Hydro and Wind Consultancy, Design & Installation

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Worth House Hydroelectric Power Scheme

Design Statement

Document Control

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Renewables First Ltd
The Mill
Brimscombe
Stroud, Glos, GL5 2QG

Phone +44 (0)1453 88 77 44
Fax +44 (0)1453 88 77 84
Email info@renewablesfirst.co.uk
www. renewablesfirst.co.uk

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Renewables First – Company

Renewables First is one of the UK's leading hydro and wind power specialists and has been delivering hydro and wind projects for over ten years. We provide all of the services from in-house resources to take a project from initial feasibility stage, through all of the consenting and engineering design stages and on to construction and commissioning. We use our experience of the installation and operational phases to provide feedback into the design stages of the next projects, ensuring that our customers benefit from our whole-project exposure.

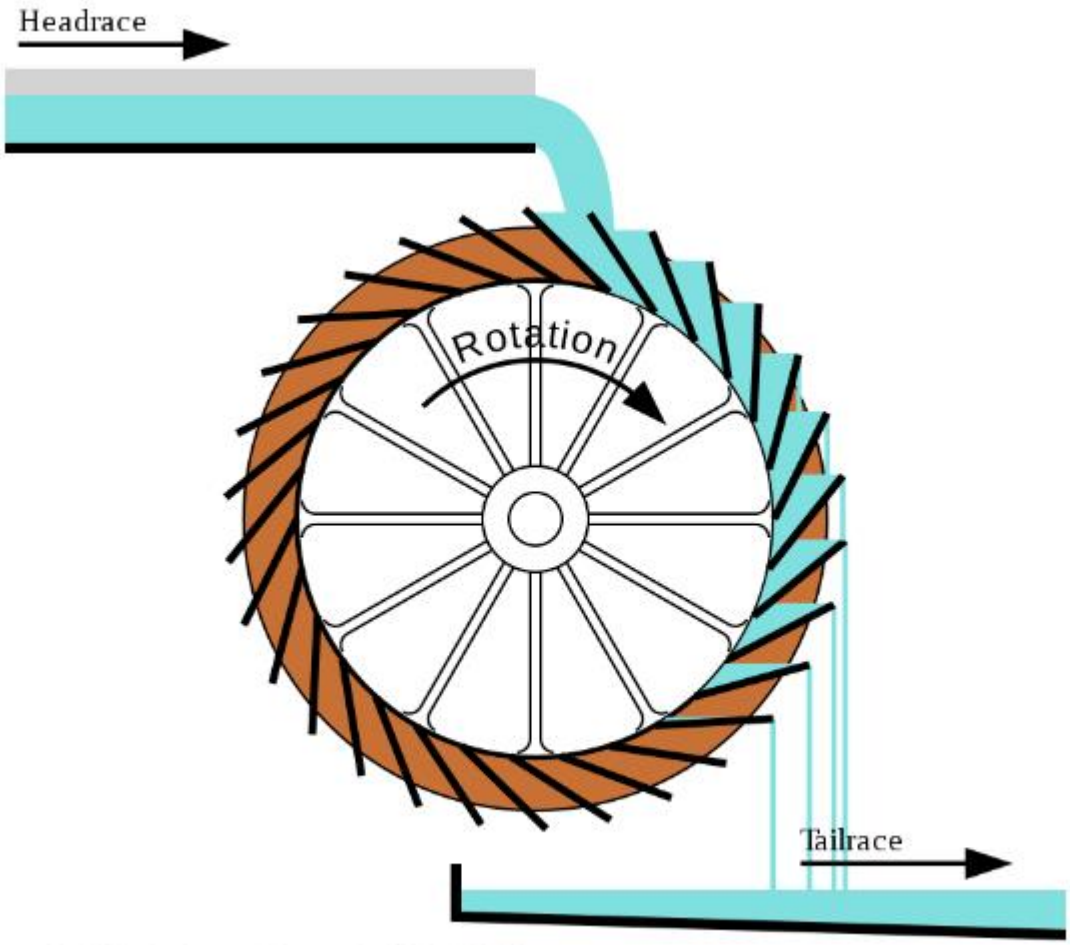
Contents

1 Introduction

This document accompanies the water resources abstraction licence application and hydroelectric power scheme application for the proposed hydroelectric power (HEP) scheme located at Worth House, Lower Washfield, Tiverton, Devon.

An overshot waterwheel system is proposed for installation just downstream of the weir on the site.

The installation will transfer the water from the upstream pond via the waterwheel to the bed of the stream below. The rotating wheel will drive a gearbox to run a generator and produce power.



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The maximum abstraction proposed for the scheme is 1.3 times Q_{mean} in line with Table B of 'Guidance for run-of-river hydropower development'. Key parameters that allow higher levels of abstraction and departure from table A are listed below with supporting information included in the subsequent sections of this report.

1. Not prevent Water Framework Directive objectives from being achieved (see the 'Water Framework Directive' section of 'Guidance for run-of-river hydropower development').
2. Maintain or improve fisheries, fish passage and fish migration (see the 'Fish passage and screening' section of 'Guidance for run-of-river hydropower development').

3. Not have unacceptable impacts (effects) on protected sites or species (see the 'Nature conservation and heritage' section of 'Guidance for run-of-river hydropower development').
4. Not have unacceptable impacts on the rights of other water users, including anglers.

2 Site details

2.1 Site description

Figure 1 to Figure 7 shows the current layout around the installation location. There is an existing concrete weir which discharges into a weir pool. The base of the weir pool appears to have originally been concrete, but has been eroded away.

Figure 1: view looking upstream from the weir.

Figure 2: weir viewed from the downstream end (intake location).

Figure 3: weir viewed from the upstream end.

Figure 4: looking down into the weir pool from the edge of the weir.

Figure 5: looking down into the weir pool from the footbridge.

Figure 6: view looking upstream from beyond the footbridge.

Figure 7: view looking downstream from underneath the footbridge

Waterwheel to be cut into the bank on the left-hand side.

2.2 Hydrological data

The water level from the crest of the weir to 5 metres downstream is 3.37 metres.

The nearest EA gauging station is at Stoodleigh approximately 3 km to the North on the River Exe. The flow rates from this gauge are not particularly relevant to the site as the catchment area is over 100 times larger and the catchment is generally higher altitude land within the Exmoor National Park.

The catchment flows have therefore been modelled using LowFlows 2 software.

The catchment area for the site is approximately 3.91 km^2.

Flow exceedance (%)	Gross flow rate (m^3/s)
Q_{10}	0.157
Q_{20}	0.102
Q_{30}	0.075
Q_{40}	0.06
Q_{50}	0.049
Q_{60}	0.04
Q_{70}	0.033
Q_{80}	0.027
Q_{90}	0.022
Q_{95}	0.019
Qmean (Q30)	0.075
Q_{95}/Q_{mean}	25%

Table 1: flow exceedance for the site from LowFlows 2.

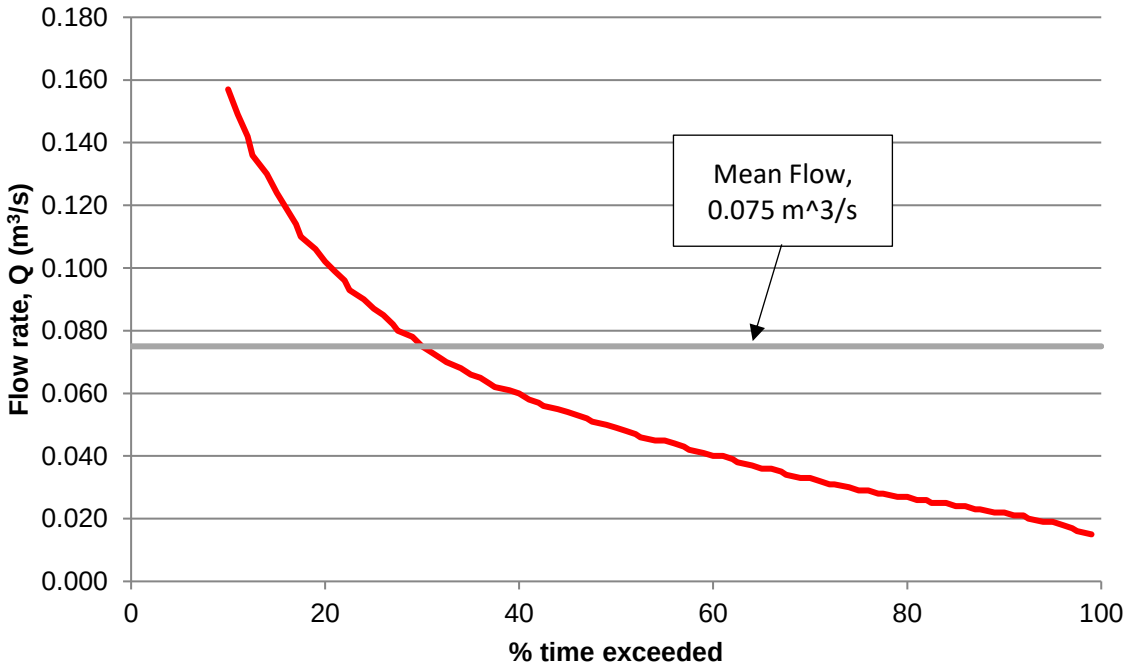

Figure 8: flow duration curve for the site.

3 Proposal

3.1 Proposal summary

The HEP system consists of a single overshot waterwheel turbine installed just downstream of the weir. The intake will be on the weir and the outfall will be just downstream of the footbridge. The scheme is expected to generate a peak electrical power output of 2.0 kW.

3.2 Summary of hydrology information

It is proposed that the HEP scheme flow is 1.3 times Q_{mean}. The hands-off-flow across the weir is proposed to be zero as the flow is discharged just downstream of the weir, so the depleted reach is small. The weir pool is also a manmade construction, so is deemed to not have high ecological value. There will continue to be flow over the weir during periods of high flow.

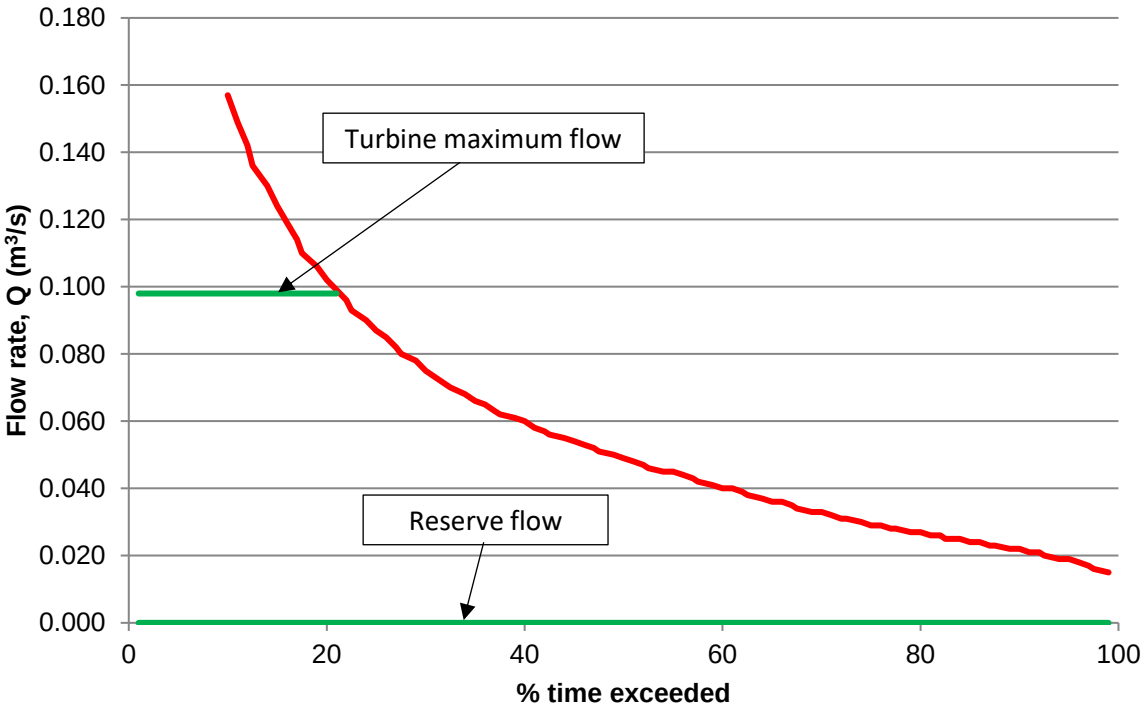

Figure 9: flow duration curve with turbine flow.

Table 2 outlines the key hydrological information for the proposed HEP system.

Turbine intake location (weir)	SS 94695 14692
Outfall location	SS 94709 14690
Depleted reach	12 m
Turbine type	1 no. overshot waterwheel
Waterwheel diameter	3.0 m
Waterwheel rated flow	0.098 m^3/s
Hands-off-flow	0 m^3/s
Rated system head	3.37 m
Maximum hourly abstraction	353 m^3
Maximum daily abstraction	8,467 m^3
Maximum annual abstraction	1,862,784 m^3

Table 2: key hydrological information for the HEP system.

3.3 Layout

Refer to site plan drawing (WORTH_P001_R2) and general arrangement (WORTH_P002).

23_00039_HOUSE-Layout_of_Arrays__Cable_Routes___Equipment-1916399

3.4 Operation

Flow will enter the headrace at the weir via a trash screen and travel along a channel to the waterwheel. At the end of headrace there is a sluice which controls the flow of water into the waterwheel. The flow is controlled to achieve an upstream water level in the head race. The flow is also limited by the maximum power generated by the waterwheel. Water is discharged at the bottom of the waterwheel downstream of the weir.

Although the headrace will be notched into the existing weir, this will not raise the upstream water levels, as any excess flow will be able to spill over the sides of the headrace during periods of high flow or when the waterwheel is not operational.

3.5 Cable routes

The power and control cables will share ducting installed as part of approved planning application 23/00039/HOUSE

These will enter the ducts installed across the footbridge immediately adjacent to the water wheel.

4 Ecology

4.1 Designations

A desktop review of ecology designations was undertaken using the MAGiC online database.

The site is not within a SSSI, SAC, RAMSAR, SPA, NNR, LNR, NP or AONB designation.

The proposal is within the SSSI impact risk zone for Bickleigh Wood Quarry SSSI and Tidcombe Lane Fen SSSI. However, the construction and operation of the scheme will not impact upon these areas.

Some of the surrounding land is classified as priority habitat (deciduous woodland). The river bank where the scheme will be constructed is outside of this priority habitat. The control equipment will be located away from the river in an existing building.

4.2 Fish and aquatic habitats

An overshot waterwheel is to be used. This technology poses little risk to fish, so only a 100mm trash screen on the intake will be used.

The Environment Agency Ecology & Fish Data Explorer has been used to carry out a desk study of the fish species that could be impacted by the scheme.

The fish species shown in Table 3 have been recorded during surveys in the River Exe upstream of the site. All these species could therefore be present in the section of the stream downstream of the weir. However, no migration across the weir would be possible, so migratory species would not be found upstream of the weir.

Species
Atlantic salmon
Brown/ sea trout
Bullhead
Minnow
Stone loach
Lamprey
3-spined stickleback
Grayling

Table 3: fish species observed in the River Exe upstream of the site.

5 Geomorphology

When the HEP scheme is operating, it will reduce the flow over the weir. The weir pool and downstream channel is a heavily eroded concrete construction, so this reduced flow will have little effect on the geomorphology of the site.

6 Water Framework Directive

The WFD objectives for the Exe (Barle To Culm) water body (shown in Table 4) have been assessed. The proposed installation will have no or negligible effect on these objectives.

Classification Item	Status	Year
Ecological	Good	2027
Biological quality elements	Good	2027
Invertebrates	Good	2015
Macrophytes and Phytobenthos Combined	Good	2027
Physico-chemical quality elements	Good	2015
Acid Neutralising Capacity	Good	2015
Ammonia (Phys-Chem)	Good	2015
Dissolved oxygen	Good	2015
Phosphate	Good	2015
Temperature	Good	2015
pH	Good	2015
Hydromorphological Supporting Elements	Supports good	2015
Hydrological Regime	Supports good	2015
Supporting elements (Surface Water)	Not assessed	2015
Specific pollutants	High	2015
Arsenic	High	2015
Copper	High	2015
Diazinon	High	2015
Iron	High	2015
Manganese	High	2015
Zinc	High	2015
Chemical	Good	2015
Priority hazardous substances	Good	2015
Benzo (b) and (k) fluoranthene	Good	2015
Benzo (ghi) perelyene and indeno (123-cd) pyrene	Good	2015
Benzo(a)pyrene	Good	2015
Cadmium and Its Compounds	Good	2015
Di(2-ethylhexyl)phthalate (Priority hazardous)	Good	2015
Mercury and Its Compounds	Good	2015
Nonylphenol	Good	2015
Priority substances	Good	2015
1,2-dichloroethane	Good	2015
Benzene	Good	2015
Dichloromethane	Good	2015
Diuron	Good	2015
Fluoranthene	Good	2015
Lead and Its Compounds	Good	2015
Nickel and Its Compounds	Good	2015
Trichloromethane	Good	2015
Other Pollutants	Good	2015
Aldrin, Dieldrin, Endrin & Isodrin	Good	2015
Carbon Tetrachloride	Good	2015
DDT Total	Good	2015
para - para DDT	Good	2015

Table 4: WFD objectives for the Exe (Barle to Culm) water body.

7 Flood Risk

The 1% AEP with 85% climate change allowance flood level for the River Exe adjacent to the site is 69.67 mAOD (refer to the Product 4 Report for the site). All control equipment will be located in an existing building on site above this flood level.

All of the equipment located within the river will be flood resilient with the exception of the generator. It is not practical to locate the generator above the 1% AEP with climate change allowance level. However, it is possible to locate it above the 1% AEP. If the flood level were to exceed this, the generator would be replaced as it is a low cost item.

8 Human impacts

8.1 Navigation

The watercourse is not used for navigation, so the scheme will have no impact.

8.2 Recreational use

The site is privately owned and any flows or water levels downstream or upstream will be unchanged. Angling will therefore be unaffected by the proposal.

8.3 Heritage

There are no scheduled monuments, world heritage sites or listed buildings that will be affected by the proposed scheme.

8.4 Landscape and visual

There is no proposal to landscape the area around the proposed installation as the majority of the installed equipment is within the river below the bank level.

9 Conclusions

This proposed HEP scheme meets the necessary requirements for an abstraction licence.

An assessment has been completed to show that there will be no significant adverse impact on ecology, geomorphology and human uses of the watercourse and any impacts can be mitigated effectively.

The scheme is not considered to impact on an any Water Framework Directive objectives for the impacted water body.