Archaeological Survey of the Weir-and-Leat System at Dulverton, West Somerset

A Ridgeway Archaeology report

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by

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Introduction

This report outlines the result of an archaeological survey carried out in Dulverton, West Somerset, in very wet conditions on March 29th 2016. The survey focused on the weir-and-leat system which is such a special feature of this small market town. It builds upon and adds to the considerable amount of research already carried out by the Dulverton Weir and Leat Conservation Trust.

The weir is an impressive and substantial structure 65m in length and several metres wide which crosses the River Barle at an oblique angle upstream of the main part of town, diverting some of the water of the river into the leat. The leat is an artificial stream over half a kilometre long which channels the flowing water from the weir into the town and eventually back into the river again. Together the weir and leat form a single system of water control. During the medieval period and up to the 19th century it provided the energy to drive several mills, the buildings of which (largely rebuilt in the post-medieval period) survive as standing structures (Gathercole 2003, Riley 2015, DWLCG 2015).

Aims of the survey

The aims of the survey were tightly focused on measuring water levels along the leat relative to water levels in the river, and to see what the results might reveal about why the weir and leat were laid out the way they were, perhaps shedding light on the rationales of the original builders of these structures.

The surveying was conceived from the start as an exercise in the archaeology of flow (Edgeworth 2011, 2016). With the exception of positions used as TBMs, therefore, all readings taken were on points on the surface of water. The results represent water levels as they were at the time of the survey.

Survey methods

A combination of two different surveying technologies was employed.

The first was a GPS instrument operated by Martin Wilson (Souterrain Archaeology) with the assistance of Peter Romain (DWLCT). Points were surveyed to Ordnance Survey National Grid co-ordinates and orthometric heights. Data was recorded using RTK Differential GPS. The instrumentation was Leica Viva GS08 plus with GPS and Glonass signal tracking technology. Plan precision was generally from to 10 mm to 15 mm, and height precision between 10 mm to 30 mm.

The second was a more traditional dumpy level and staff, used by Matt Edgeworth (University of Leicester) and Philip Hull (DWLCT). The two teams operated mostly independently of each other, in areas allocated beforehand, though GPS was used to place TBMs for the dumpy level survey. For the most part the GPS team worked on open stretches of river and leat, while the dumpy level team dealt with difficult-to-get-to parts of the leat between buildings in the middle of town, where the reception of satellite signals was compromised. The two data sets thus obtained were later combined, using a 1st edition OS 1:2500 map as base plan.

Results

Figure 1 shows some of the measurements taken superimposed onto the Ist Edition OS base map (1890s). All numbers represent heights above sea level, as recorded by GPS. Arrows indicate direction of flow. Specific points of interest along the course of the leat (such as the weir, sluice, artificial drops of water, outlet, etc) are marked with the letters A-H.

Figure 2 shows the measured water levels on the leat relative to those on the river, on lines drawn from east to west on the map. The data is presented in the form of a vertical profile. Note the difference between the horizontal scale along the base and the vertical scale on the sides. As is common practice in such diagrams, the vertical dimension is exaggerated in order to facilitate analysis of subtle variations in height. The letters A-H mark the same points of interest shown in Figure 1:

A: northern end of weir
B: southern end of weir
C: sluice, the key control point
D: point of highest differential between leat and river levels
E: Town Mill (Higher Mill), vertical fall into wheel pit
F: Laundry Mill, vertical fall into wheel pit
G: Lower Mill, vertical fall into wheel pit
H: outlet

Some key general measurements are:

The total length of leat if taken from the sluice (C) to the outlet (H) is roughly 560m, though if taken from the southern end of the existing weir it is 620m, and if taken from the northern end of the weir it is 685m (the distance varying also according to where the outlet is taken to be, as this was modified in recent times).

The total fall from inlet to outlet of leat is 6.40m, from 138.26 (river level at crest.of weir) to 131.86 (river level at leat outlet).

Detailed observations

From A to C

Today the functioning part of the weir structure from A to B is 65m long, but it was probably originally much longer (and the river wider) with a continuation thought to be buried beneath the north bank of the river. The weir structure also continues in the other direction beyond point B to form the west bank of the leat, as far as the sluice at point C. It is thus difficult to say where the weir ends and the leat starts (or vice-versa): they are essentially interlocked components of the same design, functionally interdependent on each other.

The fall of water from crest to foot of weir was measured as 1.07. This will obviously vary somewhat according to changing river levels. At the time of survey, river levels were slightly higher than normal after a period of heavy rain.

The height of the surface of water immediately upstream of the weir was more or less constant at 138.26 along the entire length of the structure from A to B, though slightly lower near places where the weir was eroded or badly repaired. Presumably the crest of the weir was intended to be precisely level in order to distribute forces equally and thus prevent erosion (a point apparently not appreciated by those who carried out recent repairs on the weir). Breaches of parts of the weir through erosion lead to unequal patterns of sedimentation and thus to the formation of islands of the kind observable downstream of the weir.

The same height of 138.26 is maintained on the surface of water in the upper part of the leat from B to C all the way to the sluice. Thus it is clear that weir, upper leat and sluice function together in partially impounding and thus raising the height of water to a common level.

The sluice at C is the key point of control for the whole set of structures. The sluice gates can be manually adjusted to change the amount of water flowing into the rest of the leat. It is assumed there was always a sluice at this location, since it is the logical place for one. At the time of surveying the drop at the sluice was measured as just 0.33, from 138.26 to 137.91.

Just before the sluice a sloping side weir on the west side of the leat takes excess water into an overflow channel. The fall of water at this weir was 1.23, from 138.26 to 137.03. From here the overflow channel takes water back to the river. It is interesting to note that the surface of water in the upper leat at the sluice has already gained a height of 1.82 over the corresponding point on the river, thanks to a combination of natural river gradient and the artificial fall of water formed by the weir, relative to the contrived lack of gradient of the upper leat.

From C to D

From C to D the water in the leat follows a gradual downward incline, ensuring that it stays flowing and never turns into a stagnant ditch. But the incline is extremely slight, spread out evenly over a long distance. This stretch of leat is roughly 300m long yet with a total fall of only 0.81, from 137.91 to 137.10.

D is the point of highest differential between the level of water in the leat and that in the corresponding part of the river, on a line drawn from east to west. Here the difference in height between leat and river is about 4.50.

From D to E

From D to E the slope of the leat significantly increases, so that the flowing water speeds up as it approaches the drop into the wheel pit at Town Mill (shown on the OS map as Higher Mill). The length of this stretch is approximately 70m, with a fall in height of 0.75, from 137.10 to 136.33.

The vertical drop into the wheel pit just in front of Town Mill at E is 0.78, from 136.35 to 135.62.

From E to F

From the drop into the wheel pit at E the leat flows under Town Mill, reappearing about 25m further downstream. After an open stretch of about 40m, it goes under the High Street bridge and Holland House, to reappear again roughly 40m downstream just in front of Laundry Mill.

Gradient has levelled out considerably compared to the 'race' upstream of Town Mill. The total stretch is about 110m long, with a fall in height of just 0.33, from 135.62 to 135.29.

In front of Laundry Mill there are two separate channels, at different levels. Here we consider only the main easternmost channel (with a view to returning to do more detailed surveying of subsidiary channels at a later date).

The vertical drop(s) into the Laundry Mill wheel pit(s) at F could not be measured directly but from other measurements taken nearby the best estimate is a fall of 1.50, from 135.29 to 133.79.

From F to G

From F to G the leat flows in two channels under Laundry Mill for about 20m to reappear for a short distance of about 10m in front of Lower Mill. The total fall of this stretch is estimated at 0.19, from 133.79 to 133.60, at least with regard to the main channel. Levels on the small bypass channel have been left out of this report, for the sake of simplicity. More detailed recording needs to be done of the complex configuration of channels and their different levels as encountered in front of Lower Mills.

Access could not be obtained into the building but the height of drop into the wheel pit could still be ascertained. Immediately in front of the mill is what appears to be a wheel pit set perpendicular to the main direction of flow. The fall from the main channel into the wheel pit was measured as 1.30, from 133.60 to 132.30.

From G to H

From G to H the leat continues to flow under the mill building (and through a bypass channel) then beneath part of the garden behind it. Until recently the water would have re-emerged in the form of an open stretch of leat (marked on the OS map) which rejoined with the river. The total distance of this stretch would have been about 40m. However, during conversions of mill buildings to private house the leat was partly diverted and shortened, so that it now runs in an underground pipe which outflows from the bank into the river at a point 15-20m further upstream. The total fall of this final stretch of leat, taking the surface of water in the river opposite the present day outlet as the relevant final level, is 0.44, from 132.30 to 131.86.

Discussion

The results of the survey show the weir-and-leat system to have been carefully constructed with regard to topography and slope of land, so that it could effectively utilize gravitational pull on the flow of water at certain vertical 'falls' or 'drops' into wheel pits along the course of the leat (to drive mill wheels).

With this in mind, we can infer from the survey data some of the basic rationales that must have informed the design of various parts of the system. For example, the principle purpose of the stretch of leat from A to D (amounting to about two-thirds of total length) was to raise the level of water as high as possible above the level of the river. By way of contrast, the function of the stretch from D to H (amounting to about a third of total length) was to make maximum use of the height or head of water thus achieved, bringing the stream in a sharp descent down to the level of the river again through a series of constructed falls. Note that all three principal mills are located on that last stretch of leat.

In effect the leat transposes the steep fall of water naturally occurring in the River Barle into the centre of town, shifting it over to where its energy could be more easily tapped into and exploited. The data shows that where the gradient of the river is steepest the corresponding part of the leat is kept as flat as possible in order to raise height and maximise the differential in levels. Where the gradient of the river flattens out, on the other hand, the corresponding part of the leat significantly steepens, through a series of descending drops or steps.

There is evidence of subtle manipulation of the affordances of local topography, according to the requirements of the overall design. For example, the stretch of leat from C to D follows closely the curve of the 138/137m contour, in line with the requirement to gain as much height as possible while at the same time keeping enough of a gradient to ensure water flow. The next stretch from D to E, on the other hand, takes the water down a considerably steeper gradient as it approaches the first mill, effectively using it as a head race.

The lay-out of such a highly functional weir-and-leat system must have been surveyed in prior to construction, albeit using more basic techniques than GPS. Those who built it had a deep practical understanding of how water moves in relation to gravity, and how the energy of the river can be effectively channelled, tapped into and utilised (Gimpel 1977). The position and diagonal setting of the weir, the pivotal location of the sluice, the winding course and slightly modulated gradient of the leat, and the placing of the three vertical drops along the lower part of it, are the results of deliberate decisions, not arbitrary ones. All are in their proper place in respect of each other and the lie of the land/flow of water - rendering the total system workable, durable and relatively easy to maintain. Though individually repaired and replaced many times over the centuries, these basic elements might be assumed to be primary features.

Some features, by way of contrast, can be identified as secondary or transitory. For example, half way along the stretch of leat from C to D there is a building known as the Paper Mill (Gathercole 2003), which may had a waterwheel. But this mill was never associated with a wheel pit or vertical drop in level: it was not provided for in any way by the original design, hence the conclusion that it is not an original feature. Furthermore, a wheel pit with vertical drop could not be constructed here without radically disrupting the functioning of the rest of the leat and all the mills downstream. In the absence of a vertical drop, releases of water from the sluice might have been required to provide motive power for an undershot wheel. For these reasons a mill at this location would not have been particularly powerful or effective, and was perhaps not very long-lasting.

Today it might appear as though the leat threads its way between buildings in the centre of town, as if respecting the position of structures and street layout. But this is an illusion, for actually it is the other way round. The leat was a primary feature in the development of this part of town, with roads and buildings for the most part accommodated to it (rather than vice-versa). It could be that existing buildings were cleared prior to leat construction. As was the case with the complex water systems of Cistercian monasteries (Gimpel 1977), it was necessary to treat the laying out of features designed for flowing water as a priority, to be done prior to any building works. Attention needed to be paid to contours and slope of land, and it would have been impossible to do this while working round obstacles or following the course of streets.

Much work remains to be done in exploring the detail missed by this general survey, especially in looking for evidence of subsidiary channels in the area of town from from E to H, which was clearly something of an industrial centre. Subsidiary channels may have been original features, or could have been added to the existing system at a later date. Finding and following the course of these might lead to the discovery of further mills, previously unsuspected, in the vicinity of (and effectively utilising) the three main vertical drops at E, F and G. Some such channels are visible and still carry water, while others must survive in the form of blocked off culverts or buried archaeological features underground, hidden from view. Mapping these would shed more light upon the development of the weir-and-leat system through time, barely touched upon here.

Acknowledgements

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Abbreviations

DWLCG - Dulverton Weir and Leat Conservation Group (now the DWLCT)

DWLCT – Dulverton Weir and Leat Conservation Trust

GPS – Global Positioning System

TBM – Temporary Bench Mark

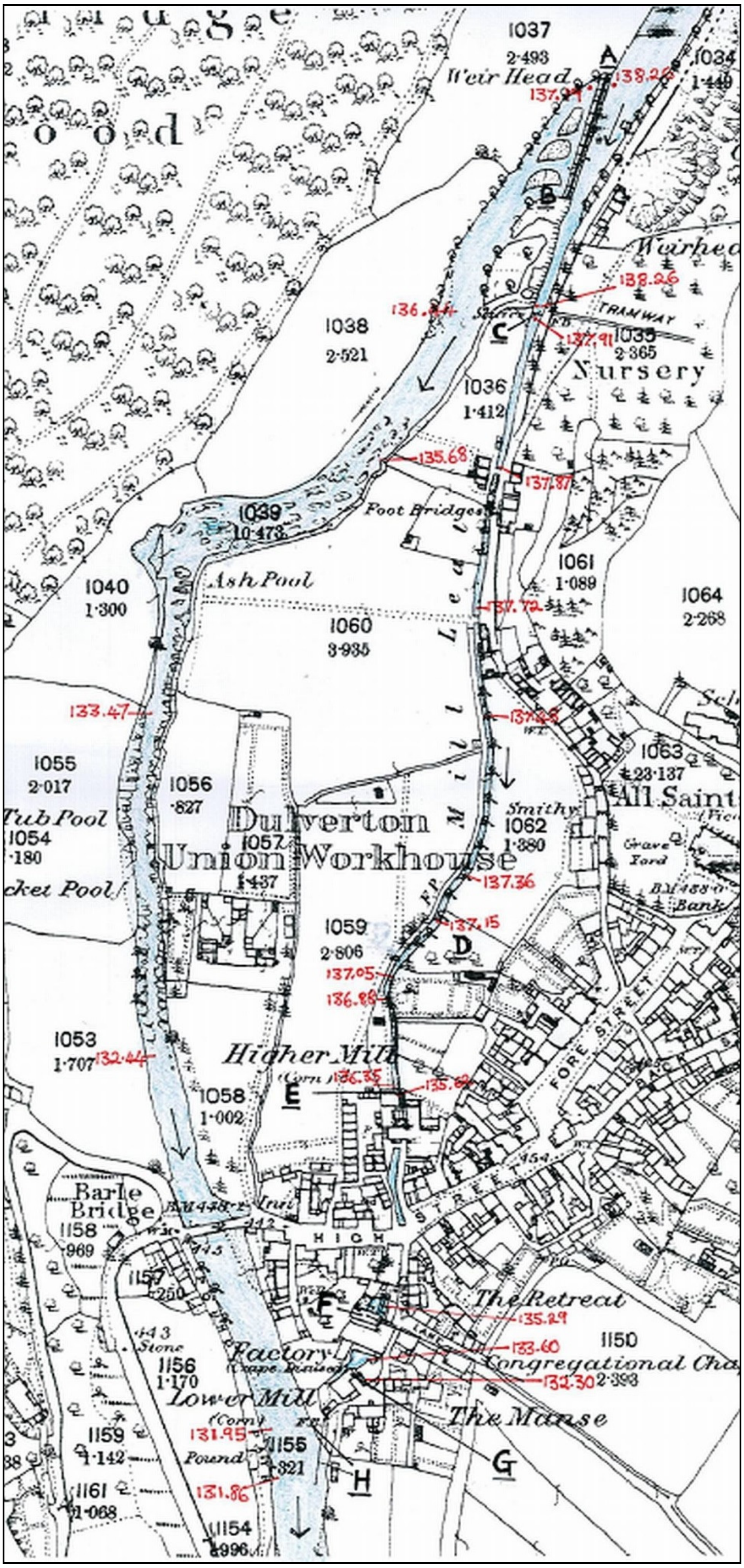

Fig 1. Selected levels marked, with OS 1st Edition map (1890s) used as base plan

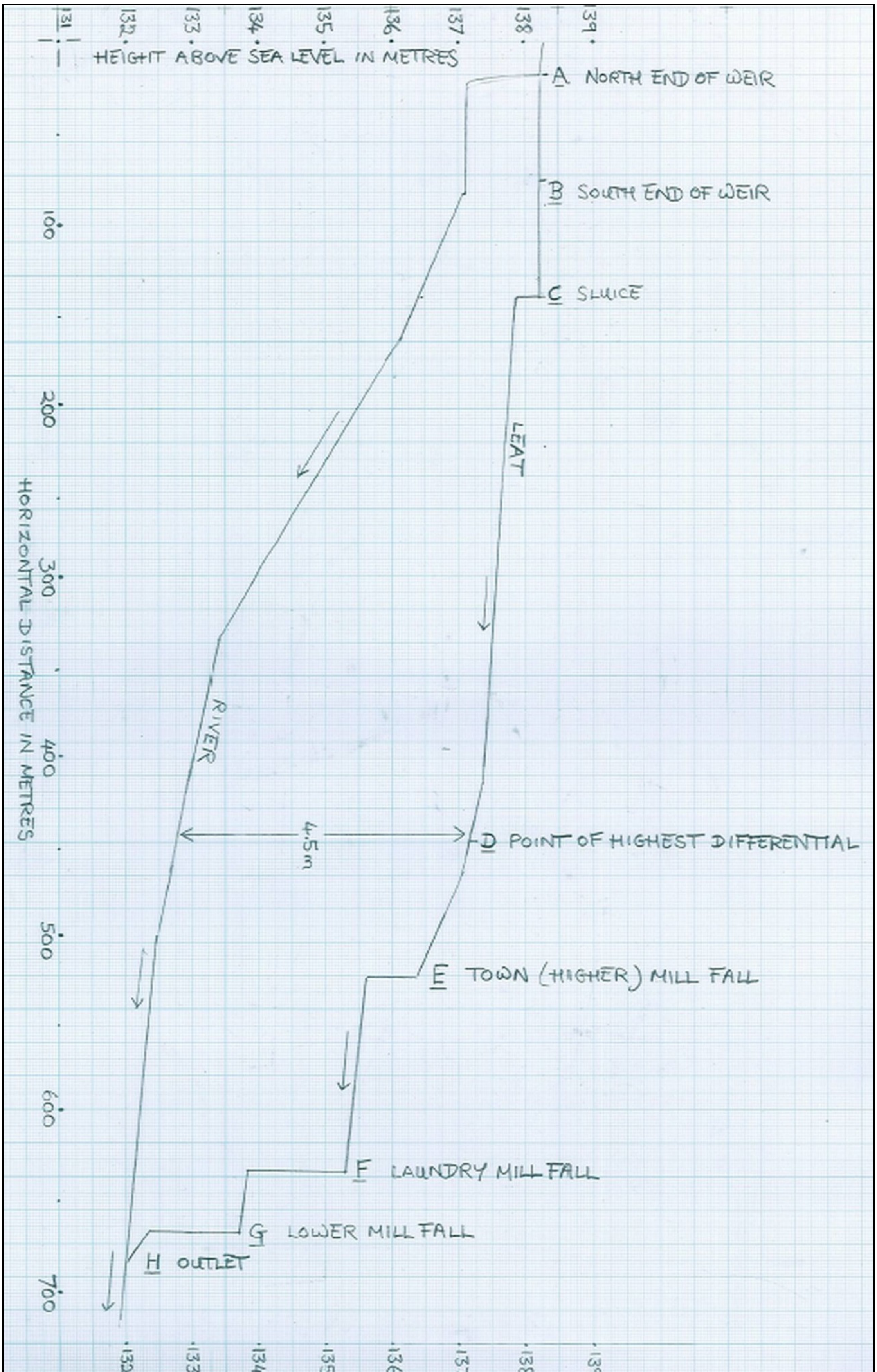

Figure 2. Profile of heights of leat and river (vertical dimension accentuated)