Hydro Application Supporting Information

For

Dare Valley Micro Hydro

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Version	**Date**	**Purpose of amendment**
1.0	25/03/2014	First issue
2.0	06/10/2014	First issue

Table of Contents

1. Associated Documents

This document should be read in conjunction with the following drawings:

Name	Drawing Number
Site Plan	04701A
Main Intake	04702B
Powerhouse	04703A
Tailrace Detail	04705A

Table 1: Associated documents

2. Background

Rhondda Cynon Taff County Borough Council (RCT) is proposing to develop a micro hydro scheme at Dare Valley Country Park in Aberdare, South Wales. Dare Valley Country Park (DVCP) is a public park in Wales. It is situated near the village of Cwmdare and the town of Aberdare, Cynon Valley, in Rhondda Cynon Taff, South Wales. It comprises 500 acres of woodlands, pasture and moorland mountainside. The site offers a wide variety of walks and wildlife trails as well as camping facilities and a heritage and visitor centre. The landholding consists of forested and grass areas and two large ponds to the northwest of the Visitor and Heritage Centre buildings. Further upstream of Pond 2 is a disused reservoir which is outside the landownership of the council, this is owned by Welsh Water. An aerial map of the site is provided in Figure 1 below which highlights the location of the main entrance and buildings, the two ponds and the reservoir. A series of tarmac pathways connect the site buildings to the ponds and reservoir.

Figure 1: DVCP aerial map (Google Earth)

The landownership of the council is shown in Figure 2 below. The areas shaded red is those owned by the council. Whilst it doesn't show the full land holding it shows the land around the two lakes where a hydro scheme could be installed is under the ownership of the council. The areas shaded blue are owned by the council and currently leased to others.

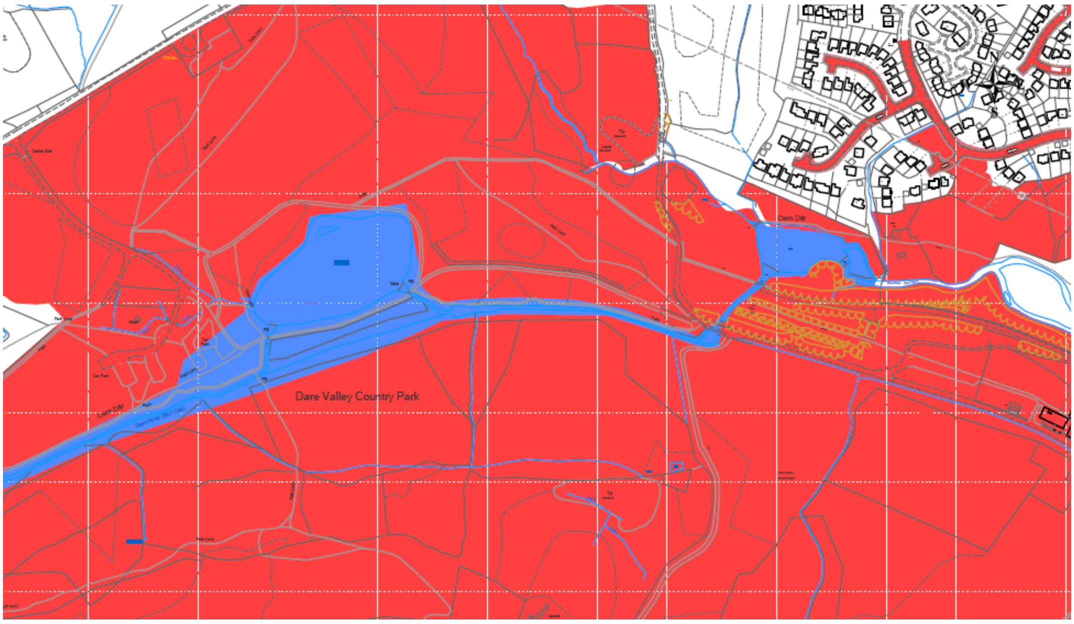

Figure 2: Land ownership map

The proposed hydro scheme would use water from Cwm Dare. We have carefully chosen the intake and outflow of the proposed scheme so as to have minimal impact on habitats and ecology. The intake would be on the existing weir at the upper pond. The powerhouse would be situated on the north west corner of the lower pond where all the water will be returned. See drawing 04701A.

Welsh Water (WW) currently have a licence to abstract water from the reservoir upstream of the upper pond. As such Mike Pedley in WW has been consulted to determine what flows they currently abstract and the impact it may have on the hydro scheme. The response from Mike Pedley is provided below which outlines that WW don't currently abstract from this site and haven't done so since 2003. They would however retain it for emergency purposes.

Hi Stuart,

I have now had some data back on our abstraction which appears to show we have not abstracted since 2003 (but frequently before then).

Historically we've abstracted between 0.5Ml/d and 6.5Ml/d though generally it's been in the range of 2.5Ml/d to 4 Ml/d when operating. Going forward we plan to retain the source for emergency purposes (e.g. droughts) but currently have no plans for re-instating it as a full time source. If you were planning to abstract downstream on this then it would be reasonable to count this water as being available under normal conditions. What we would not want to do, however, is draw down the lake artificially to maintain a flow for hydro. It is likely that we would only need the source at times of drought when river flows would be too low for hydro anyway.

Hope this helps.

Mike

2.1. Layout

The proposed layout of the scheme is illustrated in drawing number 04701A. Further details are shown on drawings 04702B, 04703A and 04705A.

This features a **powerhouse** for the hydro turbine at the north west corner of the lower pond. This houses the turbine, generator and control system. The water is conveyed to the powerhouse by means of a **penstock** (or pressure pipe). This is fed from the **main intake** located at the existing weir on the upper pond which is to be a modified concrete weir construction. Water is returned to the lower pond from the powerhouse by means of a **tailrace**.

The main components highlighted in bold are described in more detail in the sections below.

2.2. Hydro scheme

2.2.1. Levels

Levels have been measured on a site survey. Based on this, the gross head (height drop) seen by the hydro turbine is 29.1m.

2.2.2. Intake

The proposed intake design is shown in drawing 04701B and will be located at national grid ref 297755, 202790. This consists of a low profile concrete weir with an overshot, Coanda screen located over a sump. This would be built onto the existing weir as a modification. The intake is designed to allow a 50l/s compensation flow which will have priority over the flow of water to the turbine to ensure there is always a flow in the burn.

2.2.3. Penstock

The penstock will be a polyethylene pipe, 500mm in diameter and approximately 400m in length. This will be part buried at a depth of 1m and part above ground along the route shown in drawing 04701A. A concrete anchor block will be installed at the bottom of the penstock to prevent movement, as well as at a few points along the route where the pipe changes direction. Vehicular access to the penstock will be temporary, in order to lay the pipe only. Ground conditions are good and it is not envisaged that major work will be required to facilitate excavator access along the penstock route. Small deviations from the planned route may be required if large quantities of bedrock are discovered along the planned route. Following burial, the land will be reinstated.

2.2.4. Powerhouse

A simple powerhouse building will be constructed adjacent to the north west corner of the lower pond. This is shown in drawing 04701A and will be located at national grid ref 298120,202845. The footprint of the building will be approximately 5.6m x 4.1m. The building will be of simple block construction with a profile sheet roof and the walls wooden clad to blend in with the surroundings.

Inside the powerhouse will be a main inlet valve to isolate the turbine, a crossflow turbine and an asynchronous generator which will be directly coupled to the turbine. The control equipment will also be located within this building.

The turbine will discharge the water into a sump below the powerhouse.

2.2.5. Tailrace

The tailrace will be in the form of a buried pipe which will transport the water from the turbine sump back to the lower pond. Under normal conditions the water will be discharged at a higher level than the pond and so the tailrace will not be submerged. Small rocks and boulders will be laid in the tailrace where it meets the pond to ensure it blends in with the landscape and prevents erosion where it enters the pond. It will also be fitted with a 10mm spacing screen. See tailrace drawing 04705A.

2.2.6. Access

Access will be via the existing roads and pathways on site to the location of the intake. For access to the powerhouse location the access will be via the track/road adjacent to the southern edge of the pond. From here a new 3m wide strip will be cleared to allow access to the powerhouse and the laying of the pipeline.

2.3. Operation

Operation of all the hydro system will be fully automatic. The generator output is dependent on the flow of water through the system. This is controlled by a valve on the turbine. A level sensor will be located in the intake sump beneath the Coanda screen. The control system will activate the turbine valve to prevent the level in the sump falling during times of reduced flows.

Due to the design of the intake it will be physically impossible for the system to leave the watercourse dry. The minimum compensation flow will pass before water can enter the intake structure.

2.4. System Specifications and Performance

The expected specifications and performance of the renewable energy systems are shown in Table 2 below:

Quantity	Value
Turbine Efficiency	~84% (max)
System Efficiency	~75%
Rated Flow	235 l/s
Gross Head	29.1 m
Net Head	27.74 m
Power Output	50kW
Annual Energy Yield	200,080 kWh
Capacity Factor	47.4%

Table 2: System Specifications and Performance for hydro scheme

2.5. Grid Connection and Metering

The hydro scheme will be connected to the grid via a distribution board in the powerhouse which will be fed from the Heritage Centre. A 400m length of buried 95mm^2 4-core SWA will connect between the distribution board in the powerhouse and the distribution board in the Heritage Centre. This will mean the generation will be consumed on site with excess exported to the grid. A meter will be installed within the powerhouse to record the gross generation of the systems. This reading will be submitted to OFGEM in order to claim FITs (Feed in Tariffs).

2.6. Construction

An Outline Method Statement for the Construction of the project is shown in Section 4. This includes environmental and health and safety risks and proposed prevention/mitigation measures. If required, a detailed method statement can be submitted by the Contractor prior to the commencement of construction.

3. Water Regime and Abstraction Calculations

This section outlines the flow modelling for the hydro scheme and abstraction regime.

3.1. Flow Modelling

The flow duration curve is shown in the table below. Predictions are based on flow data provided by Wallingford Hydrosolutions using Low Flows Enterprise. Since the hydrology report has been provided to NRW they have agreed that Lowflows has underestimated the available flows and recommend adjusting the flow during curve by a multiple of 1.8. Hence a further

P (%)	Flow at Intake (m^3/s) Lowflows	Flow at Intake (m^3/s) adjusted by NRW
5	0.673	1.211
10	0.459	0.826
20	0.285	0.513
30	0.201	0.362
40	0.149	0.268
50	0.112	0.202
60	0.086	0.155
70	0.067	0.121
80	0.050	0.090
90	0.033	0.059
95	0.025	0.045
98	0.019	0.034
99	0.016	0.029

Table 3: Natural Flow Characteristics

3.1.1. Hands Off Flow

The compensation or 'hands off' flow for the intake has been set at Q95 as per the pre application. Therefore the hands off flow at the intake are proposed to be **50l/s at the rated abstraction**.

The hands off flow will be provided using a V-notch installed on the intake weir. The dimensions of this notch are as per drawing 04702B. The level of the notch will be set below the crest of the weir notch thus this flow will be guaranteed before any water can be abstracted.

3.1.2. Annual Abstraction Volume

The rated (maximum) abstraction will be **235l/s**, equivalent to the mean flow.

The natural and abstracted flows for the Dare River have been modelled and the results are included in Table 4 below (values given in l/s). This is based on the adjusted Lowflows flow duration curve. These calculations allow for the hands off flow which is proposed to be 50l/s at the 235l/s maximum abstraction.

Flow duration curve		As per Lowflows Enterprise	
Hands off (Q95)		0.050	m3/s
Rated Flow (maximum abstraction)		0.235	m3/s
Minimum turbine flow		0.020	m3/s
Gross Head		29.10	m

% excedance	Qtotal m3/s	Hands off Flow m3/s	Qavail m3/s	60% Qavail m3/s	% of Rated	Abstraction m3/s	Modified Flow m3/s	% Residual flow	Hours	Efficiency	Power (kW)	Energy (kWh)	Volume Abstracted (m3)
5	1.211	0.050	1.161	0.697	100.0%	0.235	0.976	81%	438	75.0%	50.3	22,038	370,548
10	0.826	0.050	0.776	0.466	100.0%	0.235	0.591	72%	876	75.0%	50.3	44,075	741,096
20	0.513	0.050	0.463	0.278	100.0%	0.235	0.278	54%	876	75.0%	50.3	44,075	741,096
30	0.362	0.050	0.312	0.187	79.6%	0.187	0.175	48%	876	74.0%	39.5	34,620	589,975
40	0.268	0.050	0.218	0.131	55.7%	0.131	0.137	51%	876	74.0%	27.7	24,227	412,869
50	0.202	0.050	0.152	0.091	38.7%	0.091	0.111	55%	876	72.0%	18.7	16,378	286,851
60	0.155	0.050	0.105	0.063	26.8%	0.063	0.092	59%	876	71.1%	12.8	11,180	198,298
70	0.121	0.050	0.071	0.042	18.0%	0.042	0.078	65%	876	63.0%	7.6	6,674	133,586
80	0.090	0.050	0.040	0.024	10.2%	0.024	0.066	73%	876	50.0%	3.4	3,001	75,686
90	0.059	0.050	0.009	0.006	2.4%	0.000	0.059	100%	657	-	-	-	-
95	0.045	0.050	0.000	0.000	0.0%	0.000	0.045	100%	438	-	-	-	-
98	0.034	0.050	0.000	0.000	0.0%	0.000	0.034	100%	175	-	-	-	-
99	0.029	0.050	0.000	0.000	0.0%	0.000	0.029	100%	88	-	-	-	-
							TOTAL		**8,804**			**206,268**	**3,550,008**

Table 4: Flow Modelling Calculations

In order to be conservative a value of 5,325,011m^3/year has been stated for annual abstraction. This is 50% above the predicted amount – for a particularly wet year.

3.1.3. Operating Regime

The abstraction will be controlled by the standard method used for medium head hydro. Flow into the turbine will be controlled by means of a level sensor mounted on the intake structure. This will ensure that the water level will always be at the set level or higher. The results from the modelling of flows are displayed graphically in Figure 3 to illustrate the operating regime.

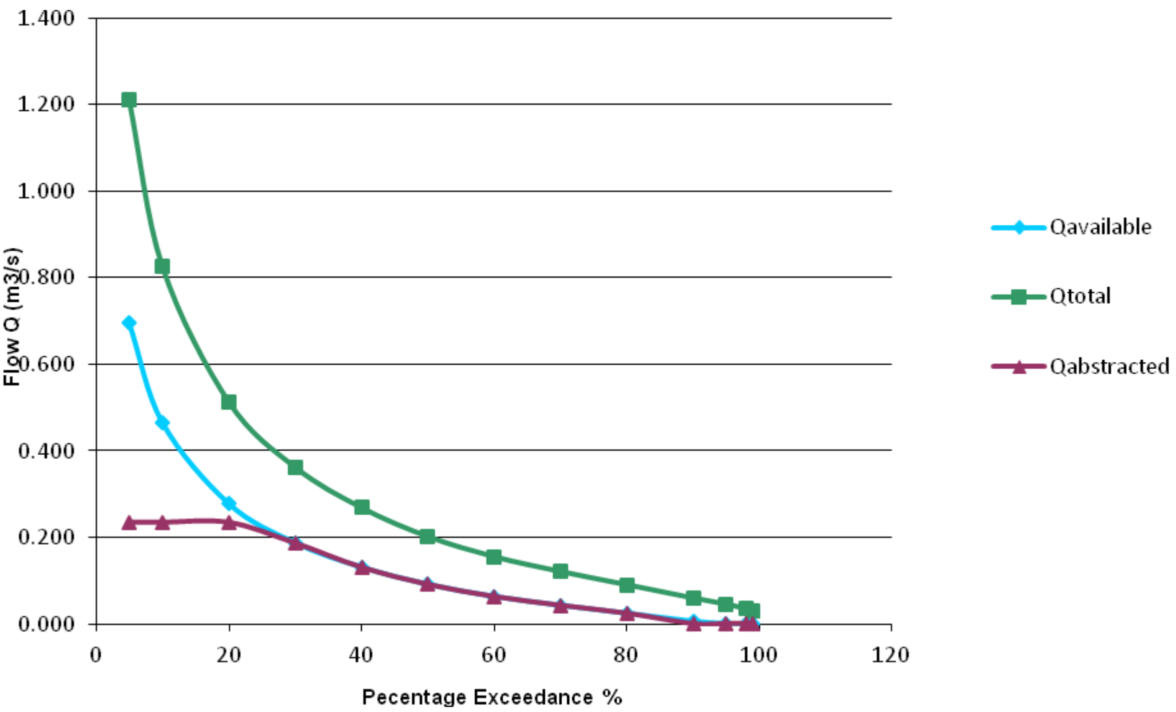

Figure 3 – Flow Modelling

During low flows (20 – 30 percent of the time) the control system will start the system automatically every 2 hours. The actuator on the turbine will open slightly, allowing water to be drawn down the penstock (pipe line), through the turbine, and back out to the burn via the tailrace. This abstraction will cause the level at the intake to drop. The level will be drawn below the set level and thus the control system will close the actuator and abstraction will cease.

During medium flows (40 – 60 percent of the time), the turbine will be able to operate controlled by the level at the intake. The actuator will open enough to maintain the water level at the set level. Any drop below this level will cause the actuator to close and abstraction to be reduced.

During periods of high flows (20 – 30 percent of the time) the total flow will be the rated flow through the turbine plus the HOF. The level will rise above the set level and the actuator will open the turbine to its full capacity. Excess water will flow over the weir.

During extremely high flows (<10%) of the time, again the total flow will be the rated flow through the turbine plus the HOF. The level will rise above the set level and the spear valve will open the turbine to its full capacity. Excess water will flow over the weir.

The system is designed to be fail safe:

- If the head sensor fails, a value of zero is obtained by the control system and it shuts the turbine, preventing any abstraction whatsoever.
- If there is any fault in any component or if the grid fails, the standby battery closes the turbine, preventing any abstraction.

4. Outline Construction Method Statement

4.1. Description of Works

To construct a new micro hydro generating station including modifications to the intake weir, buried penstock and powerhouse. A preliminary statement has been prepared below which would be updated and completed by the appointed civil contractor and submitted to NRW and the council for approval prior to construction commencing.

4.2. Expected Timing and Duration of Works

12-16 Weeks (Spring/Summer 2015)

4.3. Potential Risks to Operatives

- Injury to operatives due to plant and vehicle movements
- Injury to operatives due to manual handling
- Injury to operatives due to possibly working close to a sheer embankment and falling
- Injury from adverse weather conditions
- Injury to operatives due to working with small plant and hand tools
- Injury to operatives due to rotating machinery
- Injury to operatives by electric shock (low voltage)

4.4. Prevention Methods

- Safety method statements and risk assessments carried out on all works
- All operatives to hold CITB safety awareness card
- All plant operatives to hold CITB certificate for that item of plant
- All operatives to be suitably trained in good working practice.
- Appointed health and safety officer responsible for health and safety on-site
- All operatives made aware of plant movements
- All operatives will wear suitable PPE
- Works in/close to watercourses not to be carried out during periods of high flow
- Suitable precautions to be taken when working on electrical installation

4.5. Potential Environmental Risks

- Fuel/Oil Spillage resulting in soil contamination
- Fuel/Oil Spillage resulting in contamination of water course
- Contamination of watercourse with cementous material

- Contamination of watercourse with chemicals
- Contamination of watercourse with sediments due to run off from excavations

4.6. Prevention/Mitigation Measures

- Construction contractor will adhere to PPG 1 and PPG 5 guidance
- All operatives will be made aware of the need to protect the watercourse from contamination
- If possible, the construction will be carried out during the dry summer months
- All works in the watercourse will be carried out 'dry' by drawing down level of the upper pond and diverting the flow around the existing weir to keep the area dry.
- The works will be carried out in accordance with the principles within NRW's Guidelines on Working in Watercourses and Construction Sites
- Fuel storage tanks will be stored at least 10m from watercourses and away from areas where collision with vehicles is likely. Areas where deliveries are proposed will be protected with impermeable surfaces and isolated from surface water drainage.
- Fuel will be stored in steel tanks including secondary containment complying with relevant standards.
- A checklist will be used to ensure protection measures are in place.
- Chemicals and oils will be kept in a locked steel container
- Pollution spill kits will be kept on site. In the event of an incident these will be used. In the event of a spill a temporary bund will be put in place.
- Any soils contaminated will be removed immediately to a suitable landfill site
- Bins will be provided for debris.
- Geo-textile materials silt fences will be installed below excavations to filter suspended solids from runoff.
- When/if pumping, care will be taken in pump sizing. Water will be discharged away from the watercourse and via a straw bale/geo-textile filter to prevent entry of silt into the watercourse.
- Bank restoration will be carried out operating from the bank rather than the watercourse
- Cementous material will not be placed in the water.
- Cleaning of tools and shuttering will be carried out in water not draining directly to the watercourse
- In any event of expected heavy rain concrete will not be poured. Therefore we do not expect to have any surface run off from wet concrete sections.
- Any cement stored on site will be properly packaged, and any part used bags will be removed at the end of the working day

4.7. Civil Works Sequence of Operations

- Arrive on site and receive site induction
- Take receipt of relevant drawings
- Carry out a basic site survey

4.7.1. Intake

- Create temporary diversion around working area to prevent working within flow
- Prepare existing weir for construction modifications
- Drill rock head and fix steel dowels
- Blind formation with concrete
- Supply and install steel reinforcement for in-situ work
- Supply and install shuttering
- Supply and place concrete using a concrete pump
- Compact concrete using a vibrating poker
- Strike formwork once the concrete has been cured
- On areas where another lift of concrete is required the surface of the already placed concrete will be scabbled using a scabbler with an anti-vibration handle. Operatives will be rotated to prevent repetitive strain injury
- Fix fixtures and fittings
- Remove water diversion

4.7.2. Pipeline

- Join lengths of pipe
- Drag onto site using 360 degree excavator
- Dig trench for penstock section that is buried. The sides of the trench will be splayed to remove the risk of collapse. Any rock requiring removal to be removed with hydraulic hammer
- Set aside topsoil/sub soil for reinstatement
- Where penstock crosses small burns, burns will be diverted/over-pumped during pipe-laying to prevent excavation within flowing watercourse
- Install suitable bedding material
- Lay penstock within trench
- Construct concrete anchor blocks where appropriate
- Reinstate topsoil where appropriate and reseed with appropriate vegetation
- Tidy site on conclusion

4.7.3. Powerhouse

- Install geo-textile membrane to prevent contamination of the watercourse
- Excavate excess topsoil to rock head and set aside
- Place crushed rock bedding material
- Blind formation with concrete
- Construct formwork and reinforcement where applicable
- Supply and place concrete with concrete pump
- Compact using vibrating poker
- Strike formwork once concrete has cured
- Complete foundation to allow erection of block-work
- Re-landscape area around powerhouse using set aside topsoil
- Remove anti-pollution method
- Tidy site on conclusion
- Reinstate ground surface

4.8. Turbine Installation Works

- Install turbine in powerhouse
- Install generator
- Install main inlet valve
- Install control system, generation meter and sensors
- Connect generator and grid connection
- Test powerhouse wiring
- Commission the system

4.9. Materials Used

- Concrete – max $35m^3$
- Polyethylene pipe – approx 400m
- Steel Reinforcement
- Steel Fixtures and Fittings: Intake Screens

4.10. Checklists and Monitoring Inspection Sheets for All Staff

Checklists and Monitoring Inspection Sheets will be provided to all staff

4.11. Incidents Reporting

In the event of an environmental incident NRW will be notified immediately by the site supervisor on the emergency hotline.

4.12. Ongoing Maintenance

The weir will require very little ongoing maintenance. The new weir sump will be constructed from reinforced concrete and have a self cleaning Coanda screen installed. Any build up of sediment or rocks can be cleaned from the weir by opening the scour valve at the bottom of the main weir.

4.13. Sediment Management

4.13.1. Weir

There is currently no sediment management in place. In the event that there is a build up of sediment the scour valve can be opened to lower the water level behind the weir and allow the sediment build up to be cleared. This is not envisaged to be a regular requirement due to the small scale of the burn.

4.14. Fish Screening

Although there is not thought to be fish in the burn at the intake a screen will be fitted at the intake. The screen will be of 2 mm spacing and will prevent any small fish which may be present entering the penstock and thus the turbine.

5. Abstraction Monitoring

Volumes of abstraction can be obtained based on the output of the turbine and its efficiency across its operational flow range. Daily meter readings will be taken from which it will be possible to estimate the volume abstracted over each 24 hour period.

6. Appendix A - Photos

Figure 4: Existing Weir on Upper Pond

Figure 5:View looking away from intake in pipe route direction