ELLERGREEN | hydro

Afon Claerwen

Clearwen HoF Operation

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Hydropower Consultancy & Development

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1. INTRODUCTION

This report is intended to accompany applications for Impoundment License for a proposed hydropower scheme on the Afon Claerwen, downstream of the Claerwen Dam. The river links the Claerwen Reservoir to the Dolymynach Reservoir and the total of this reach is around 3.5km in length.

Flows in the river are already heavily modified. It is understood that the Afon Arban, which joins the river immediately downstream of the Claerwen Reservoir, provides the base flow in the Afon Claerwen, and this will fluctuate naturally. However, the river is also used to move volumes of water from the Claerwen Reservoir down into the Elan Valley system, and when the dam releases water an additional flow (typically of 3.7m³/s) is added to the river.

It is proposed to construct an intake weir approximately 1.5km downstream of the Claerwen Dam. The intake will span the small natural island in the center of the river, meaning the intake will be split in two halves. From the intake a pipeline will be laid into the river bank. The pipeline itself is of approximately 1800mm internal diameter. The pipeline will run a length of approximately 2km before entering the powerhouse which will hold the turbine and electric equipment. Once the water has passed through the turbine, it will be discharged outside the powerhouse to an open channel running back into the Afon Claerwen. For greater detail please see the submitted license application drawings.

2. Abstraction

The intention of this scheme is to make use of the flows released from the Claerwen Reservoir, as they pass from the Claerwen Dam to the Dolymynach Reservoir, to generate electrical power. To this end, the hydropower scheme would be designed to make use of the discharges from the dam only, with a maximum capacity for abstraction of 3.7m³/s. When the dam is not releasing, all water in the Afon Claerwen will be allowed to pass unhindered down the river, and the hydropower installation will not operate.

Once the dam begins releasing, the hydroelectric scheme will activate and abstraction for power generation will begin, with the full release of up to 3.7m³/s being utilised. The max abstraction of the system will be 3. 7m³/s so releases above this amount will not be abstracted and will continue down the derogated reach. This will have the effect of removing the majority of dam release flows from the depleted reach of the river, and as such the depleted river will have a more natural flow variation, governed only by flows in the Afon Arban.

NRW have approved and granted an abstraction license for the abstraction; with the abstraction limit of 3.7m³/s. They have specified no hands of flow set amount but instead the hands off flow is the flow in the River Arban and a result of the abstraction matching the Clearwen Dam releases only. To help clarify the above here are some examples:

Arbon Flow	20lps
Dam Releave Flow	2000lps
Resulting Abstracted Flow	2000lps*
Resulting derogated reach flow (HOF)	20lps*

*Due to details within the impoundment license, two notches are included within the intake weir for fish passage, these flows will during certain flow regimes allow more water down the derogated reach than intended as they are notches that pass water ahead of water flowing over the weir crest and are therefore pass water never available for abstraction. The notches are also open unrestricted notches and hence flows through them increases as water level increases. Therefore the resulting abstraction flows will be slightly less that 2000lps in the example above and the resulting derogated reach flow will be slightly higher than 20lps.

3. Operation

The hydro scheme will be designed and constructed to ensure that water is only abstracted from the watercourse when water is being released from the dam, and only the volume being released is abstracted. This will be achieved by having a head level monitoring system at the dam that will calculate the flow and communicate the information to the flow control system on the turbine.
The monitoring system will be a standalone head level sensor positioned within the channel downstream of the dam outfall (see figure 1). Positioned in the channel the head level sensor will gauge the depth of water and using open channel calculations the real time mass flow rate of water being released will be calculated. This calculation will be calibrated via spot gauging at a range of different flows.

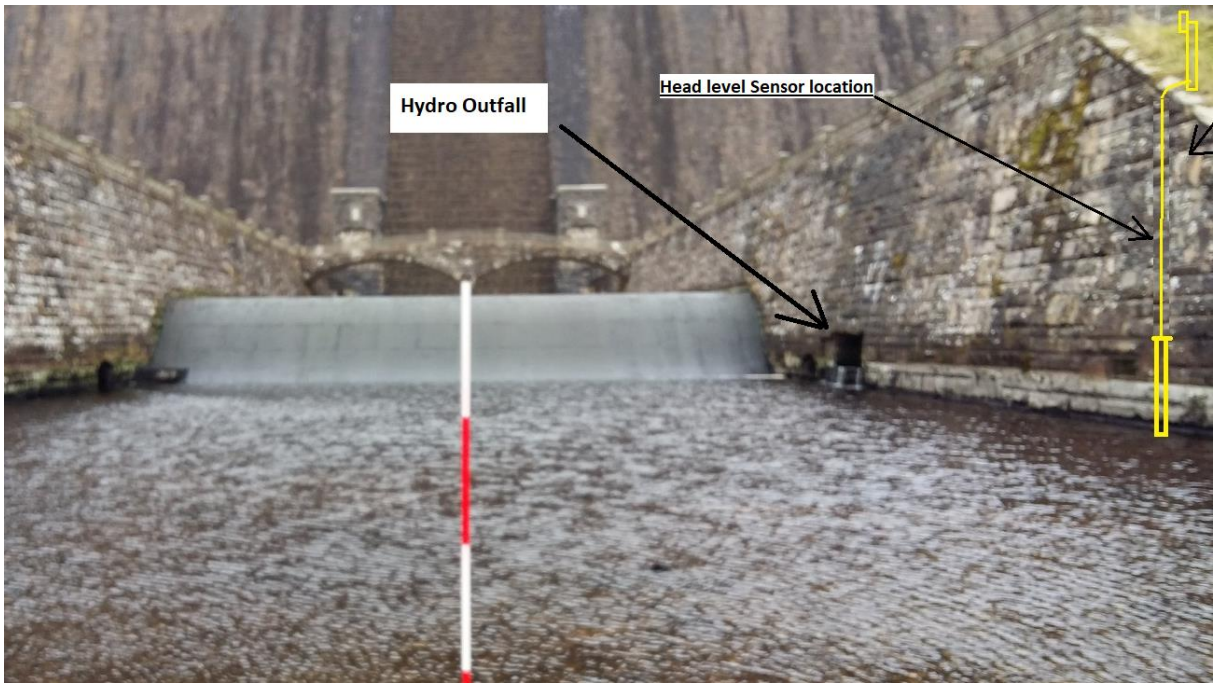

Figure 1: Head Level Sensor Location

This information will be sent to the powerhouse via a telecommunication system; telecommunication was chosen over a physical cable to eliminate the need of having a wire buried from the dam to the powerhouse. The head level sensor will be powered by a small solar panel and battery powerpack (see figure 2) which will allow it to operate independently of external power sources. A data logger will also be included on the system. This has been utilesed elsewhere by Ellergreen Hydro on hydro projects and other by hydro operators and proven to work reliably. To ensure failsafe operation lost communication or malfunction will trigger turbine shut down and halt the abstraction. Further secondary failsafe to the derogated reach is further provided as a result of the two notches provided for fish passage on the intake weir.

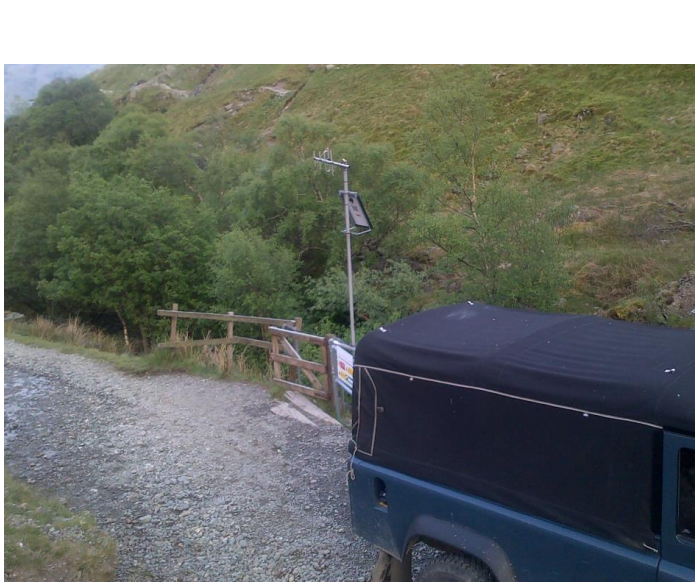

Figure 2: Example of a solar powered head level sensors with data logger and real time telecoms systems

This system on the right in figure 2 utilises the mobile phone network GSM, the system for Clearwen will utilized satellite telecommunication although provision for other forms of comms (eg GSM) is necessary to ensure the best system for the site is made use off, and comms over multiple systems may be preferred after initial testing.

Once received by the powerhouse the information on dam releases will be communicated over to the turbine flow governor which will limit the flow to the appropriate level of abstraction. Using the turbine guide vane (guide vane rather than spear valve as a Francis turbine) to control the flow of water will control the amount of water is drawn from the penstock pipe and in turn the amount of water that is abstracted from the watercourse by the intake. The turbine being the control point is already the case on all other normal run of river high head systems.

For example when the turbine governor is fully open and the scheme is abstracting its full amount (3.7m³/s) the penstock will draw water lowering the level in the header tank and causing the water level in the intake sump tank to also lower. By lowering the level of water in the sump tank the intake will be able to abstract water flowing over the structure. Please note, as on all hydro pipelines, the pipeline is always full of water even when not running so there is no significant delay in abstraction or 'fall behind' where the scheme could start falling behind rapidly changing river flows (eg heavy rainfall after a dry period).

Another example would be when the turbine governor is fully closed and the scheme is not abstracting any water. In this scenario the penstock pipe will not draw any water thus keeping the water level in the header tank at a constant level, in turn keeping the level of water in the intake sump. Having the water level constant in the intake sump will mean that the sump will fill, and with nowhere to go, any water passing over the intake screen will enter at the top and exit at the bottom of the screen. This is not different to any other high head

hydro scheme. Where the turbines always govern the flow and subsequent abstraction and the screen spills, the only change is that the head level sensor is located at the dam rather than within the intake tank.

4. Notches

Built into the intake structure there will also be two notches that will be positioned below the level of the weir crest, this will ensure that flow from the watercourse will pass through the notches before passing over the intake screen, safeguarding a minimal flow down the derogated reach at all times and ensuring that each side of the island has a flow along it. The notches will also be used for fish passages with rock ramps leading down from both notches. The notches will be placed on either side of the small island (the island that divides the intake in two) preventing any fish from being stuck on one side of the intake. Both rock ramps will be constructed with local stone (see figure 3) with one rock ramp (main channel side) having a gradient of 1:10; thus allowing fish to climb over the intake crest without difficulty.

Figure 3: Example of a rock ramp

Notch flows

The notches when full to the intake crest level will pass 39lps (320mm by 160mm) through the main notch within the main channel and 15lps (220mm x 110mm) through the smaller notch within the side channel. During moderate and high flows the water level over the weir will mean that higher flows are experienced. For example when the dam discharges 3700lps the Arbon flow is 50lps, 3750lps arrives at the intake. Ideally the hydro would discharge 3700lps but the notches (which will be discharging 135lps and 80lps) mean that only 3750-215= 3535lps are passing over the weir at the screens. The abstraction will therefore be a maximum of 3535lps when presented with these flows from the Abron and the Dam.

The derogated reach flow will be 215lps in this instance.

In a scenario where this discharge from the dam is 3700lps and the Arbon flow is higher say 250lps (Arban Q58), the notches do not reduce abstraction. In these flows the notch discharge is 140lps and 84lps so 224lps in total. At this time the screens will receive a flow to them of more than enough for their abstraction and the screens will spill the last 26lps required to provide the correct HOFs flow of 250lps.