe descends to the tip site from where it follows an existing track / road until a hairpin bend. At this point the penstock continues east towards the turbine house.

The turbine house is located on the north side of the river to avoid the penstock pipe crossing the river to a site on the opposite side as was originally proposed.

The pipe enters the turbine house and delivers the water to the turbine after which it falls vertically into a pit below the turbine house, allowing any remaining energy to dissipate and the flow to slow down, before re-joining the Afon Mûr-gwenyn at a 45-degree angle via a riprap channel.

4. ECOLOGY

4.1. SAC & SSSI

As mentioned in Section 2.2, part of the application site forms part of an SAC, the Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites. This is a large, composite SAC which in total covers an area of 2813 ha. A plan of the SAC with the application site identified is included at Appendix B. The designated features of the SAC present at Aberdunant are 4 bat roosting sites as detailed on the plan at Appendix C which support the lesser horseshoe bat Rhinolophus hipposideros. The SSSI that provides supporting habitat to the bats measures 8.8ha, therefore constituting 0.31% of the total area of the SAC.

Natural Resources Wales have a Core Management Plan including Conservation Objectives in place for the SAC[2]. Aberdunant SAC / SSSI forms two management units, with internal references 2 & 54. The Management Plan details the relationship between the designated features and each management unit. For Aberdunant, the lesser horseshoe bat Rhinolophus hipposideros is listed as a Key Species. No other designated features are recorded.

This application for impoundment and abstraction of water from three minor watercourses via three small intakes has no relevance to the bat roosts as they are not directly affected. Any

[2] Available here: https://naturalresources.wales/media/672832/mow-sac-plan.pdf

potential effects of the scheme as a whole on the bat roosts will be subject to examination later in the planning process.

4.2. Lower plants

The majority of the SAC comprises oak woods which provide a favourable habitat for lower plants (mosses, liverworts, lichens and slime moulds). They are listed as a key feature or species of 22 management units within the wider SAC, however they are not listed at Aberdunant.

Nevertheless as these lower plants thrive in humid conditions and given the proposed abstraction from watercourses within the SSSI, the applicant commissioned a specialist report by Dr Des Callaghan of Bryophyte Surveys Limited to examine the significance of the lower plant flora within watercourses where they would be depleted by the proposed abstraction. The report is attached at Appendix D.

The report states that the oceanic bryophyte assemblage qualifies as being of conservation importance but only marginally and the assemblage is not of outstanding interest, ranking about 57th in Wales according to the Weighted Ravine Marker Score, from over 300 rivers that have been scored.

There are no species present along the proposed depleted reaches that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), or which are included on any relevant IUCN Red List.

The conclusion of the report states that the scheme has the potential to have a negative effect on populations of some species that comprise the oceanic bryophyte assemblage, but none of the species that may be affected are rare in Wales and the residual effects on the assemblage are unlikely to be of high conservation significance.

It is anticipated that the abstraction licence will include the requirement for allow a residual flow down the watercourses below which no abstraction can take place. This ensures that the watercourses remain wet at all times. Above the residual flow the HEP scheme will take only a proportion of the water, and there will be a maximum abstraction rate above which no additional water is taken. These measures should ensure that any changes to the hydrological regimes within the watercourses have a limited effect on the mosses and liverworts that the watercourses support.

Further, the report confirms that the lower plants within the Aberdunant Management Unit are not particularly significant when compared with other parts of the SAC and indeed they are not designated features of this part of the SAC.

4.3. Fish

<u>Intake locations</u>

As stated earlier we do not believe there to be fish present in any of the watercourses at the proposed intake locations, due to (1) the steep profiles of the watercourses both above and below the intake points, which include waterfalls; (2) the small size of the watercourses, meaning that there is little water volume and limited connectivity during drier periods.

Nonetheless we have adopted a conservative approach. The pre-application letter contained advice from a Technical Fisheries Officer who indicated that provision for downstream fish passage should be made on the weirs at all three intake locations. This has been included in

the submitted designs via rectangular notches that pass the protected low flow, with plunge pools below to prevent stranding and physical harm to fish. Provision for upstream eel passage has also been incorporated into the design per the pre-application advice.

Outfall

The pre-application advice advised that lower sections of the Afon Mûr-gwenyn provide supporting habitat for migratory salmonids. The Afon Mûr-gwenyn is a tributary of the Afon Glaslyn, much of which is included with the Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites SAC and part of which is designated the Glaslyn SSSI.

The SAC Management Plan does not mention migratory salmonids. The Glaslyn SSSI Citation[3] states that Atlantic salmon *Salmo salar* and sewin (sea trout) *Salmo trutta trutta* use the Glaslyn river as a migration route to access their spawning grounds higher up the catchment.

The outfall from the HEP scheme is not located in an area designated SAC or SSSI.

As stated above and further evidenced in the Geomorphology Photosurvey which is part of the licence application, there is a natural waterfall that is likely to prevent migratory fish moving further than about 275 metres upstream from the outfall location, in addition to a smaller waterfall 175 metres upstream, which may also be a barrier. The contribution that the Afon Mûr-gwenyn makes to support Afon Glaslyn (with length of about 16 miles) as an ecosystem for Salmonids is therefore limited. Further, as 100% of the abstracted water is returned to the watercourse before it joins the Afon Glaslyn, there is no effect on that river or its SSSI.

Water outfall from a turbine house can have undesirable effects where it returns to the natural watercourse in two areas: it can create a vigorous flow which attracts migratory fish towards the turbine house outfall, and high energy flows can potentially disturb the river bed which could be a spawning ground for fish.

In the case of Aberdunant the impact is likely to be limited and there are also a number of mitigations:

- In between the abstraction points and the outfall point, there are 4 additional tributaries adding water to the watercourse. This will cause the water that is being returned to the river to form a materially lower percentage of the flow than at the abstraction points, thereby reducing the risk that migratory fish are attracted to it.
- The river bed at the outfall location is comprised mainly of slate shards (see picture below), which appear robust and less likely to be disturbed by the hydro outfall.
- The turbine house is designed so that after passing through the turbine the water falls into a pit where any remaining energy is dissipated, before returning to the river via a riprap which further serves to distribute and slow down the flow as much as possible so that it cannot disturb the river bed or form an attraction to migratory fish. The turbine house is located about 5 metres away from the river bank to allow appropriate distance for this to happen.
- The water is returned to the river at a 45-degree angle to further smooth the flow and reduce turbulence on the riverbed.

[3] Available here: https://naturalresourceswales.gov.uk/media/650027/SSSI_0724_Citation_EN001f53c.pdf

Close up of river bed at outfall location with A4 clipboard for scale

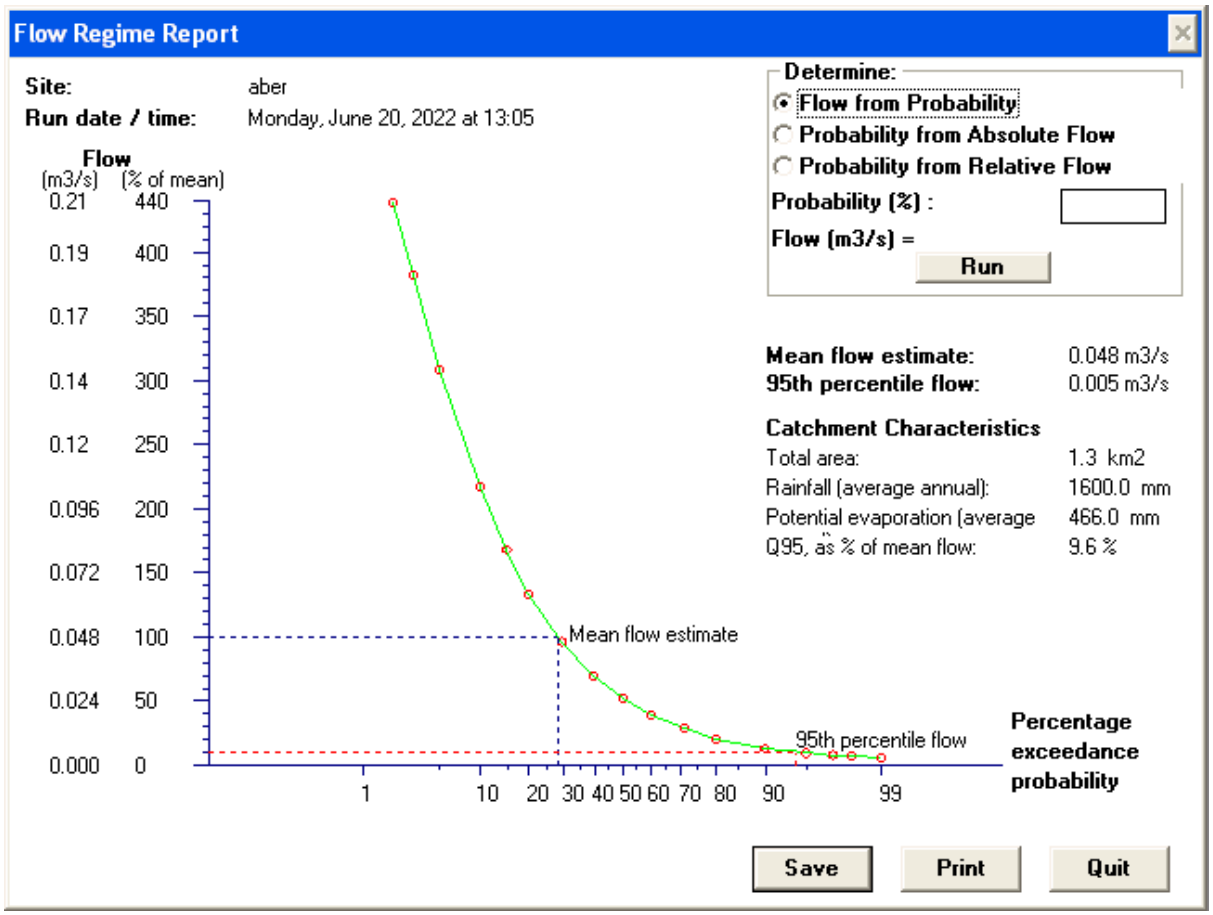
River bed at point of outfall which would be on the left hand side of picture

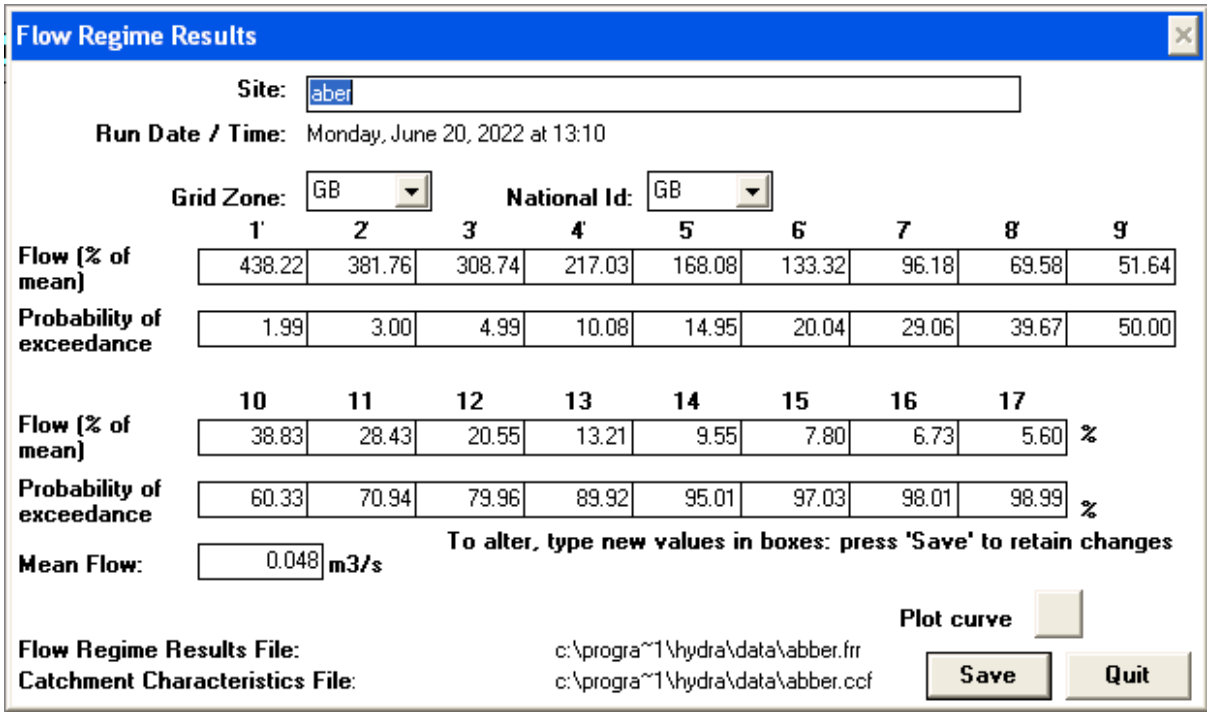
5. HYDROLOGY STATISTICS AND ANALYSIS

5.1. HydrA forecasted flow characteristics

The HydrA software package analysis predicts an annual mean flow across the three proposed intake locations (Qmean) of 48 lps and the flow exceeded for 95% of the year (Q95) to be 5 lps.

The predicted Flow Regime analysis is presented below.





6. ABSTRACTION REGIME CONSIDERATIONS

6.1. NRW abstraction management regimes

Natural Resources Wales has a process in place to determine the appropriate abstraction rate for a potential HEP scheme: Tier 1 assessment provides the standard initial abstraction rate assumption. Tier 2 assessment allows additional site information to be used for a more detailed assessment of environmental risk, which could mean that a scheme may move to an alternative zone with subsequent application of that zone's abstraction rates.[4]

6.2. Tier 1 categorisation

The proposed scheme at Aberdunant, with a depleted reach and part of it located within a designated site (the Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites SAC, and Aberdunant SSSI) has a Tier 1 categorisation of Zone 1. The standard abstraction rates for Zone 1 sites are:

Zone 1 Abstraction Regime		
Low flow protection (Hands off Flow)	**% take of available flow**	**Maximum abstraction rate**
Minimum of Q95 i.e. 5 litres per second	10 or 40%	62.4 litres per second i.e. 1.3 x Qmean

[4] See: https://naturalresourceswales.gov.uk/permits-and-permissions/water-abstraction-and-impoundment/hydropower/abstraction-rates-for-hydropower/?lang=en

6.3. Tier 2 considerations

In some cases it may be possible to consider additional physical and environmental characteristics of a site that could support movement of a scheme to a different zone. In the case of Aberdunant, the following information can be considered:

Effect on flow-sensitive features:

- The reason for the scheme's initial Zone 1 classification is the SAC and SSSI, and the designated feature of these areas is the bat roosting sites which support the lesser horseshoe bat Rhinolophus hipposideros. No other designated features are recorded, unlike other management units in the SAC, which do record bryophytes for example.
- The oak woods provide a favourable habitat for lower plants which feature in the wider SAC. However, the specialist report from Dr Des Callaghan states that the bryophytes only qualify marginally as being of conservation importance. There are no species that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), or which are included on any relevant IUCN Red List.
- The conclusion of the bryophyte report states that the scheme has the potential to have a negative effect on populations of some species that comprise the oceanic bryophyte assemblage, but none of the species that may be affected are rare in Wales and the residual effects on the assemblage are unlikely to be of high conservation significance.

Responsive hydrological regime:

- Q95 as a % of mean flow is 9.6%. I.e. Q95/Qmean is 0.096, and Q10/Qmean is estimated at 2.2. This virtually meets the NRW definition of flashy hydrology i.e. Q95/Qmean of 0.1 or less and Q10/Qmean greater than 2.3.
- Upstream catchment characteristics: the average gradient of the principle channels in the catchment upstream of the points of abstraction is greater than 10%, and the depleted reaches have bed gradients of 10% or above and it is therefore likely that it will have the hydrological and geomorphological characteristics of Zone 3. For reference the gradients are recorded in the table below.

Watercourse / Intake	Afon Mûr-gwenyn / Near	Un-named tributary 1 / Middle	Un-named tributary 2 / Far
Gradient upstream of intake	15%	15%	16%
Gradient of depleted reach	10%	10%	12.5%

- Upstream catchment size: The combined catchment area is 1.3 km2. The streams constitute a headwater tributary and the development of an HEP scheme presents a low risk to ecosystem connectivity within the river catchment.
- Contributing inflows: There are four additional tributary inflows joining the watercourses between the intakes and the outfall.
- Barriers: the natural terrain and steepness of the watercourses provides natural barriers to migratory salmonids. Abstraction for hydropower will not create any new barriers by reducing flows over existing structures.
- Design: The abstractions would be via quarter-height Coanda/overspill intakes, which have the least effect on river flora, fauna and natural sediment and stone movement.

6.4. Proposed abstraction regime

For the reasons given above, abstraction for HEP will not affect the designated key features of the SAC / SSSI, and will have no significant effect on flow-sensitive features of that site. The characteristics of the site including bed gradient and hydrological regime indicate that a Zone 3 abstraction regime is appropriate.

The proposed abstraction regime is therefore for the same Hands off flow, with an increased percentage take but a reduced maximum abstraction rate, as shown in the following table.

Zone 3 Abstraction Regime		
Low flow protection (Hands off Flow)	**% take of available flow**	**Maximum abstraction rate**
Q95 i.e. 5 litres per second	70%	48 litres per second i.e. 1.0 x Qmean

APPENDICES

Appendix A. NRW Pre-application advice

Cyfoeth Naturiol Cymru
Natural Resources Wales

Dean Needle

Flumina House
Foundry Lane
Milford
Derbyshire
DE56 0RN

Sent via email to:
dean.needle@derwenthydro.co.uk

Your reference: PPN-00846

Date: 16/09/2022

Dear Dean,

Request for pre-application advice for abstraction at Aberdunant Hall, reference PPN-00846

Thank you for your request for pre-application advice. You have requested advice regarding implementation of a new HEP scheme at Aberdunant Hall Hotel and Holiday Park. The scheme is proposed to have 3 points of abstraction. Please find my response below.

Licence type required and how to apply

From the Site Plan submitted with your pre-application enquiry it looks like the 3 points of abstraction are situated on 3 separate watercourses (Points 1 and 2 on separate unnamed tributaries of the Afon Mur-gwenyn and Point 3 on the Afon Mur-gwenyn). You have confirmed that the abstractions at each intake will be secured by an impoundment structure and that 3 separate pipes will take the water from each intake and combined into one pipe at location 4 on the associated Site Plan. The turbine house and discharge of water will be at location 10 on the associated Site Plan.

Based on the above information, three separate abstraction licences will be required. As abstraction is to be secured by physical means i.e. an impoundment structure, three separate impoundment licences will also be required.

Please include these details on how you propose to abstract from the 3 intakes and how that abstraction will be controlled as part of your formal application.

To apply for these licences you will need to complete one WRA application form, three WRD applications forms (one for each abstraction) and three WRE application forms (one for each impoundment). All applications for abstraction and impoundment licences should be made using the forms available on our website, they can be

found here: Home > Permits and permissions > Water abstraction and impoundment licences > Apply for a water abstraction or impoundment licence

Fees and Charges

The following information is based on the Water Abstraction Charges Scheme 2021/2022, further information can be found here on our website: Home > About us > What we do > How we regulate > Water Abstraction Charges Scheme 2021 / 2022. Please be aware that this is subject to change.

There is a tiered application fee for hydroelectric power generation applications, depending on the capacity of your scheme.

- £375 for schemes generating 25 kW or less.
- £750 for schemes generating over 25 kW up to 50 kW.
- £1,125 for schemes generating over 50 kW up to 100 kW.
- £1,500 for schemes generating over 100 kW up to 250 kW.

Larger hydropower schemes (over 250 kW) which are more complex and at a scale which requires greater technical input from us are charged at the base charge of £1,500 with an additional charge of £125 per hour to cover time and material costs.

Where applications for abstraction licences and impoundment licences for associated activities are jointly submitted, a single application fee will be charged in accordance with the charging scheme.

In accordance with section 6.2 of the Water Abstraction Charges Scheme 2021 / 2022, the annual charge is not payable in respect of water authorised to be abstracted for direct use in the production of electricity or any other form of power by generating station or apparatus of a capacity of not more than five megawatts. If the water abstracted is proposed to be used for any other purpose, an annual charge will apply.

Your application for a new licence may need to be advertised. We decide if the proposal needs to be advertised based on the location of your site and the potential risk to the environment or other water users. We arrange to publish the notice in a local newspaper and on our website. If advertising is needed you will need to pay us a £100 administration fee and half the cost of the bilingual advert. We will pay for the other half of the advert. Advertising costs vary between newspapers but are usually between £500 and £1,500. We will contact you to confirm whether advertising is needed and provide details of the costs you will need to pay.

Cyfoeth Naturiol Cymru
Natural Resources Wales

Water Availability

Water availability at this location is determined by the Llŷn & Eryri Catchment Abstraction Management Strategy (CAMS). River water availability at the location of your abstractions has not been assessed, we assess applications in these areas on their individual merits. You can find the relevant document here on our website: Home > About us > What we do > Water > Water available in our catchments. If an abstraction returns 100% of the water abstracted back to the same catchment it is known as "non-consumptive". Consequently we may be able to consider licensing new non-consumptive abstractions where we would not license other water uses.

New abstraction licences are time limited – this will provisionally be to the common end date for the catchment, as set out in our Abstraction Management Strategies. Time limits will range from six years up to a maximum of 18 years. Licences are eligible for renewal once they have reached the common end date. The current common end date for all licences issued in the Llŷn & Eryri CAMS area is 31 March 2037.

Abstraction rates for hydropower

This section includes information on flow splits and Hands off Flows (HoFs)

Protecting low flows - The flow rate at which abstraction should stop as streamflow falls is usually described as a ‘Hands-off Flow’ (HoF). All new hydropower abstraction licences will specify a Hands-off Flow. The protected low flow rate is usually equivalent to a low summer flow and termed a Q95 flow when described as a flow duration statistic. There may be cases where the environmental sensitivity of the depleted reach requires a higher flow rate to be protected.

Protecting high flows - A maximum rate of abstraction above which no additional flow may be abstracted will be set. This rate is typically expressed as a proportion of the mean flow (Qmean).

Protecting flow variability - A hydropower abstraction will normally need to allow a proportion of the natural flow to pass downstream of the intake to mimic the river’s natural flow variability within the depleted reach. This flow is a proportion of the total flow in the range between the HoF and the maximum abstraction rate. The proportion abstracted is termed the ‘percentage take (% take)’. Where a scheme will result in a depleted reach, simple site characteristics are used to classify its location into one of three zones to determine initial abstraction rates, these zones are:

- Zone 1: Where a proposed scheme may affect sites designated for nature conservation, supporting habitat, certain protected species, and salmon spawning grounds (Table 2 below).

Table 2. Abstraction rates for Zone 1 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	10 or 40%	1.3 x Qmean

Your scheme will be in Zone 1 and initial abstraction rates in Table 2 will apply if:

- any part of your proposed scheme including the depleted reach is within, or may affect a site designated for nature conservation
- the flow sensitive species freshwater pearl mussel (Margaritifera margaritifera) and native white clawed crayfish (Austropotamobius pallipes) are present in any river reach affected by your scheme
- it is located in a river reach that is in the upstream or downstream catchment of a Special Area of Conservation in which salmon is a notified feature
- there are gravel beds for existing or potential salmon spawning grounds present in the depleted reach or at the points of intake and outfall.

- Zone 2: Where a proposed scheme is not in Zone 1 but is a river or stream where the average channel gradient of the depleted reach is less than 10% slope (<10%) (Table 3 below).

Table 3. Abstraction rates for Zone 2 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	50%	1.3 x Qmean

- Zone 3: Where a proposed scheme is not in Zone 1 but is a river or stream where the average channel gradient of the depleted reach is 10% slope or greater (=>10%) (Table 4 below).

Table 4. Abstraction rates for Zone 3 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	70%	Qmean

In some cases it may be possible to consider additional physical and environmental characteristics of a site that could support movement of a scheme to a different

zone. This may be possible where a proposed hydropower scheme is located within a site of high value for nature conservation (Zone 1) but it can be clearly demonstrated that the proposal will not affect any flow sensitive features of that site. The scheme may then be re-assessed as a Zone 2 or 3 scheme dependent on bed gradient of the depleted river reach. I have included more information on designated sites, protected species and supporting habitat relevant to this site in further sections below.

You can find out more about abstraction rates for hydropower here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Abstraction rates for hydropower

Fish/eel passage requirements

I have consulted a Technical Fisheries Officer to understand what the specific requirements are at the proposed intake locations. This advice is based on the locations in the Site Plan and the photographs of the proposed intake locations you have submitted. The requirements may change if the proposed intake locations are altered.

Provision for downstream fish passage will need to be made on the weirs at all three intake locations. This should be achieved using a rectangular notch to pass the protected low flow and to ensure that fish can pass freely over both the screened overspill intake and residual flow sections of the weir in high flows, with plunge pools below both to prevent stranding and physical harm to fish.

Upstream eel passage will also need to be in place at all three intake locations. It has been requested that an eel rope or similar be included in any design. You can find more information on both fish and eel passes here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Fish passes for hydropower weirs

A Fisheries Officer is happy to attend the site with you to discuss fish and eel passage in more detail. To do this you can either email TimAmgylcheddDwyforacMeirionnydd@cyfoethnaturiolcymru.gov.uk or you can contact Walter Hanks directly on 07769645651.

Hydropower schemes affecting designated sites, protected species and supporting habitat

As you have stated, the scheme does sit within the Meirionnydd Oakwoods and Bats SAC and Aberdunant SSSI. The scheme also sits on a tributary of the Afon Glaslyn which forms part of the Meirionnydd Oakwoods and Bats SAC and Glaslyn SSSI. Lower sections of the Afon Mur-gwenyn provide supporting habitat for migratory salmonids. It has been confirmed that the proposed location of the turbine house and

return of the abstracted water is located within this supporting habitat, so impact upon this must be considered as part of your application. A Fisheries Officer is happy to discuss this with you, I have included the relevant contact details above under the Fish/eel passage requirements section.

You can find a list of designated site features that are sensitive to changes in flow here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Hydropower schemes affecting designated sites, protected species and supporting habitat

You can also find the features for which a site is designated by looking at the maps and site designations here on our website: Home > Guidance and advice > Environmental topics > Wildlife and biodiversity > Protected areas of land and seas > Find protected areas of land and sea

If an impoundment or abstraction is proposed within, or likely to affect a designated site, then applicants will be required to carry out ecological surveys and an impact assessment, presented in an Environmental Statement, to determine how the scheme may affect the designated features and their conservation status. The assessment should show:

- the notified features of the site that are likely to be affected;
- the mechanism and scale of likely impacts;
- the measures that could be implemented to avoid or reduce damage to the notified features;
- the measures that are proposed to compensate for any damage that cannot be mitigated.

We will use this information in the licence determination process to make a detailed evaluation of the impacts of a proposed scheme.

We place much stricter limits on how much water may be abstracted in these sites to protect flow sensitive ecology and are also likely to require a very high standard of environmental design for a scheme. Licence applications may be refused if there is a risk that designated species and habitats cannot be adequately protected from a hydropower development.

I have focussed on information regarding designated sites and supporting habitat for the purposes of this pre-application enquiry however, you can also find information regarding protected species and habitats, and when associated surveys may be required, at the above link.

Information to be submitted with your application

The following information must be submitted alongside all applications for a hydropower scheme:

- hydrology statistics (including estimates of the daily mean flow and Q95 for each intake).
- geomorphology photosurvey
  (You can find out more about geomorphology in relation to hydropower scheme design here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Understanding geomorphology for hydropower scheme design, and the requirements for a geomorphology photosurvey are detailed here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Geomorphology photo surveys for hydropower developments).
- location plans and technical drawings (You can find more information here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Location plans and technical drawings).
- evidence of Rights of Access
  (You can find out more about 'entitlement to apply' here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > What evidence do I need of right of access to an abstraction point

Submission of the above information is sufficient in support of an application for a low risk hydropower scheme (see characteristics of low risk schemes here on our website: Home > Permits and permissions > Water abstraction and impoundment licences > Hydropower > Applying for licences for hydropower schemes) however, applications for all other schemes that don't meet the low risk criteria must submit the basic supporting information requirements above in addition to one or more of the following:

Scheme impact	Supporting information requirement
Schemes affecting a designated site, supporting habitat, protected species or salmon spawning ground or otherwise qualifying for a Zone 1 abstraction regime (See Abstraction rates for hydropower & Designated sites, protected species and supporting habitat).	Ecological and environmental surveys Environmental statement
Schemes with complex hydrological catchments or abstraction regimes that differ from our guidance for purposes of amenity, landscape, recreation or environmental protection. (See Abstraction rates for hydropower & Hydrology).	Hydrological analysis and impact assessment
Sites sensitive to changes in geomorphology (See Understanding geomorphology in hydropower scheme design & Siting an intake weir for hydropower).	Quantitative geomorphological assessment
Sites where multiple abstractions or in-river structures are present on a river reach (See Cumulative impacts).	Cumulative geomorphological impact assessment
Sites that do not apply our zoned abstraction regimes or meet our requirements for low risk siting and design.	Water Framework Directive compliance assessment

Cyfoeth Naturiol Cymru
Natural Resources Wales

For information – other permissions

In addition to abstraction and impoundment licences, you may need other permissions or consents.
On our website you can find a short list and summary of the other permissions frequently required. This list is not exhaustive, and it is your responsibility to check you have all permission required for your proposed activity.

Home > Permits and permissions > Water abstraction and impoundment licences > Other permissions you may need for your abstraction or impoundment

I am happy to discuss any aspects of this advice further so if you have any queries, please do not hesitate to contact me.

Yours sincerely

Hannah Pearce
Water Resources Permitting Officer

Direct e-mail address: Hannah.pearce@cyfoethnaturiolcymru.gov.uk
Direct telephone: 0300 065 4554

Appendix B. Plan of Aberdunant SAC within the Meirionnydd Oakwoods and Bat Sites SAC

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

Lleoliad mapiau uned rheoliar raddfa fawr

Location of large scale management unit maps

Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites

Map 1 / 1

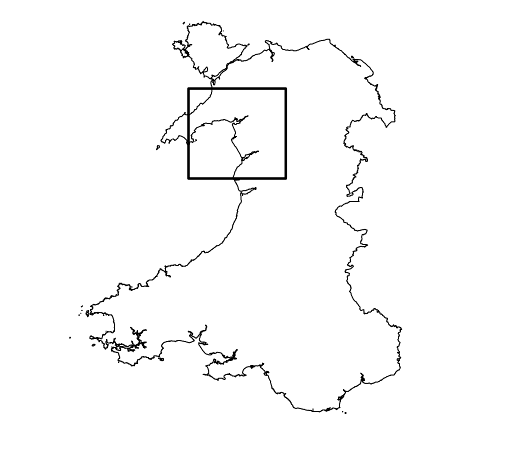
Côd Safle y GE
EC Site Code **UK0014789**

Ardal Cadwraeth Arbennig (ACA)
Special Area of Conservation (SAC)

Tafluniad map: Y Grid Cenedlaethol Prydeinig
Projection: British National Grid

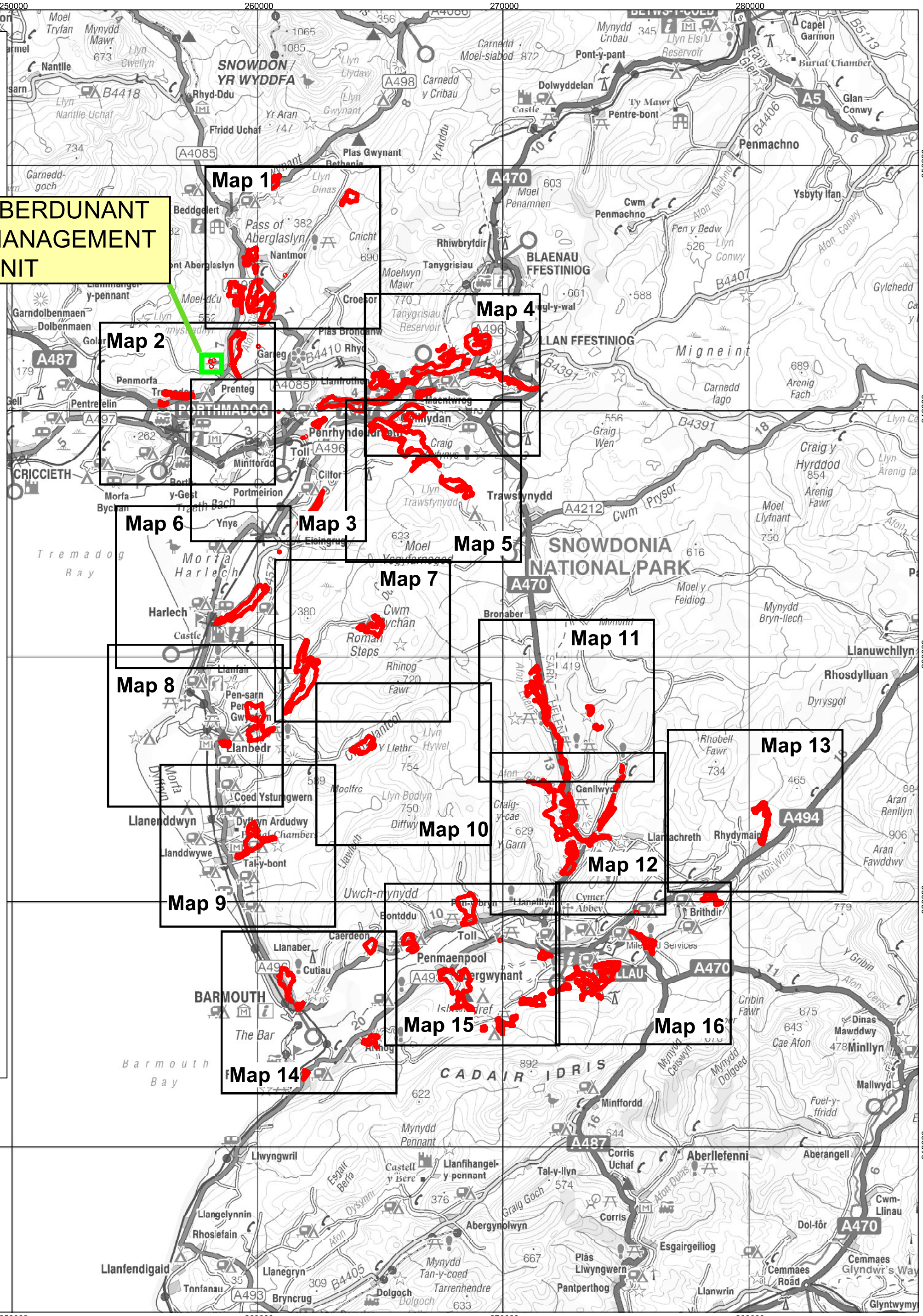
G/N

Graddfa
Scale **1:200,000** **16/04/2008**



Cydran SoDdGA / **Component SSSI**

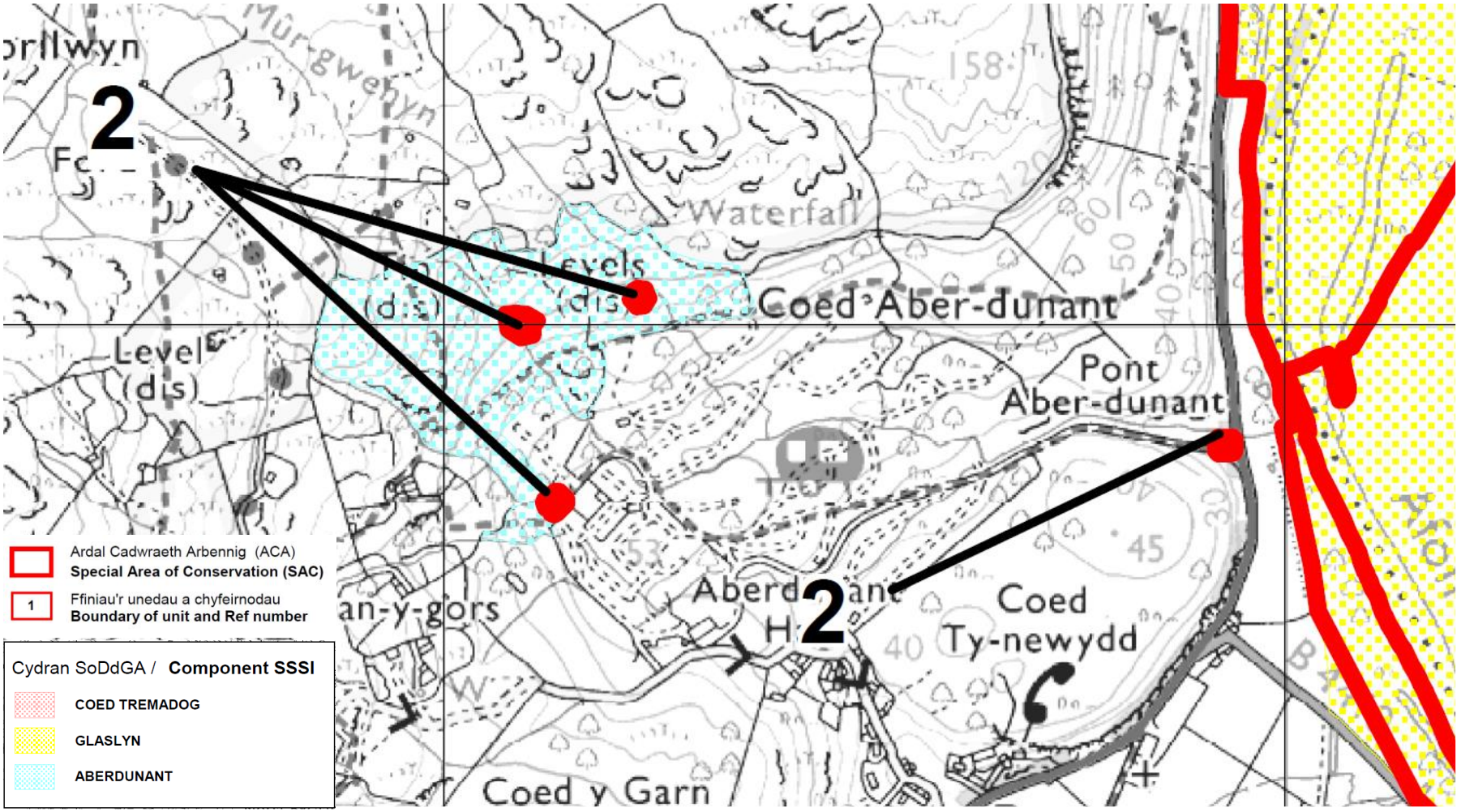
COEDYDD NANMOR	Map 1
COEDYDD NANTGWYNANT	Map 1
COEDYDD BEDDGELERT A CHEUNANT ABERGLASLYN	Map 1
GLASLYN	Map 1, 2, 3
COED TREMADOG	Map 2, 3
ABERDUNANT	Map 2
COEDYDD DYFFRYN FFESTINIOG (GOGLEDDOL)	Map 3, 4, 5
DOLORGAN BARN	Map 3
COED CAMLYN	Map 4, 5
CEUNANT CYNFAL	Map 4, 5
CEUNANT LLENNYRCH	Map 4, 5
COED Y RHYGEN	Map 5
COED LLECHWEDD	Map 6
GLYN CYWARCH	Map 6
RHINOG	Map 7, 10
COED LLETYWALTER	Map 8
COED ABER ARTRO	Map 8
COED CORS Y GEDOL	Map 9
COED GRAIG UCHAF	Map 10
AFON EDEN - CORS GOCH TRAWSFYNYDD	Map 11, 12
GANLLWYD	Map 11, 12
ABER MAWDDACH / MAWDDACH ESTUARY	Map 12, 14, 15
CRAIG Y BENGLOG	Map 13
BARMOUTH HILLSIDE	Map 14
ARTHOG HALL WOODS	Map 14
CADAIR IDRIS	Map 14, 15, 16
COEDYDD ABERGWYNANT	Map 15
PENMAENUCHAF HALL	Map 15
BRYN Y GWIN ISAF	Map 15
MWYNGLODDIA WNION A EGLWYS SANT MARC	Map 16
COEDYDD DYFFRYN WNION	Map 16



Appendix C. Plan showing designated features of the SAC within the Aberdunant Management Units

Coedydd Derw a Safleoedd Ystlumod Meirion / Meirionnydd Oakwoods and Bat Sites SAC – Aberdunant Management Unit (ref: 2)

Extract from Map 2 (https://naturalresources.wales/media/672877/MoW_map2.pdf)



Appendix D. Aberdunant HEP: Bryophyte Survey and Assessment by Bryophyte Surveys Limited

Bryophyte Surveys Ltd




Aberdunant HEP:
bryophyte survey and assessment

Authored by: Dr Des Callaghan

Date: 02 December 2022

Disclaimer

This Report was completed by the author on the basis of an agreed scope of works and under terms and conditions agreed with the Client. I confirm that in preparing this Report I have exercised all reasonable skill and care. The author accepts no responsibility to any parties whatsoever for any matters arising outside the agreed scope of works. This Report is issued in confidence to the Client and the author has no responsibility to any third parties to whom this Report may be circulated, in part or in full, and any such parties rely on the contents of the Report solely at their own risk.

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CONTENTS

INTRODUCTION

The author was instructed by Derwent Hydroelectric Power Limited to undertake a bryophyte survey and assessment for a proposed HEP scheme at Aberdunant, Caernarvonshire. All work has been undertaken by Dr Des Callaghan (Bryophyte Surveys Ltd), a professional bryophyte consultant.

METHOD

Taxonomy

Taxonomy follows Blockeel et al. (2021).

Desktop review

A review was undertaken of the scheme design and previous bryophyte records from the area, including those held by the NBN Gateway and within the national bryophyte recording database of The British Bryological Society, managed by the Biological Records Centre (Wallingford, UK), plus information held by NRW.

Fieldwork

Fieldwork was undertaken during 28–29 November 2022. All parts of the stream lengths that would be impacted by the HEP scheme were visited. No significant survey constraints were encountered. An inventory of the species present was compiled, with specific attention paid to locating species of conservation concern. A hand-held GPS (Garmin GPSMAP 62s) was used to record locations of notable species encountered. Small samples of critical species were collected for determination by microscopy.

Assessment of interest

Based upon the results of the survey, assessment of the significance of the species present was made according to the following procedures:

- Legally protected species – assessment of the presence of any bryophyte species that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended);
- IUCN Red Listed species – assessment of the presence of any bryophyte species that is included on any relevant IUCN Red List (Bosanquet and Dines 2011; Callaghan in press; Hodgetts et al. 2019; IUCN 2022).
- SSSI selection criteria – assessment of the conservation importance of the bryophyte assemblage according to the selection criteria for Sites of Special Scientific Interest (Bosanquet et al. 2018);
- Oceanic Ravine Bryophytes – assessment of the conservation importance of the bryophyte assemblage according to the selection criteria for ‘Oceanic Ravine Bryophytes’ under Section 7 of the Environment (Wales) Act 2016; and
- Weighted Ravine Marker Score – assessment of the conservation importance of the bryophyte assemblage according to the scoring system for oceanic ravine bryophytes in southern Britain (Bosanquet 2011).

BASELINE CONDITIONS

Previous bryophyte records

There has been very little previous recording of bryophytes within the site. A short list of species was collected by G. Griffith in 1998 in Coed Gorllwyn and Coed Aberdunant, which included no notable species. Some of the site was included within a much larger area that was surveyed by Newton (2004), who noted *Lejeunea lamacerina* along one of the present watercourses and some other notable bryophytes in woodland nearby, including *Harpalejeunea molleri, Plagiochila bifaria* and *Rhabdoweisia crenulata*.

Species inventory

A total of 81 bryophyte species (27 liverworts and 54 mosses) was recorded during the present survey (Appendix 1). *Harpalejeunea molleri*, which was found at a distance of 190 m from the easternmost stream by Newton (2004), was not found along the present stream corridors, despite a careful search. A map showing the locations of the more notable species is provided in Figure 1. Photographs showing the locations and niche occupied by some of the notable species are provided in Figures 2–4.

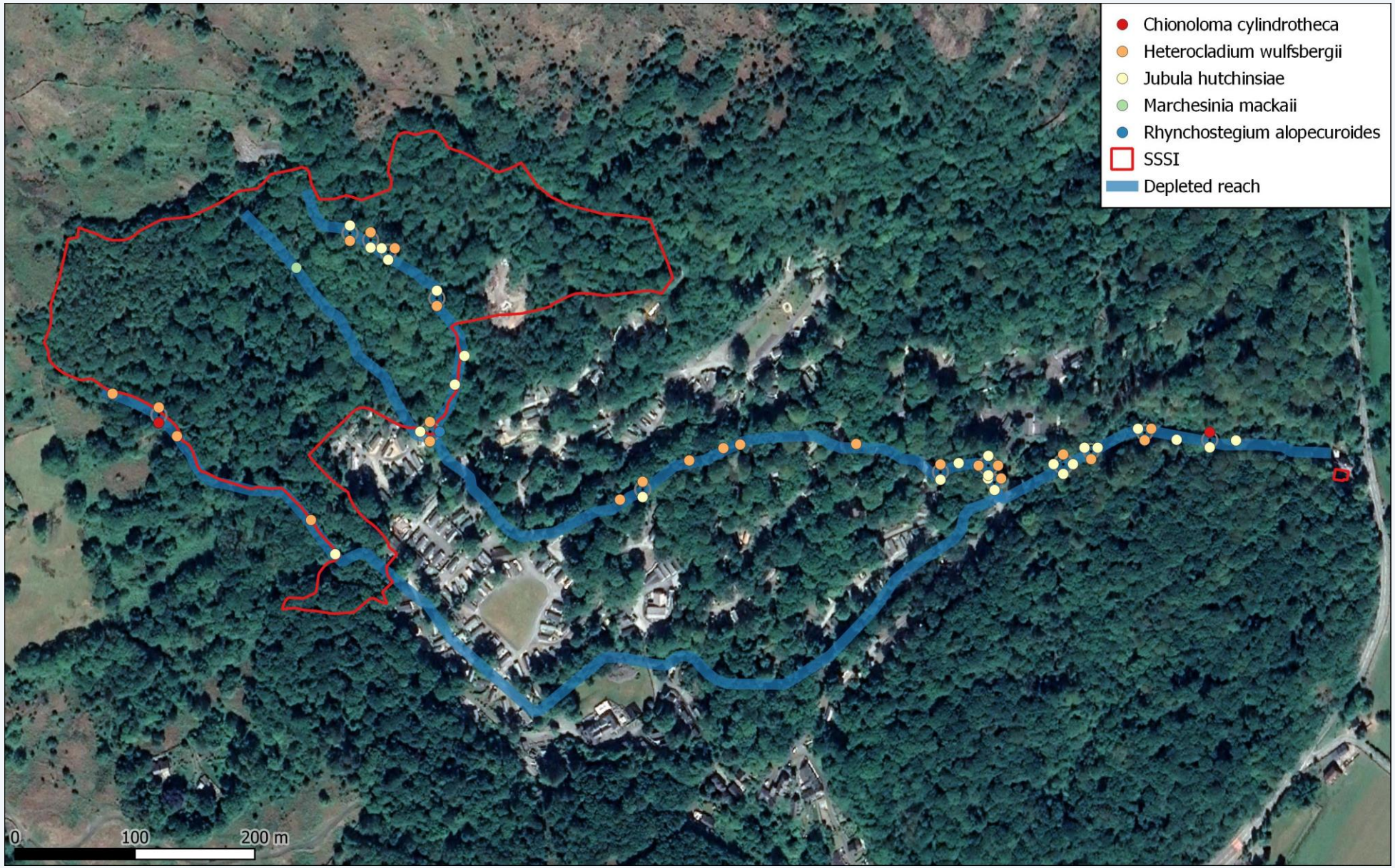

Figure 1. Locations of the more notable bryophyte species found at Aberdunant during the present survey.

Figure 2. Location of *Jubula hutchinsiae* within the lower part of the site (SH5883941897).

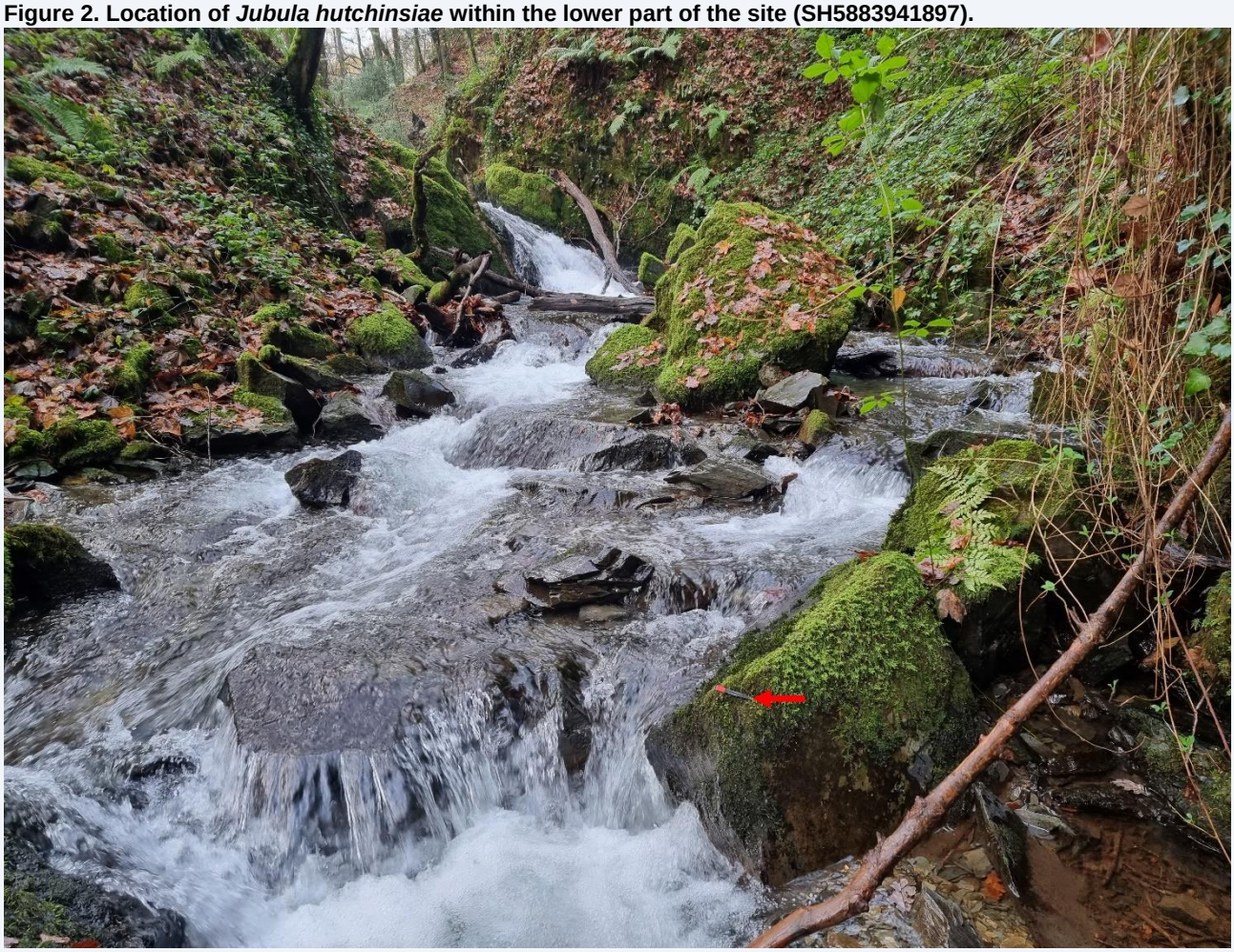

Figure 3. Location of *Heterocladium wulfsbergii* within the lower part of the site (SH5876541890).

Figure 4. Location of *Rhynchostegium alopecuroides* within the middle part of the site, on the lower boundary of the SSSI (SH5816741889).

Assessment of interest

Legally protected species

No species are present that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended).

IUCN Red Listed species

No species are present that are included on any relevant IUCN Red List (Bosanquet and Dines 2011; Callaghan in press; Hodgetts et al. 2019; IUCN 2022).

SSSI selection criteria

An assessment of the site against the SSSI selection criteria for bryophytes (Bosanquet et al. 2018) is provided in Table 1. The site supports one qualifying bryophyte feature of interest:

1. Hyperoceanic and rare or scarce oceanic species of Atlantic woodland (criterion 3.1.3).

Table 1. Site assessment against SSSI selection criteria for bryophytes.

Species	Year of first record	Year of last record	3.1.1 Annex II	3.1.2 Endemic	3.1.3 Atl woodland	3.1.3 Mont heath	3.2 Acid mont cliff	3.2 Arable	3.2 Basic mont cliff	3.2 Bog	3.2 Calc grassland	3.2 Coastal habitats	3.2 Dune/saltmarsh	3.2 Epiphytes	3.2 Fen/swamp	3.2 Flushes	3.2 Lake/reservoir	3.2 Low acid rock	3.2 Low calc rock	3.2 Low heath	3.2 Mine/quarry	3.2 Riparian	3.2 Scree	3.2 Snowbed	3.2 Up heath	3.2 Woodland	3.3 Red List species
Heterocladium wulfsbergii	2022	2022			3																	3					
Jubula hutchinsiae	2022	2022			1																						
Lejeunea lamacerina	2004	2022			1																						
Lejeunea patens	2022	2022			1																						
Plagiochila bifaria	2022	2022			1																						
Plagiochila spinulosa	2022	2022			1	1																					
Rhynchostegium alopecuroides	2022	2022			3												3					3					
Scapania gracilis	2022	2022			1																						
Site score:					**12**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	
SSSI threshold:					**12**	**12**	**18**	**12**	**36**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**15**	**12**	**12**	**15**	**12**	**12**	**12**	**12**	

Oceanic Ravine Bryophytes

An assessment of the site against the criteria for Oceanic Ravine Bryophytes is provided in Table 2. The site qualifies under Criteria 3 and 4.

Table 2. Site assessment against the Section 7 Oceanic Ravine Bryophyte criteria.

Criterion	Species present within site	Number of species present	Criterion met?
1. Any one of the following species: *Campylopus setifolius, Chionoloma recurvifolium, Cololejeunea microscopica, Daltonia splachnoides, Drepanolejeunea hamatifolia, Hageniella micans, Harpalejeunea molleri, Leptoscyphus cuneifolius, Metzgeria leptoneura, Plagiochila exigua, Plagiochila heterophylla, Radula voluta* or *Sematophyllum demissum.*	Nil	0	No
2. Three or more of the following species: *Andreaea megistospora, Dicranum scottianum, Fissidens polyphyllus, Jubula hutchinsiae, Lepidozia cupressina, Lepidozia pearsonii, Pseudomarsupidium decipiens* or *Radula aquilegia.*	*Jubula hutchinsiae*	1	No
3. Five or more of the following species: *Anastrepta orcadensis, Colura calyptrifolia, Douinia ovata, Heterocladium wulfsbergii, Hygrobiella laxifolia, Isothecium holtii, Marchesinia mackaii, Plagiochila bifaria, Plagiochila punctata, Pseudohygrohypnum eugyrium, Rhynchostegium alopecuroides, Porella pinnata, Rhabdoweisia crenulata* or *Sphenolobopsis pearsonii.*	*Heterocladium wulfsbergii, Isothecium holtii, Marchesinia mackaii, Plagiochila bifaria, Rhynchostegium alopecuroides.*	5	Yes
4. Eight or more of the following species: *Bazzania trilobata, Fissidens bryoides* var*. caespitans, Hyocomium armoricum, Lejeunea lamacerina, Lejeunea patens, Lophocolea fragrans, Plagiochila spinulosa, Saccogyna viticulosa, Scapania gracilis, Solenostoma paroicum* or *Sphagnum quinquefarium.*	*Bazzania trilobata, Fissidens bryoides* var*. caespitans, Hyocomium armoricum, Lejeunea lamacerina, Lejeunea patens, Plagiochila spinulosa, Saccogyna viticulosa, Scapania gracilis, Sphagnum quinquefarium.*	9	Yes

Weighted Ravine Marker Score

An assessment of the site against the Weighted Ravine Marker Score (Bosanquet 2011) is provided in Table 3, which shows the site scores 32 points. Out of more than 300 sites that have been scored in Wales, a score of 32 ranks the site at about 57th (S.D.S. Bosanquet personal communication).

Table 3. Site assessment against the Weighted Ravine Marker Score.

Species	Biogeographic element	Weighted Ravine Marker Score
Jubula hutchinsiae	Hyperoceanic	3
Lejeunea lamacerina	Hyperoceanic	3
Lejeunea patens	Hyperoceanic	3
Plagiochila bifaria	Hyperoceanic	3
Plagiochila spinulosa	Hyperoceanic	3
Scapania gracilis	Hyperoceanic	3
Fissidens bryoides var. *caespitans*	Oceanic	2
Hyocomium armoricum	Oceanic	2
Isothecium holtii	Oceanic	2
Marchesinia mackaii	Oceanic	2
Rhynchostegium alopecuroides	Oceanic	2
Saccogyna viticulosa	Oceanic	2
Bazzania trilobata	Suboceanic	1
Sphagnum quinquefarium	Suboceanic	1
	TOTAL:	**32**

Summary of interest

There are no species present along the stream lengths that would be depleted by the proposed HEP that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), or which are included on any relevant IUCN Red List. The oceanic bryophyte assemblage qualifies as being of conservation importance against the SSSI criterion for hyperoceanic and rare or scarce oceanic species of Atlantic woodland (criterion 3.1.3), and against the criteria for Oceanic Ravine Bryophytes under Section 7 of the Environment (Wales) Act 2016. However, it triggers these criteria marginally and the assemblage is not of outstanding interest, ranking about 57th in Wales according to the Weighted Ravine Marker Score, from over 300 rivers that have been scored.

ASSESSMENT OF EFFECTS AND MITIGATION MEASURES

Potential impacts

Legally protected species

The proposed scheme will have no effect on any legally protected bryophyte species.

IUCN Red Listed species

The proposed scheme will have no effect on any bryophyte species included on any relevant IUCN Red List.

Oceanic bryophyte assemblage

The proposed scheme has the potential to have a negative effect on populations of some species that comprise the oceanic bryophyte assemblage. The species most at risk are likely to be those whose niche is most closely tied to the stream hydrology, in particular *Jubula hutchinsiae* (Figure 2)*, Heterocladium wulfsbergii* (Figure 3) and *Rhynchostegium alopecuroides* (Figure 4).

Mitigation measures

Based on NRW guidance, to ensure a flow in the watercourses for the maintenance of riverine habitat for the conservation of flora and fauna, it is expected that an abstraction licence would not allow abstraction unless the rate of flow in the streams immediately below the intake weirs is Q95, which is the flow that would be equalled or exceeded 95% of the time under natural conditions (i.e. the 5-percentile flow). Further, the water abstracted cannot exceed 40% of the natural stream flow >Q95, with a maximum abstraction rate of 1.3x Qmean.

Significance of residual effects

The proposed scheme will have no effect on any legally protected species or any species included on any relevant IUCN Red List. Even given the mitigation measures described, the scheme has the potential to have a negative effect on populations of some species that comprise the oceanic bryophyte assemblage, but none of the species that may be affected are rare in Wales and the residual effects on the assemblage are unlikely to be of high conservation significance.

CONCLUSIONS

- The present report provides a comprehensive bryophyte survey and assessment of the proposed Aberdunant HEP scheme.
- A total of 81 species of bryophytes was found within the survey area.
- There are no species present along the stream lengths that would be depleted by the proposed HEP that have special legal protection under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), or which are included on any relevant IUCN Red List.
- The oceanic bryophyte assemblage qualifies as being of conservation importance against the SSSI criterion for hyperoceanic and rare or scarce oceanic species of Atlantic woodland (criterion 3.1.3), and against the criteria for Oceanic Ravine Bryophytes under Section 7 of the Environment (Wales) Act 2016. However, it triggers these criteria marginally and the assemblage is not of outstanding interest, ranking about 57th in Wales according to the Weighted Ravine Marker Score, from over 300 rivers that have been scored.
- To ensure a flow in the watercourses for the maintenance of riverine habitat for the conservation of flora and fauna, it is expected that an abstraction licence would not allow abstraction unless the rate of flow in the streams immediately below the intake weirs is Q95, and that the water abstracted cannot exceed 40% of the natural stream flow >Q95, with a maximum abstraction rate of 1.3x Qmean.
- Even given the mitigation described, the scheme has the potential to have a negative effect on populations of some species that comprise the oceanic bryophyte assemblage, but none of the species that may be affected are rare in Wales and the residual effects on the assemblage are unlikely to be of high conservation significance.

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APPENDIX 1 – SPECIES INVENTORY

The below provides an inventory of the bryophytes recorded during the present survey. Taxonomy follows Blockeel et al. (2021). Frequency of occurrence within the study area is estimated as: R – Rare; O – Occasional; LF – Locally Frequent; F – Frequent; LA – Locally Abundant; and A – Abundant.

CC No	Division	Family	Species	Frequency
L004.01	Marchantiophyta	Lunulariaceae	*Lunularia cruciata*	O
L009.02	Marchantiophyta	Conocephalaceae	*Conocephalum salebrosum*	F
L013.01	Marchantiophyta	Pelliaceae	*Pellia epiphylla*	F
L013.03	Marchantiophyta	Pelliaceae	*Pellia endiviifolia*	O
L019.03	Marchantiophyta	Metzgeriaceae	*Metzgeria furcata*	F
L019.04	Marchantiophyta	Metzgeriaceae	*Metzgeria conjugata*	LF
L021.02	Marchantiophyta	Aneuraceae	*Riccardia chamedryfolia*	O
L024.01	Marchantiophyta	Frullaniaceae	*Frullania tamarisci*	F
L024.05	Marchantiophyta	Frullaniaceae	*Frullania dilatata*	F
L025.01	Marchantiophyta	Jubulaceae	*Jubula hutchinsiae*	LF
L031.02	Marchantiophyta	Lejeuneaceae	*Lejeunea lamacerina*	O
L031.03	Marchantiophyta	Lejeuneaceae	*Lejeunea patens*	O
L032.01	Marchantiophyta	Lejeuneaceae	*Marchesinia mackaii*	R
L038.01	Marchantiophyta	Lepidoziaceae	*Bazzania trilobata*	R
L040.01	Marchantiophyta	Lepidoziaceae	*Lepidozia reptans*	O
L043.01	Marchantiophyta	Trichocoleaceae	*Trichocolea tomentella*	R
L044.01	Marchantiophyta	Lophocoleaceae	*Lophocolea bidentata*	O
L045.01	Marchantiophyta	Lophocoleaceae	*Chiloscyphus polyanthos*	O
L048.02.a	Marchantiophyta	Plagiochilaceae	*Plagiochila porelloides* var. *porelloides*	O
L048.03	Marchantiophyta	Plagiochilaceae	*Plagiochila asplenioides*	O
L048.06	Marchantiophyta	Plagiochilaceae	*Plagiochila spinulosa*	O
L048.07	Marchantiophyta	Plagiochilaceae	*Plagiochila bifaria*	O
L062.01	Marchantiophyta	Saccogynaceae	*Saccogyna viticulosa*	O
L071.11	Marchantiophyta	Cephaloziaceae	*Cephalozia curvifolia*	R
L092.01	Marchantiophyta	Scapaniaceae	*Diplophyllum albicans*	F
L094.15	Marchantiophyta	Scapaniaceae	*Scapania undulata*	O
L094.21	Marchantiophyta	Scapaniaceae	*Scapania gracilis*	R
M001.06.a	Bryophyta	Sphagnaceae	*Sphagnum palustre* var. *palustre*	R
M001.14	Bryophyta	Sphagnaceae	*Sphagnum quinquefarium*	R
M001.25	Bryophyta	Sphagnaceae	*Sphagnum auriculatum*	R
M006.03	Bryophyta	Polytrichaceae	*Atrichum undulatum*	O
M008.01	Bryophyta	Polytrichaceae	*Polytrichastrum alpinum*	R
M010.02	Bryophyta	Polytrichaceae	*Polytrichum formosum*	F
M010.03	Bryophyta	Polytrichaceae	*Polytrichum commune*	R
M012.01	Bryophyta	Diphysciaceae	*Diphyscium foliosum*	O
M026.06	Bryophyta	Leucobryaceae	*Campylopus flexuosus*	R
M027.02	Bryophyta	Leucobryaceae	*Leucobryum juniperoideum*	R
M028.02	Bryophyta	Amphidiaceae	*Amphidium mougeotii*	O
M032.06.b	Bryophyta	Fissidentaceae	*Fissidens bryoides* var. *caespitans*	O
M032.15	Bryophyta	Fissidentaceae	*Fissidens taxifolius*	O
M032.16	Bryophyta	Fissidentaceae	*Fissidens dubius*	LF
M032.17	Bryophyta	Fissidentaceae	*Fissidens adianthoides*	F
M034.04	Bryophyta	Dicranaceae	*Dicranum scoparium*	O
M034.06	Bryophyta	Dicranaceae	*Dicranum majus*	R
M058.01.b	Bryophyta	Pottiaceae	*Chionoloma tenuirostre* var. *holtii*	O
M058.02	Bryophyta	Pottiaceae	*Chionoloma cylindrotheca*	R
M094.02	Bryophyta	Grimmiaceae	*Racomitrium aciculare*	F
M094.03	Bryophyta	Grimmiaceae	*Racomitrium aquaticum*	O
M110.42	Bryophyta	Bryaceae	*Bryum capillare*	O
M115.01	Bryophyta	Mniaceae	*Mnium hornum*	F
M117.01	Bryophyta	Mniaceae	*Rhizomnium punctatum*	F
M118.06	Bryophyta	Mniaceae	*Plagiomnium undulatum*	F
M118.07	Bryophyta	Mniaceae	*Plagiomnium rostratum*	R
M120.01	Bryophyta	Orthotrichaceae	*Zygodon viridissimus*	R
M120.03	Bryophyta	Orthotrichaceae	*Zygodon rupestris*	R

CC No	Division	Family	Species	Frequency
M120.04.a	Bryophyta	Orthotrichaceae	*Zygodon conoideus* var. *conoideus*	F
M126.07	Bryophyta	Orthotrichaceae	*Ulota crispa*	R
M135.01	Bryophyta	Hookeriaceae	*Hookeria lucens*	O
M137.02	Bryophyta	Fontinalaceae	*Fontinalis squamosa*	F
M141.08	Bryophyta	Plagiotheciaceae	*Plagiothecium succulentum*	O
M141.09	Bryophyta	Plagiotheciaceae	*Plagiothecium nemorale*	F
M143.01	Bryophyta	Plagiotheciaceae	*Pseudotaxiphyllum elegans*	F
M171.01	Bryophyta	Scorpidiaceae	*Hygrohypnella ochracea*	R
M178.01	Bryophyta	Thuidiaceae	*Thuidium tamariscinum*	F
M184.01	Bryophyta	Brachytheciaceae	*Rhynchostegium riparioides*	R
M184.02	Bryophyta	Brachytheciaceae	*Rhynchostegium alopecuroides*	R
M189.01	Bryophyta	Brachytheciaceae	*Kindbergia praelonga*	O
M190.05	Bryophyta	Brachytheciaceae	*Sciuro-hypnum plumosum*	F
M191.07	Bryophyta	Brachytheciaceae	*Brachythecium rivulare*	R
M196.01.a	Bryophyta	Hypnaceae	*Hypnum cupressiforme* var. *cupressiforme*	O
M196.02	Bryophyta	Hypnaceae	*Hypnum andoi*	O
M210.03	Bryophyta	Hylocomiaceae	*Rhytidiadelphus loreus*	A
M224.01	Bryophyta	Neckeraceae	*Homalia trichomanoides*	R
M225.01	Bryophyta	Neckeraceae	*Thamnobryum alopecurum*	F
M228.01	Bryophyta	Lembophyllaceae	*Heterocladium heteropterum*	O
M228.02	Bryophyta	Lembophyllaceae	*Heterocladium flaccidum*	R
M228.03	Bryophyta	Lembophyllaceae	*Heterocladium wulfsbergii*	F
M229.01	Bryophyta	Lembophyllaceae	*Isothecium myosuroides*	F
M229.04	Bryophyta	Lembophyllaceae	*Isothecium holtii*	O
M230.01	Bryophyta	Myuriaceae	*Ctenidium molluscum*	LF
M231.01	Bryophyta	Myuriaceae	*Hyocomium armoricum*	A