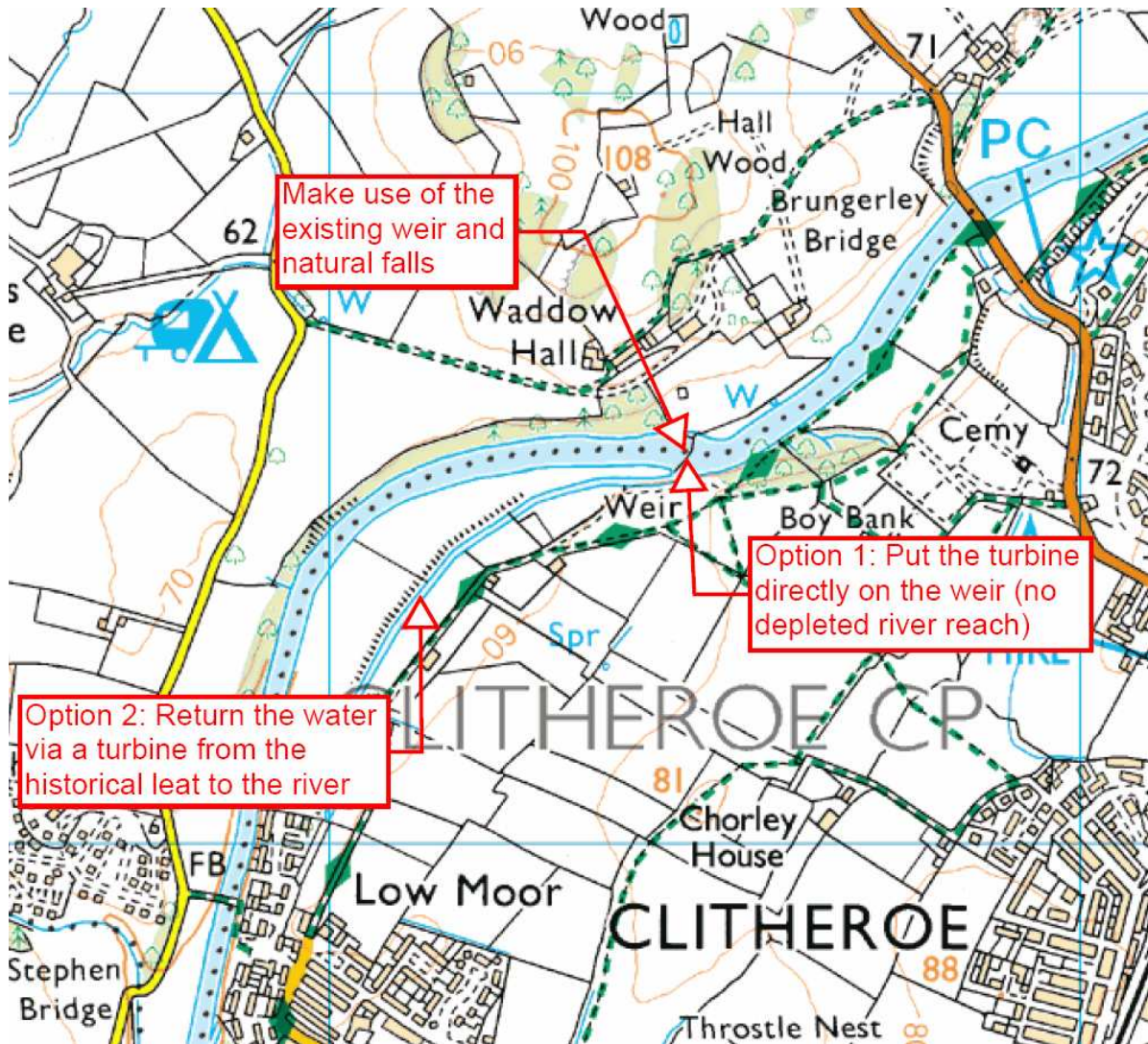


Site I: Waddow weir, Waddington

Site Assessment

Figure 1 Map showing general layout



Waddow Hall is a training and activity centre belonging to the Girl Guide Association. The property is on the River Ribble, near Waddington, Clitheroe. There is a significant sized weir adjoining the grounds of Waddow Hall. The ownership of the opposite bank of the Ribble here is unconfirmed at time of print. The ownership of the weir itself has not been determined successfully. Historically, water was abstracted from the opposite side of the River Ribble to Waddow Hall and flowed down a mill leat, presumably to Low Moor cotton mill. It is not known where the water was returned to the river, and presumably this now occurs beneath ground, as no discharge point was identified. This mill leat, though silted up, is still visible and contains water until Low Moor. The sluice gates at the leat intake are visible from Waddow Hall.

The optimal location for an intake on this weir is the far bank, where the historic intake is situated. In addition, the Environment Agency has some infrastructure in place on the Waddow Hall side of the weir which may be adversely affected by hydro development on this side. Close negotiation with the Environment Agency would be necessary in order to minimise this impact.



Figure 2 Weir from below showing sluice gates on the far side



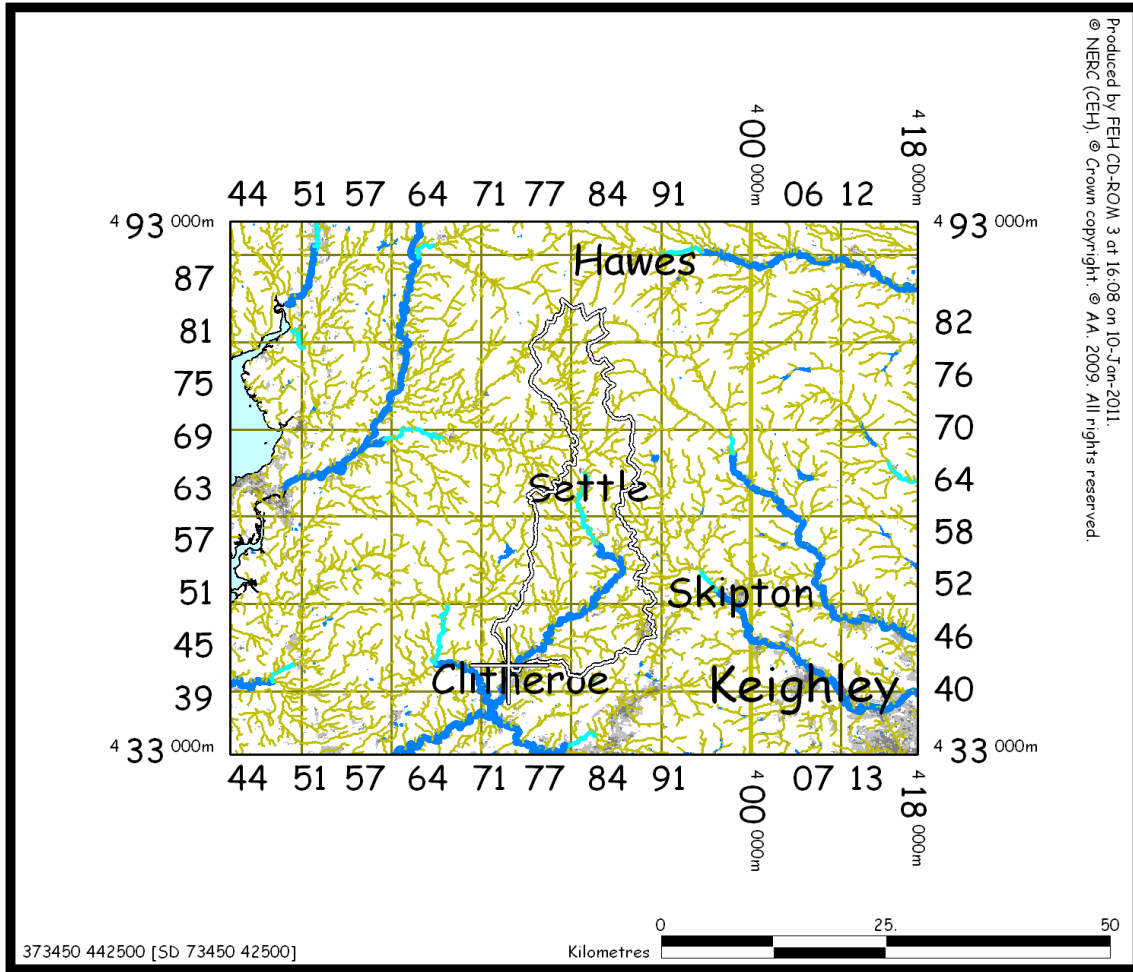
Figure 3 The weir from Waddow Hall



Figure 4 Top of the salmon ladder

Catchment Analysis

Figure 5 Catchment boundary defined by Flood Estimation Handbook Software



Flood Estimation Handbook software is used to determine the following catchment descriptors, for the proposed intake location, selected during the site visit.

Intake Grid Reference	373460, 442500
Powerhouse Grid Reference	372940, 442090
Catchment Area	400 km
Annual Rainfall	1350 mm

Annual Flow Statistics

Low Flows software is used to produce a Flow Duration Curve (FDC), which demonstrates how the river flow varies throughout the year. It presents the percentage time of the year each flow rate is exceeded. A particular notation is used to refer to FDC flow rates; e.g. 'Q₉₅' refers to the flow rate which is exceeded 95% of the year.

Table 1 Mean flow rate and flow rate at Q₉₅

Period	Mean Flow Rate [m ³ /s]	Flow Rate at Q ₉₅ [m ³ /s]
Annual	11.94	1.351
January	20.96	3.332
February	14.33	2.606
March	15.04	2.977
April	8.375	1.681
May	5.518	1.275
June	4.664	1.13
July	4.469	1.035
August	7.228	1.094
September	8.49	1.138
October	15.23	1.942
November	17.45	2.288
December	21.56	2.915

Table 2 Annual flow duration data

Exceedance Probability	Flow Rate [m ³ /s]
5	43.61
10	29.14
20	17.18
30	11.35
40	7.863
50	5.749
60	4.255
70	3.155
80	2.32
90	1.657
95	1.351
99	1.005

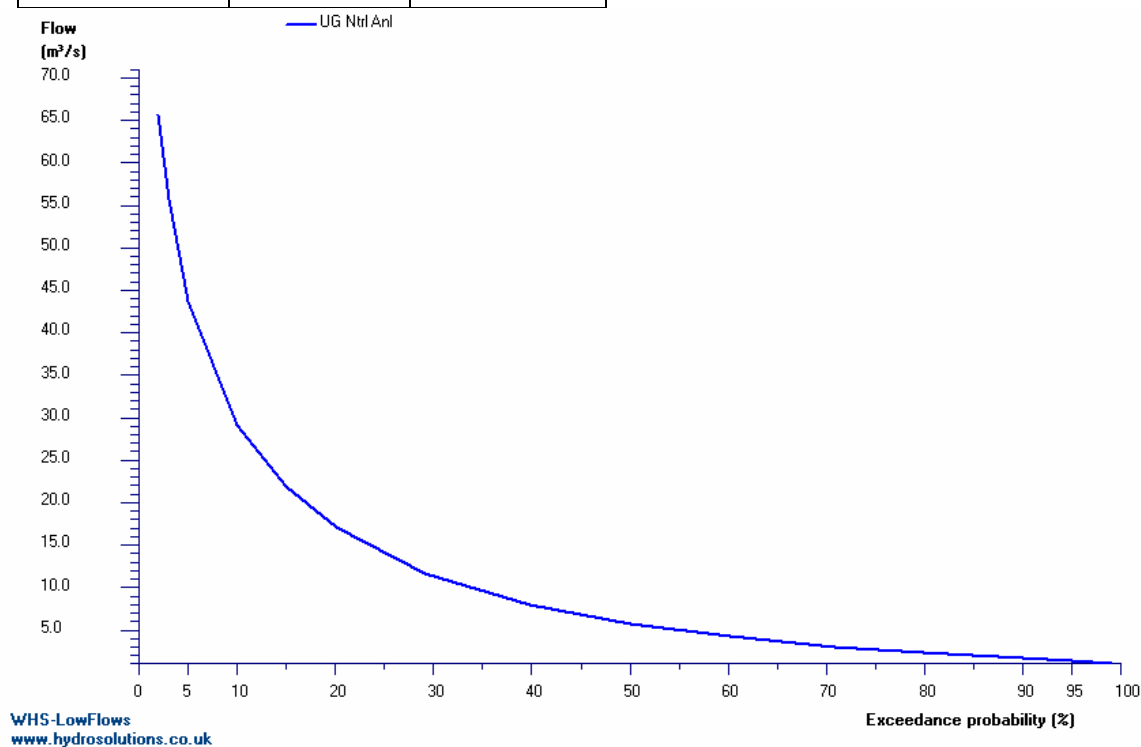


Figure 6 Annual flow duration curve produced using low flows software

Hydropower Analysis

Site: Waddow Hall					
Run Date / Time: 14 January 2011 at 14:37					
Mean Flow: 11.45 m ³ /s			Rated Flow: 11.45 m ³ /s		
Provisional Rated Flow: 12.92 m ³ /s			Gross Hydraulic Head: 3.00 m		
Residual Flow: 1.47 m ³ /s			Nett Hydraulic Head: 2.85 m		
Applicable Turbines	Gross Annual Average Output	Nett Annual Average Output	Maximum Power Output	Rated Capacity	Minimum Operational Flow
Francis Open Flume	1035.7	1025.3	283.3	272.0	4.90
Propellor	800.8	792.8	280.1	268.9	8.91
Semi Kaplan	1042.4	1031.9	281.7	263.7	4.90
Kaplan	1123.3	1112.0	285.9	267.6	3.76
	MWh	MWh	kW	kW	m³/s

Table 3 Hydropower Analysis

Gross Head [m]	3
Net Head [m]	2.9
Design Flow [m ³ /s]	13m ³ /s
Rated Capacity [kW]	260-270 kW
Average Annual Energy Output [MWh]	800-1120 MWh
Average annual Carbon Dioxide offset	348-487 tonnes

Impact Assessment

The weir at Waddow Hall is an attractive and historic installation. It is proximal to footpaths and is a popular visitor attraction. Waddow Hall itself is a Grade II listed building and any alterations to the river at the weir would be clearly visible from the Hall and from footpaths.

There is an existing salmon ladder installed on the weir, but no fish pass. The River Ribble is an important migratory river, and it would be desirable for a fish pass to be installed. The upper River Ribble is of high water quality, and is a healthy salmonid migratory river. Fish populations are likely to include salmon and sea trout, plus brown trout.

According to the Forest of Bowland Landscape Character assessment, the Waddow Hall building is on Undulating Lowland Farmland with Wooded Brooks, and the grounds between the Hall and the River Ribble are Valley Floodplain. This site is not within the Forest of Bowland Area of Outstanding Natural Beauty.

A desktop enquiry has revealed that the River Ribble is a Biological Heritage Site. Nearby woodland and grassland including Bay Bank, and Sherburn Wood are also Biological Heritage Sites. A detailed assessment of the environmental impact of a hydropower scheme at Waddow Hall is outside the scope of this report. However, it is recommended that communications with the Environment Agency are opened as early as possible, to determine what, if any, are the environmental issues that may cause obstacles to project progression.

Statutory Requirements

The Environment Agency has been approached to investigate any existing significant abstractions on the Ribble. This is a new scheme as far as planning permission and water abstractions are concerned, so the developer will be required to apply to the council and the Environment Agency for these.

It is not thought that the weir is listed, and the development will not affect the listed Waddow Hall directly. However, the weir structure has integral historical value.

A full Environmental Impact Assessment will probably be required at this site to assess the river and river bank ecology. The land in which a head channel might be built will also need to be investigated to assess the environmental impact of any construction.

The total budget cost for the whole scheme is approximately **£1,000,000**. It should be noted that the civil works costs can vary considerably as material costs fluctuate. Likewise, mechanical and electrical (M&E) equipment costs vary in accordance with demand. Professional fees should be considered subject to change, as the scope of licensing and planning requirements are not yet defined. Consequently the budget estimate at this stage should be considered accurate to plus or minus 20%.

Revenue and Simple Payback period

This scheme produces a significant amount of energy and a grid connection is recommended to optimise the revenue. Alternatively, the obvious proximal end user would be Waddow Hall, with surplus energy then being supplied to the grid. Due to the schemes proximity to the town of Clitheroe, problems with grid connection are not envisaged, though this is yet to be confirmed.

Under the current government feed-in tariff regulations, hydropower schemes receive a generation tariff according to their rated capacity. Schemes between 100 kW and 2 MW receive 11p/kWh. This generation tariff is received regardless of how the electricity is used. The current base value of electricity per kilowatt hour on top of this has been assumed as 3p/kWh.

In conclusion, the total value of the generated electricity would be 14 p/kWh, giving an average annual value of approximately **£112,000**. The simple payback, taken as the budget scheme cost divided by the annual value of electricity generated, is **9years**.

Budget Development Cost

The total budget cost for the whole scheme is just over £1million. It should be noted that the civil works costs can vary considerably as material costs fluctuate. Likewise, mechanical and electrical (M&E) equipment costs vary in accordance with demand. Professional fees should be considered subject to change, as the scope of licensing and planning requirements are not yet defined. Consequently the budget estimate at this stage should be considered accurate to plus or minus 20%.

Conclusion

This site has great potential. It will be of utmost importance to provide mitigation against ecological damage by limiting the areal extent of disruption, as well as careful design of a suitable fish pass and flow regime, in partnership with the Environment Agency. The simple payback time calculated makes this scheme very economic.

Table 4 Development Budget Cost

Budget Scheme Cost Estimate

Waddow Hall

	ITEM	UNIT	QUANTITY	MIN	MAX
Turbine					
	Turbine Quotation	No	1	£320,000.00	£400,000.00
Grid Connection					
	Grid Connection	No	1	£100,000.00	£160,000.00
Civils					
	Weir	m ³	150	£75,000.00	£93,750.00
	Fish Pass	m ³	30	£15,000.00	£18,750.00
	Metalwork	m	5	£10,000.00	£12,500.00
	Fish Pass Length	m	10	£20,000.00	£25,000.00
	Pipe Installation	m			
	Rock	m	0	£0.00	£0.00
	Gravels	m	0	£0.00	£0.00
	Soft	m	0	£0.00	£0.00
	Pipe Materials	No	0	£0.00	£0.00
	Temporary Access	m			
	Rock	m	0	£0.00	£0.00
	Gravels	m	0	£0.00	£0.00
	Soft	m	400	£22,000.00	£27,500.00
	Temporary Access on Good Ground	m		£0.00	£0.00
Powerhouse					
	Powerhouse	kW	260	£50,000.00	£62,500.00
Prelims					
	Duration	Months	4	£12,000.00	£15,000.00
Sub Total					
	Sub Total			£624,000.00	£815,000.00
Professional Fees					
	Professional Fees			£93,600.00	£163,000.00
Sub Total					
	Sub Total			£717,600.00	£978,000.00
Contingency					
	Contingency			£143,520.00	£195,600.00
GRAND TOTAL				£861,120.00	£1,173,600.00

Further Information

This site report is produced by Inter Hydro Technology on behalf of Forest of Bowland AONB, and funded by a partnership including Lancashire County Council, Lancaster & District Local Strategic Partnership, Pendle Borough Council and Ribble Valley Local Strategic Partnership.

This site report should be read in conjunction with the rest of the Forest of Bowland AONB Hydro Feasibility Study which can be downloaded at

<http://www.forestofbowland.com/climatechange#hydro>