

Natural Resources Wales

**Salmon For Tomorrow 2 -
Clywedog**

Clywedog Design Philosophy

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Contents

	Page	
1	Introduction	1
	1.1 Overview	1
	1.2 Client Brief	1
	1.3 Site	2
2	Background	3
	2.1 Construction drawings	3
	2.2 Previous Assessments	4
	2.3 Hydraulic model	4
	2.4 Survey	4
	2.5 Flood Risk	5
	2.6 Environmental Constraints	6
	2.7 Utilities	7
	2.8 Land ownership	9
3	Options Development	11
4	Proposed Design	11
	4.1 Design Criteria	12
	4.2 Buildability	12
	4.3 Maintenance	13
5	Key Risks & Opportunities	14
	5.1 Risks and constraints	14
	5.2 Opportunities	15
6	References	15

1 Introduction

1.1 Overview

Natural Resources Wales (NRW) have appointed Ove Arup and Partners (Arup) to appraise and design fish passage improvements as part of the Salmon for Tomorrow 2 programme. This programme comprises sites located across Wales (Figure 1) with works comprising of a mix of new fish pass installations, modification of existing fish passage or in some cases weir removal. The project is funded by the European Fisheries Fund and the Welsh Government are aiming to improve spawning along 1500 km of waterways which is currently being impeded by weir structures.

This report provides information regarding the design of one of these sites: Cribynau weir on Afon Clywedog near Llanidloes, Grid Reference SN94432 85506. By removing the weir, 3.5km of river habitat will be opened up and natural river processes will be encouraged.

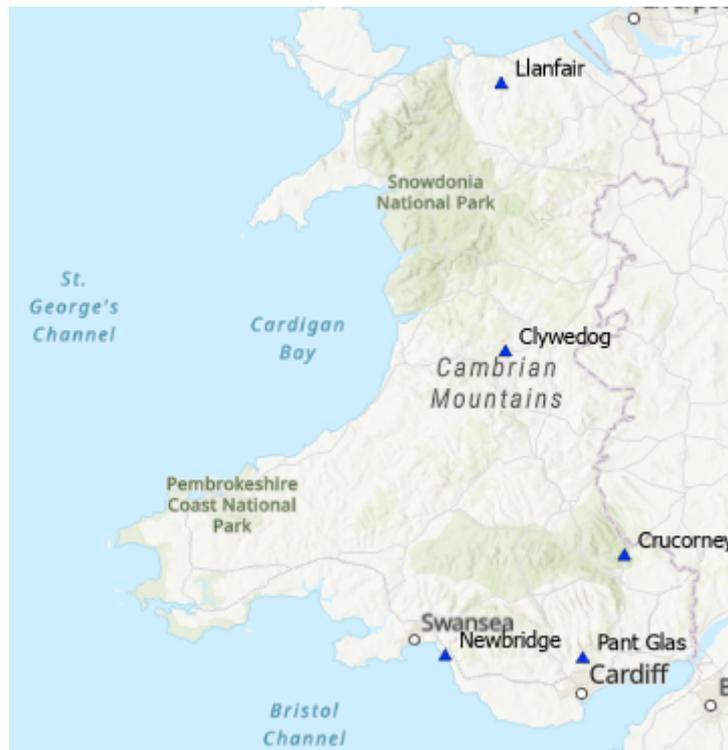


Figure 1. Map indicating locations of Salmon for Tomorrow 2 sites

1.2 Client Brief

The project brief provided by NRW is as per the extract below:

“This project aims to improve fish passage in the Afon Clywedog. Grid Reference SN94432 85506 (Near Llanidloes). The existing NRW gauging weir is redundant and is to be removed. This will provide access to 3.5km of river and restore natural river processes.”

1.3 Site

The weir is at the base of a steep valley with dense vegetation and rocky banks. The site was previously used as a gauging station, but it no longer serves any functional purpose. The weir consists of a central low flow channel between raised walls, with the main body of the weir at a higher level on either side. Concrete wing walls are built into each bank. Submerged gabion baskets added after the construction of the weir extend 10 to 15m upstream of the main weir with a central channel to accommodate low flows.

Approximately 3.5km upstream of the weir is the Clywedog reservoir. The Severn Trent managed reservoir's flow regulation has significant influence on the hydrology of the Clywedog. The reservoir traps sediment before it can be transported downstream, resulting in this section of the river being depleted in gravels that would support salmon spawning. It has been suggested that gravel could be reintroduced to the watercourse during construction works to improve habitat for migratory salmonids (NRW, 2020).

Between the 15th October and the 15th May there is a fisheries embargo for in-river working, however, due to the lack of fish in the river currently, there may be flexibility to undertake works at a more appropriate time to coincide with reduced releases from the upstream reservoir.



Figure 2. The Clywedog weir looking upstream (NRW, 2020)

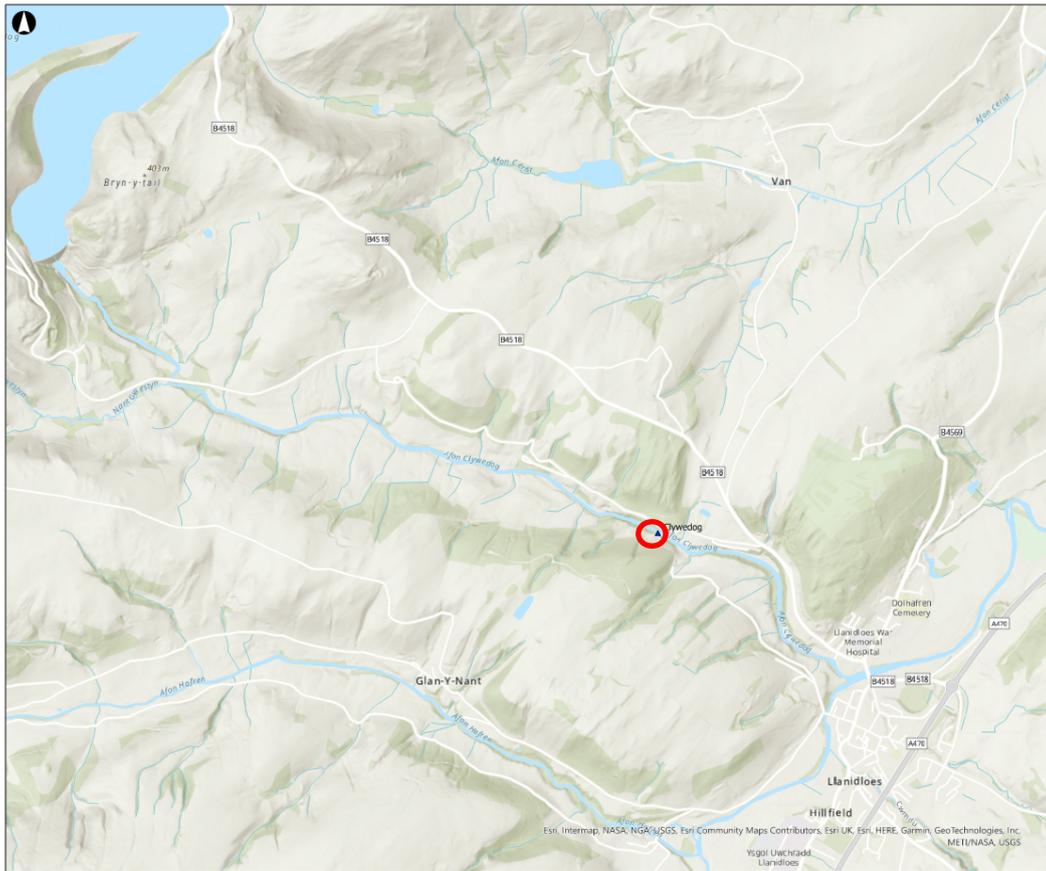


Figure 3. The weir location is circled in red on the Afon Clywedog.

On the left-hand (North) bank is a caravan park (Clywedog Riverside Holiday Home Park) which is accessed from the B4518 from Llanidloes. Static caravans are situated adjacent to the downstream side of the site with a private road passing close to the site. The caravan park is busiest in the summer and is closed for a period over winter.

The right-hand (South) bank is a wooded embankment which leads to a grassed field. There are no public roads close to the right hand bank.

2 Background

Multiple sources of information have been used in preparing the design, as summarised below.

2.1 Construction drawings

Construction drawings from the Severn River Board dated 1958 consisted of:

- *Construction Backfill Details;*
- *Details of Recorder and Gauge Standards* – Details the gauging station which no longer exists;

- *Plan of the Structure;*
- *Upstream Apron Remedial Works – Cross Sections and Long Sections of Gabion Matting;*
- *Upstream Apron Contract Document and Specifications;*
- *Upstream Apron – Plan view of Gabion Matting;*
- *Well for Downstream Recorder – Detail of Gauging Station which no longer exists;*
- *Well Radius and Holes - Detail of Gauging Station which no longer exists.*

2.2 Previous Assessments

The following assessments have been issued by Arup in relation to the project:

- Arup, *Preliminary Ecological Appraisal (PEA)*, March 2021;
- Arup, *Geomorphology Assessment*, May 2021;
- Arup, *Weir Removal Risks and opportunities*, August 2021.
- Arup, *River Clywedog at Llanidloes Model Inception Note*, December 2021;
- Arup, *WFD Assessment*, January 2022;
- Arup, *Environmental Action Plan*, April 2022.

Several site visits have also been carried out.

2.3 Hydraulic model

The existing hydraulic ‘River Severn in Powys’ model, developed in 2006 by JBA Consulting on behalf of NRW was shared with Arup. The model is a 1D-2D Flood Modeller Pro (FMP) – TUFLOW model. However, the weir location in question was not represented in the model extents. Considering the age of the model there were concerns with the hydrology used, and whether the flow releases from the upstream reservoir have changed in that time. It was therefore decided in December 2021 that a new hydraulic model should be created to model the effects of weir removal. The approach to the modelling was agreed in *290013-ARP-00-CL-RP-YX-0001 Model Inception Note* (Arup, 2021).

2.4 Survey

LiDAR was acquired for the entirety of the river, including the reservoir, however it was found that there was insufficient LiDAR to model the Clywedog Reservoir.

A topographic survey was conducted in March 2021 and detailed a 500m stretch of the Afon Clywedog, upstream and downstream of the weir location. To facilitate the hydraulic model build, an additional topographic survey extending further up- and downstream of the weir, over a total distance of 1.5km with in river sections,

was carried out in February 2022, as specified by *290013-ARP-CP-CL-WO-CX-0002 Clywedog River in Channel Survey Specification*.

A specification to sample the silt upstream of the weir for possible contaminants has been issued as per *290013-ARP-ZZ-CL-SP-CE-0001 Silt sampling specification* (February 2022).

2.5 Flood Risk

As the watercourse is downstream of the Clywedog Reservoir, the flows are well regulated. Discussions with the reservoir owners (Severn Trent Water) and NRW have confirmed that releases from the reservoir for regulatory purposes are often carried out and come with some prior warning, however flood releases for drawdown and dam safety purposes are not. This could pose a significant risk during construction.

The Flood Risk Assessment Wales (FRAW) shown in Figure 4 shows that flood waters are primarily contained within the channel downstream of the weir. To determine the impacts that weir removal would have on erosion and flooding both upstream and downstream, a geomorphological investigation and a Flood Consequence Assessment have been carried out, see section 3.

The FRAW mapping shows that no residential properties are at risk of flooding from the River Clywedog, however directly downstream of the weir the caravan park on the left bank is Flood Zone 2.

Therefore, the construction Risk Assessments and Method Statements should implement safe systems of work to include consideration of flood forecasts, inclement weather and local river levels during construction.

Flood mapping of small watercourse and surface water flooding highlights no particular risk to the surrounding area, Figure 5.

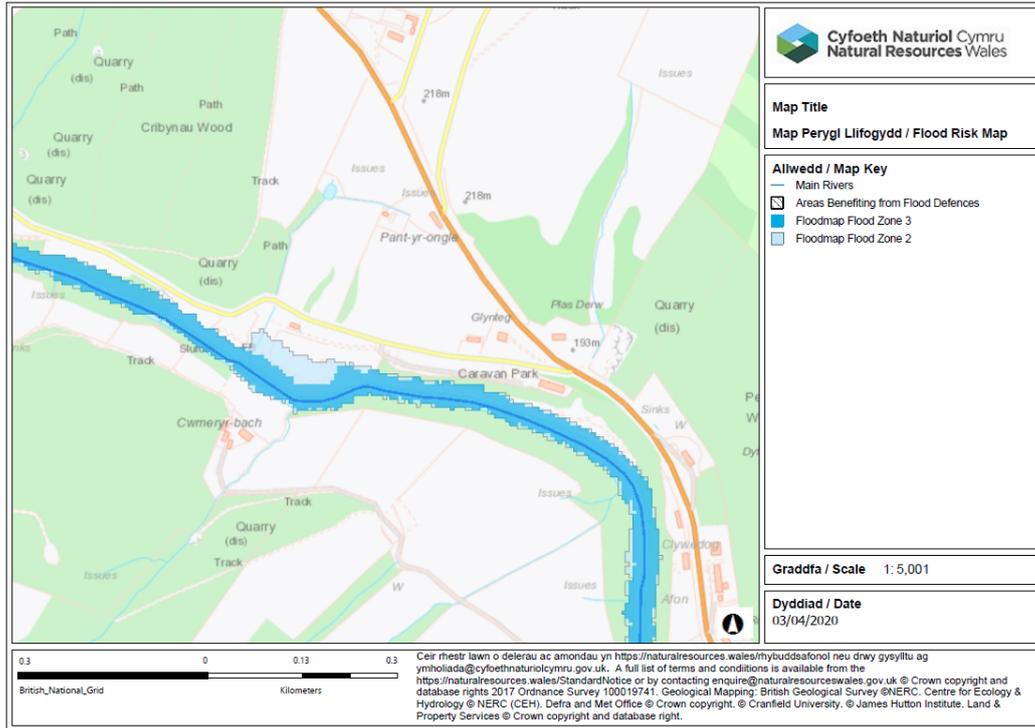


Figure 4. Flood Zone map, extracted from NRW project brief (NRW, 2020).

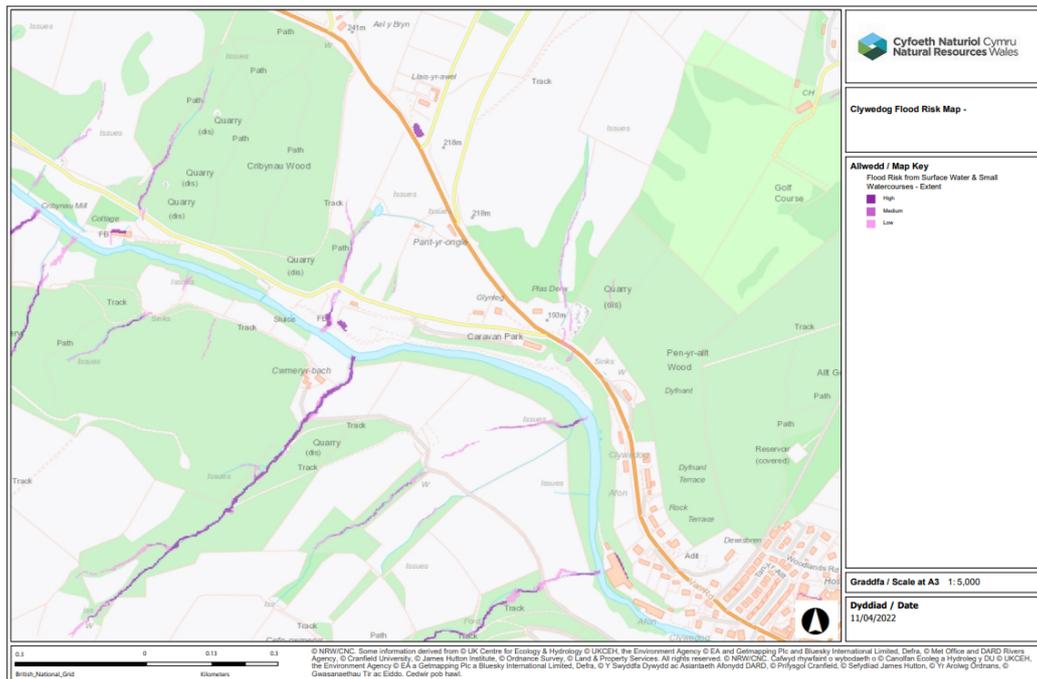


Figure 5. Surface Water and Small watercourse flood risk mapping (NRW, 2022)

2.6 Environmental Constraints

A Preliminary Ecological Appraisal (February 2021) has been conducted for the site and was informed by a desk study and a site visit (February 2021) by an ecologist.

In summary, the following key recommendations have been made:

- Standard pollution control measures should be implemented during construction to protect habitats on/adjacent to the Site.
- The site is located within an area of ancient woodland. The works should be planned to avoid impacts to trees. All works should still follow strict pollution prevention best practice to protect this habitat, and species it may support.
- Where vegetation clearance is required, vegetation should be reinstated on at least a like-for-like basis.
- The river is likely to support a range of fish species. If the river channel is to be partially/fully drained a watching brief should be in place to ensure no fish are stranded. If any dead or distressed fish are noticed the works should be stopped, the methodology reviewed, and the NRW incident hotline contacted.
- The presence of Great Crested Newts (GCN) has been confirmed in the vicinity of the site. Works should proceed with care and measures will need to be employed to ensure that no GCN are harmed (to be detailed in a Precautionary Working Method Statement).
- If disturbance to the mature trees is possible, a further survey to confirm likely presence/absence of bats will be required.
- If vegetation clearance is required during the nesting bird season, a nesting bird check by a suitably qualified ecologist (SQE) will be required and any nesting birds protected from disturbance during construction.
- A visual inspection by a SQE to confirm absence of dormouse nests prior to scrub clearance is required. Dormouse surveys may be required if vegetation clearance requirements change.
- Any lighting required should avoid sensitive habitats, and any open excavations should be covered at night-time.
- Measures to enhance the value of the site for biodiversity are proposed including bird and bat boxes.

A review of environmental designations has also noted that the site is within the Clywedog Historic Landscape area¹. The site is not thought to be a significant contributor to the historic landscape and the weir removal would only result in a local impact at most, which means an assessment would not be required.

2.7 Utilities

A utilities search was carried out by Arup in October 2021. BT and Scottish Power Energy utilities were identified by returns as shown in Figure 6 and Figure 7.

¹ <https://www.cpat.org.uk/projects/longer/histland/clywed/clyint.htm>

An overhead communications cable crosses the river downstream of the weir which may impact construction plant. Local utilities related to the redundant recorder house may also be present.

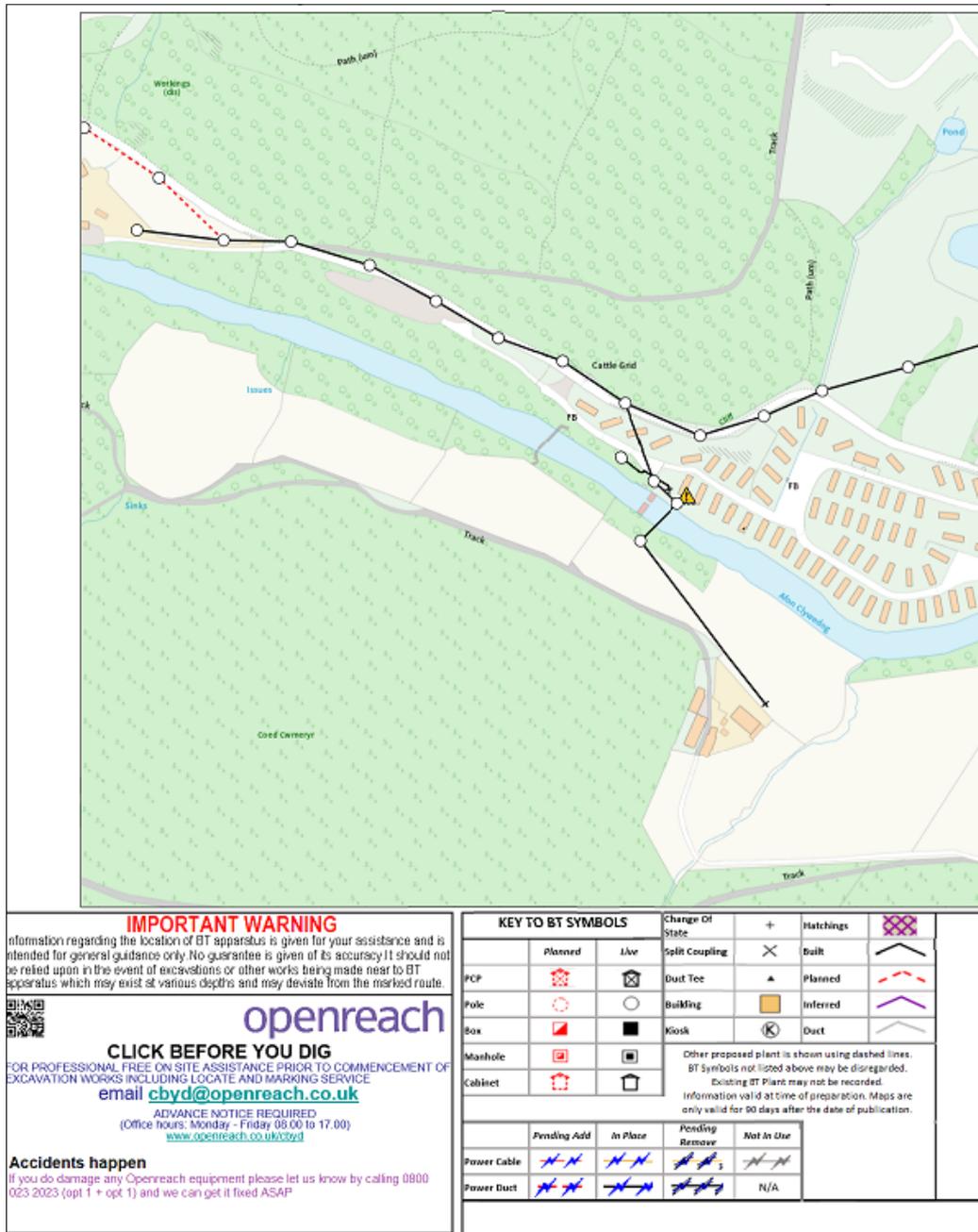


Figure 6. BT utility return as of October 2021.

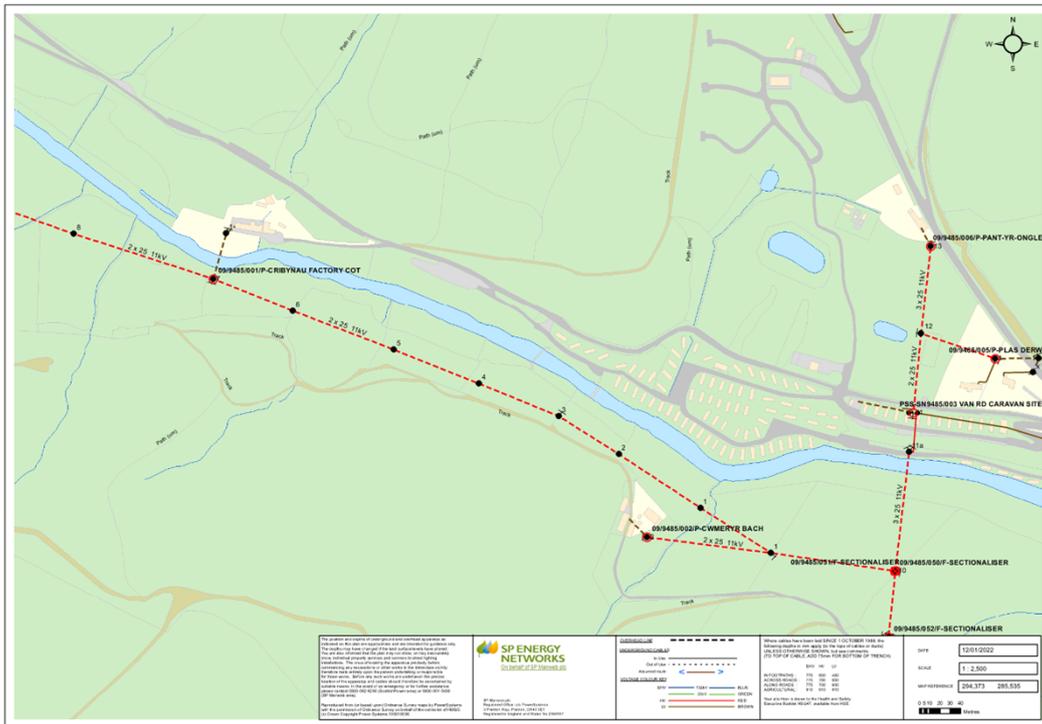


Figure 7. Scottish Power Energy utility search as of October 2021.

2.8 Land ownership

Figure 8 shows the land ownership adjacent to the weir. The left-hand bank and half of the weir are shown to belong to the Clywedog Caravan Park. The right-hand bank is owned by a private landowner, but this does not include any of the river or weir.



Figure 8. Land ownership map provided by NRW.

3 Options Development

The scope for this scheme has been to remove the weir, as opposed to installing structures to enhance fish passage. During option development, full and partial weir removal were considered.

Partial weir removal would involve either lowering the crest level of the weir or creating a full depth break through part of the structure. This would provide reduced benefits for fish passage upstream compared with removing the entire weir, as well as leaving an asset that would require periodic inspection, maintenance and repair. Sediment would still be retained upstream and clearance due to blockage would be required. However, partial removal may require less construction activity leading to reduced costs and risks.

Full removal of the in river structures would improve fish passage and allow the river to return to a nearer-natural state. It was the preferred option for the reasons outlined above, pending hydraulic modelling results and an assessment of its technical feasibility.

Since bedrock was identified in the river and following assessment of the as-builts, full removal was deemed feasible without causing an unnecessary risk.

Arup reviewed the information and built a model, the details of which are specified and agreed within the Model Inception Report, 2021 (Arup, 2021).

A Flood Consequence Assessment found that the preliminary weir removal design reduces flows for approximately 600m upstream of the weir location, with minimal downstream effects. There is no indication that weir removal would result in flooding detriment (Arup, 2022).

4 Proposed Design

The proposed design at Clywedog is a complete weir removal. This will allow fish passage and have the maximum benefit to river naturalisation, as well as reducing future maintenance liabilities for NRW.

The removal will include the following permanent works:

- Demolition of the concrete weir, base and wing walls. Material reuse or disposal will be decided between the contractor, landowner and NRW.
- The left wing wall removal will include removal of the remainder of the recorder house structure.
- Wing walls will be demolished to the bedrock level. Given the presence of shallow bedrock, riverbank erosion as a result of weir removal is likely to be limited, however where necessary erosion protection will be specified.
- The 10-15m of gabions and rockfill mattress will be removed from the channel upstream of the weir and disposed of. Material may be suitable for reuse locally, however it is likely to be disposed of offsite.

- Sediment is currently held behind the weir and will likely require removal to facilitate the demolition. Sampling of the sediment will determine the waste classification for reuse. Sediment will generally be allowed to redistribute naturally over time.
- Pending discussion with the caravan park owners, the existing access to the redundant gauging station will be regraded but may require fencing or other means of preventing access to the river as a steep drop may be formed.

4.1 Design Criteria

4.1.1 Weir removal

The weir removal design will utilise the principles outlined in the CIRIA C763 *River weirs: Design, maintenance, modification and removal* guidance document.

4.1.2 Bank Protection

The 1D hydraulic model provides cross sectional average velocities which does not provide detailed information of likely patterns of erosion across the river channel. A geomorphologist's professional judgement and experience will be used to determine the likely locations most at risk of erosion and the likely river response to weir removal.

NRW have indicated that they would not like gabion baskets to be used as part of the design from a durability and aesthetic perspective, and that the use of concrete should be minimised.

At this stage, it is assumed the protection to be provided for the banks is to be designed for 1 in 20-year flows.

4.2 Buildability

A construction compound is expected to be set up in the caravan park upstream of the weir. Pending discussion with the caravan park owners, access is anticipated to be agreed via the existing route to the weir adjacent to the caravans. Access would then be set up from the compound into the river.

It is expected that the sequence of works will be as follows:

- Install temporary works to facilitate weir removal, likely to involve either half- or full width of the river being dewatered,
- Removal of gabions upstream of the weir to facilitate construction access. Gabions are expected to be disposed of offsite.
- Where upstream sediment must be removed to facilitate weir demolition, the material will be placed downstream in the river.
- Remove concrete weir structure and wing walls and dispose of off site—expected to be in two halves with flows diverted in one half of the river whilst demolition takes place in the other.

- Construct necessary bank protection and regrading.
- Reinstate site and carry out landscaping and / or replanting works as necessary.
- Remove temporary works, access and the construction compound.

The proposed design has looked to minimise the amount of in river working by allowing bed material to regrade naturally rather than creating an artificial slope. This will also minimise the quantities of imported materials required and is possible due to the bedrock material of the river and banks minimising erosion risk. Likewise, the suggested waste classification testing of the bed material will confirm whether the material can be used on site rather than requiring offsite disposal. A summary of the material use and disposal is provided in Table 1.

Table 1. Summary of site material use and disposal. Accurate prior to return of river sediment sampling results.

Material	Action	Comment
Gabions: metal frame	Off-site disposal	Offsite removal will be covered by the contractor's site waste management plan
Gabions: Fill material	Off-site disposal	Offsite removal will be covered by the contractor's site waste management plan
Upstream Sediment	Left where possible or placed downstream	Limited removal to facilitate weir demolition
Weir and wing walls: Concrete	Off-site disposal	Offsite removal will be covered by the contractor's site waste management plan

4.3 Maintenance

Following weir removal, a monitoring regime for the site should be put in place. This is anticipated to consist of a visual inspection following periods of high river flows and a topographic survey of control points at 1-, 3- and 5-years post weir removal. This inspection regime will be detailed by Arup in coordination with NRW technical specialists at a later stage. Reactive mitigation works in response to risks materialising should also be anticipated. Risks are detailed in the risk assessments which have been compiled over the design process.

4.4 Consents and Permissions

In order to be constructed, the works will require the licences and agreements noted in Table 2.

Table 2. Consents and permissions required.

Permission	Responsibility	Note
Permanent Flood Risk Activity Permit (FRAP)	Arup	
Temporary FRAP	Contractor	
Impoundment licence	Arup	Likely 6 month timescale, includes FCA and WFDa
Landowner agreement	NRW	To cover compound and access on left-hand bank, and weir removal on right-hand bank
F10	NRW	Notify HSE of works

5 Key Risks & Opportunities

5.1 Risks and constraints

A project risk register (290013-ARP-XX-CL-PG-RA-0001) has been produced by Arup and NRW identifying key risks and proposing mitigation. The highest scoring risks following mitigation were:

- Contractor pricing for the scheme exceeding NRW's budget.
- Access to site from the preferred location not being available.
- Bad weather during construction, including high flows and in particular due to releases from Clywedog reservoir.
- Agreement with landowners, in particular the caravan park.

A design hazard register is in place and will be updated throughout the project. Key risks include:

- Stability of the existing structures during demolition. This will require careful temporary works planning by the contractor.

- In-river working, including the risks of flooding in high flow events, which will require management and monitoring by the contractor.
- Plant / pedestrian interaction, in particular through the caravan park used for access. Vehicle movements should be minimised and separation measures put in place.
- Asbestos cement inlet pipe 2.4m long leaving the recorder house structure, set at an approximate invert of 170.633m AOD identified on as-builts.

Key construction constraints include:

- The construction period being limited by in-stream working requirements, to be confirmed by NRW.
- Impact on the woodland and the caravan site is to be minimised through minimising construction traffic, noise and lighting. This is to be detailed in the Environmental Action Plan.
- The public access through the caravan site is to be kept open where possible which may impact site access/traffic.
- Water supply flow regime is dictated by Severn Trent.
- Limited access to the right hand bank.

5.2 Opportunities

Additional opportunities could include:

- Re-use of site won materials instead of offsite disposal depending on the results from the sediment testing.
- Improve public safety for the caravan site by closing off access to the river via the historic recorder house.
- Retaining gravel within the river and reinstating sediment transport by removing the weir will improve river habitat and improve fish spawning opportunities.
- Other enhancement measures such as planting and bat or bird box installation are also possible.

6 References

References

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