Archimedean Screw
Hydropower installation at
Bullhouse Mill

HYDROLOGY ANALYSIS

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Hydrology analysis

Energy can be extracted from falling water and harnessed to provide mechanical or electrical power. The theoretical amount of energy available from any given site is directly proportional to two factors: the actual volume of water passing the site (the flow) and the height through which the water falls at the site (the head). In order to assess the actual potential of this site, it is necessary to have measurements of both the changing flow and head over the course of several years. This will determine what can be expected to be the average annual energy capture.

Flow duration curve

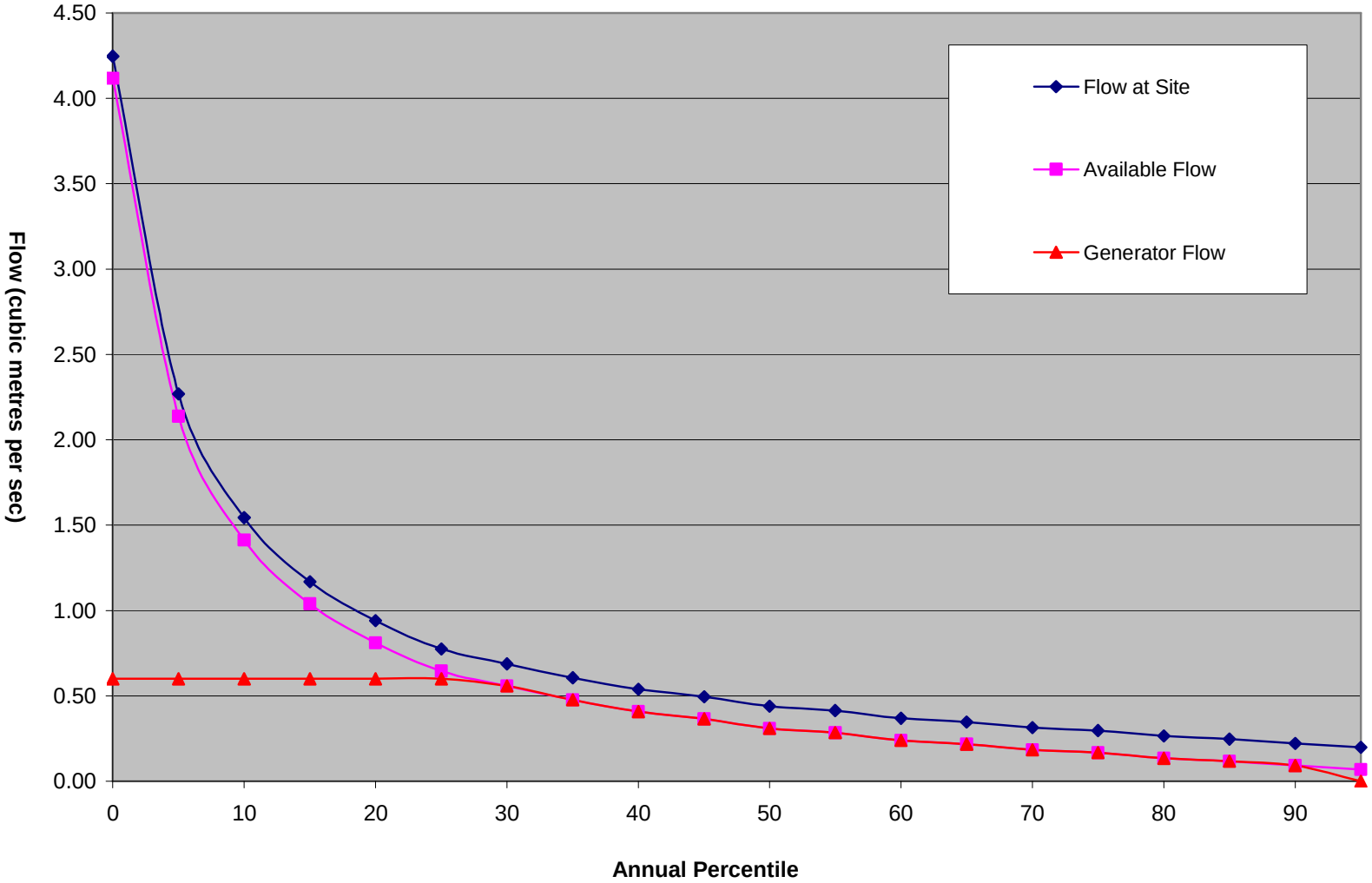
There is no flow gauging station on the River Don in the immediate vicinity of this weir, and flow is moderated by several reservoirs located in the upper tributaries. These reservoirs are operated by Yorkshire Water (YW) and are used for drinking water supply. The compensation flow released from these reservoirs is measured at Dunford Bridge weir (SE 161 024). This flow data was requested from YW and used in conjunction with a computer model analysis to calculate a Flow Duration Curve of the expected flows at Bullhouse Mill.

This curve is calculated by analysing the data statistically and breaking it down into different flow bands, each occurring for 5% of the year. Each band then represents the percentile flow available, or the flow that is in the river for that percentage of the year or more. For example, Q90 means that for 90% of the year the flow will be at this level or more. The average annual output is then calculated from the flow duration curve, in order to give an indication of the scheme size. A residual flow must always be left to bypass the hydro scheme and is stipulated within the licence required. The residual flow is subtracted from the measured flow to give the actual flow available for power generation.

Through the EA's licensing process, a minimum residual flow of 0.130m³/s has been agreed. This is slightly above the EA's guideline of the Q95 flow to be expected at this weir (based on a model of natural flow for this catchment), and was chosen because it would serve to operate a fish pass. The EA has therefore accepted this in the licence which it has issued for this project.

Please refer to the Environmental Sustainability Assessment for more details of the proposed flow regime.

Flow Duration Curve



Head duration curve

The height that the water falls over the site is known as the head, and this varies with the flow in the river. Site measurements indicated that a gross head of 3.0m could be achieved when the flow is low, if the weir boards are restored as proposed. When the flow is high, the tail water rises, which reduces the effective head across the site. This reduces the output of the generator and may indeed stop it altogether if the head is too small for the system to function effectively. The magnitude of this problem is highly site-specific, depending on the width of the weir and on the nature of the downstream channel. An estimate can be determined from the flow data and past observation. If the scheme proceeds then further measurements should be taken during times of high flow to verify the actual shape of the head duration curve that has been used for this study.

Additional head will be lost due to friction as the water moves through the intake and outflow channels, and past the coarse screens at the entrance to the intake channel, so the net head available for generation will be reduced. It has been estimated that up to 100mm could be lost, based on survey measurements of the existing situation together with the hydraulic losses introduced by the increased flow and channel restrictions.

Head Duration Curve

