Archaeological building recording at a valve house at the foot of the dam of Upper Bittell Reservoir Worcester and Birmingham Canal

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Introduction

Historic building recording of a valve house at the foot of the dam of Upper Bittell Reservoir Worcester and Birmingham Canal, near Hopwood (SP 01777 74940) was undertaken at the request of David Viner, Heritage Advisor, Canal & River Trust.

The project was undertaken during work on the reservoir and the refurbishment of the operational aspects of the valve house. It was undertaken in anticipation of the possible need to dismantle parts of the valve house, both to give safe access to the valve mechanism and in case the mechanism needed to be removed.

Summary

Historic building recording was undertaken at a valve house at the foot of the dam of Upper Bittell Reservoir Worcester and Birmingham Canal, near Hopwood. The valve house is circular and is constructed of large, ashlar masonry blocks with vertical tooling marks. The roof is a dome of brick, over-pointed on the inside and rendered on the outside. Within the valve house is the valve mechanism.

The documentary material

Documentary research was undertaken at The Waterways Archive, Ellesmere Port, the author's personal collections and the internet.

Historic mapping

The earliest available map was the 1st edition Ordnance Survey map of 1884 (Fig 2.1). This shows the valve house at the foot of the dam although it does not annotate it as such. The same is true of the Ordnance Survey maps of 1904 and 1927. However, the Ordnance Survey map of 1938 (Fig 2.2) clearly refers to the structure as 'Valve House'.

Ellesmere Port

No detailed information regarding Upper Bittell Reservoir could be located. However, comparable installations at other nearby reservoirs could be. These were:

- Rotton Park Reservoir, Birmingham Canal (1829), and
- Cannock Chase Reservoir (now Chasewater Reservoir)

At Rotton Park Reservoir a very similar dam and outfall arrangement was constructed to that of Upper Bittell. At Rotton Park (Fig 11.1) a pipe pierced the dam with control valves at the toe of the embankment, on both landward and reservoir sides. On the landward side was a 'sluice cock' (Fig 11.2) which is similar in general arrangement to the one at Upper Bittell. The drawing does not show a valve house although it may have been omitted for clarity. Another possibility is that small valve houses, such as the one at Upper Bittell, were added at a later date. The orientation of these small valve houses with respect to the equipment that they protected may be significant here (see below, Cannock Chase Reservoir and the description of the valve house at Upper Bittell). On the reservoir side was another control valve, this one being underwater, and operated remotely by a winch and chain arrangement (Fig 11.3). At Upper Bittell the head valve on the cast iron culvert is simpler than at Rotten Park, having only a simple worm screw operated by a windlass which draws a rod up or down inside a cast iron sleeve running down the embankment (David Viner pers com).

At Cannock Chase Reservoir a valve house was constructed. This was one on top of the dam rather than at its foot, as at Upper Bittell and it was hexagonal rather than circular. However, some useful comparisons may still be made. The walls were of concrete rather than stone, as at Upper Bittell, although they were of comparable thickness. A particularly interesting feature is that the alignment of the valve house at Cannock Chase seems to have been arbitrary with respect to the mechanism that it contained (Fig 11.4), exactly as the one at Upper Bittell appears to be (see below). The details of the roof are sketchy but it appears to be of timber.

Other historic sources

Comparisons with other valve houses and valve towers

Valve towers are situated within the reservoir, adjacent to the reservoir dam, and usually accessed by a footbridge from the dam. Valve houses are usually situated on the top or at the foot of the dam.

Valve houses/towers are usually small structures, either circular (eg valve house at Fan Fawr and Beacons Reservoir) or rectangular (eg valve houses at Piethorne and Cobbinshaw Reservoirs), although square examples (eg valve house at Thirlmere Reservoir) and large examples (eg valve house at Ladybower Reservoir, Upper Derwent Valley, Derbyshire) exist.

At Belvide reservoir, which supplies the Shropshire Union in Staffordshire there is a similar valve house to the one at Upper Bittell. This is listed Gd II*, built in 1833 with a cast iron dome (Fig 11.5).

Common constructional features are the use of large ashlar masonry, often dressed in a rusticated fashion and the design of the buildings to resemble medieval castles with crenelation, machicolation, turrets and arrow slits (eg valve houses at Fan Fawr and Beacons and Thirlmere Reservoirs). Roof structures include barrel vaults (eg valve houses at Cobbinshaw and Ladybower Reservoirs).

Upper Bittell reservoir

A useful summary of what is known about Uper Bittell reservoir may be found n the book by the Revd Alan White (White 2005). In 1829, with trade on the Worcester and Birmingham Canal continually on the increase and more and more water needed, a new location for a reservoir was suggested behind the one that already existed at Lower Bittell. This was to be above the summit level of the canal and would therefore not require pumping to deliver its supply. This reservoir would extend over 80 acres of land and would be fed by three small streams which drained the surrounding farmland and by a culvert conveying water ad required, from Cofton reservoir. It would contain about 10,000 locks of water and cost about £2000. By January 1832 the reservoir contained 6000 locks of water and the embankment was still being raised. The whole work was successfully completed in November 1832 with a 30 foot depth of water. The following year, in April a cottage was built on the south-west bank of the reservoir for a resident attendant. Upper Bittell reservoir tended to get low in time of drought whereas Lower Bittell reservoir often had a surfeit of floodwater. In 1835 it was decided to install a pumping engine to pass water from Lower to Upper Bittell, as and when required. By Aril 1836 a branch canal was almost finished, enabling bricks and other materials and coal for the pumping engine to be delivered by boat. This came to be known as Jacob's Cut. The engine was completed and in use by spring 1837. In 1842 it was decided to raise the embankment and increase the capacity of Upper Bittell reservoir and was completed in the summer of 1843.

The fieldwork

General

Fieldwork took place on the 12th February 2018. It comprised measured survey of the valve house in order to produce a plan, elevation and developed elevation of the valve house wall. Photographs were taken as necessary.

Description

The valve house at Upper Bittell is circular (Fig 3.1) and is constructed of large, ashlar masonry blocks with vertical tooling marks as the stones are laid. A stone-for-stone, developed elevation was produced (Fig 3.3) to facilitate the dismantling and re-erection of the valve house if this takes place. The individual stones are shaped to a curve. The existing door (Fig 4), which is of grille construction, is of painted steel and is probably a replacement of an earlier one. At the junction of the elevation and roof is a simple roll moulding executed in stone, though now much decayed and repaired in places with brick.

The roof is a dome of brick, over-pointed on the inside and rendered on the outside (pers com David Viner). This too is much decayed and has been repaired with non-matching bricks (Figs 4, 5, 6 and 10). The render may originally have been lime but the current covering appear to be cementitious. It butts against the upper iron strap (see below) suggesting this bracing was added some time before the early 20th century.

There are two iron straps around the building, one around the roll moulding and the other around the lower part of the dome (Figs 4, 5 and 6). It is possible that the dome showed signs of distortion after construction and the straps were added to counteract lateral pressure. The age of the straps is unknown but they are secured with square-headed bolts (Fig 7). Square-head bolts were common in early applications because they were easier to make with the tools, metals and techniques of the time. Square heads required less accurate tolerances, so that a wrench that was not the exact size of a bolt might be near enough to turn a hand-machined square bolt head. Square heads, however are large and require more room to turn. By 1841, British toolmaker Joseph Whitworth and his American counterpart, William Sellers of the Franklin Institute had proposed creating a system of standardized screw threads. Standardized bolts and nuts soon followed as toolmakers developed new techniques for making them in quantity. Therefore, it is possible that the bolts and straps predate the early 1840s. However, it is equally possible that there was an ample supply of such bolts available to the waterway maintenance crews and that existing stocks would have been used-up before they were replaced with hexagonal headed bolts, which only started to become common in the 1880s.

Within the valve house is the valve mechanism. This comprises the valve box (Fig 9), a rectangular fabrication in iron, into which the pipe from the reservoir enters and the discharge pipe leaves. The valve box supports an iron framework (Fig 8) which in turn supports a threaded shaft that enters the valve box *via* a stuffing box or gland. It is the rotation of this shaft that opens and closes the valve. It was noted that this mechanism is orientated at a slight angle to the axis of the valve house that passes through the doorway.

Commentary

Background

There is a long history of dam and reservoir construction in Britain (Environment Agency 2011). In the second half of the eighteenth century, many ornamental lakes were established in the landscaped grounds of country estates and, by the end of the century, reservoirs were needed to supply the canals rapidly being built across the country. During the first half of the nineteenth century, the demand for unpolluted water supplies to the rapidly expanding industrial towns led to a major increase in reservoir construction. This continued throughout the nineteenth and twentieth centuries, but has been followed by a decline in dam construction since the 1980s.

Before 1900, nearly all British dams were of the embankment type (with a notable exception in Vyrnwy, a gravity dam built in 1890 to supply water to the city of Liverpool). Although in the twentieth century a large proportion of dams were built of masonry or concrete, the majority of dams in Great Britain are earth embankments. Reservoir safety is thus intimately concerned with the behaviour and long-term performance of old embankment dams. Until the 1950s, most embankment dams in Britain were built to a traditional design with a central core of puddle clay (eg Rotton Park, Fig 11.1). More modern embankment dams typically use a wider core of rolled clay. However, the use of puddle clay cored dams continued until 1972, with the completion of Jumbles, north east of Manchester.

Historic construction methods

By the middle of the nineteenth century a fairly standard design of embankment dam had been adopted, with an upstream slope of one vertical in three horizontal and a steeper downstream slope of one vertical in two-and-a-half or two horizontal This is the case at Rotton Park. Although control of material and workmanship should ensure the integrity and water-tightness of the core within the body of the dam, leakage could occur through the natural strata of the valley underneath or around the sides of the dam. Leakage could also occur in the basin of the reservoir. In the early puddle clay core dams, it was usual to extend the puddle clay into a cut-off trench below ground level thus connecting the core to a stratum of low permeability. The trench often continued into the valley sides. Sometimes very deep trenches were dug but the trench was usually narrow, with vertical sides.

The catastrophic failure of two dams in the nineteenth century, Bilberry in 1852 and Dale Dyke in 1864, led to major changes in the design and construction of puddle clay core embankment dams. It is noteworthy that the Bilberry dam had three adverse features: a puddle clay filled cut-off trench in which springs were encountered, highly permeable fill on either side of the puddle clay core, and a culvert through the embankment. The latter being a feature of Rotton Park and Upper Bittell. With regard to Dale Dyke, failure was most likely to have been caused by leakage from a fractured outlet pipe which passed through the embankment, but the design and construction of the embankment itself was also criticised (Rawlinson and Beardmore, 1864).

Initially, the practice with puddle clay core dams was to lay the outlet pipe through the embankment and puddle core. In some cases the pipes were surrounded with fill material, but it became more common to surround pipes with concrete. Rawlinson (1879) came to definite conclusions about the unsuitability of these practices:

An engineer, whether designing waterworks or other works, should not put any portion of the material liable to decay out of reach: he should not bury such material as cast iron under an embankment having a 500-feet base, so that nothing but the destruction of the bank could ever render it accessible for repairs.

The practice of placing outlet pipes, or culverts containing outlet pipes, through the embankment was largely superseded by the more costly but much safer expedient of driving a tunnel through the natural ground. When the hazards of a pipe containing water under reservoir pressure were better understood, the early practice of controlling the flow of water by a single valve at the downstream toe was widely changed and upstream controls became more common, as at Rotton Park.

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Archive
The physical archive consists of:

6 x A4 pages	The text of the report
15 x illustrations of various sizes	Illustrations for the report

It has been deposited at The Waterways Archive, Ellesmere Port.

The digital archive consists of:

6 x A4 pages	The text of the report (.doc format)
15 x illustrations of various sizes	Illustrations for the report (.bmp format)
1 x copy of the combined report	(.pdf format)

This has been deposited with OASIS

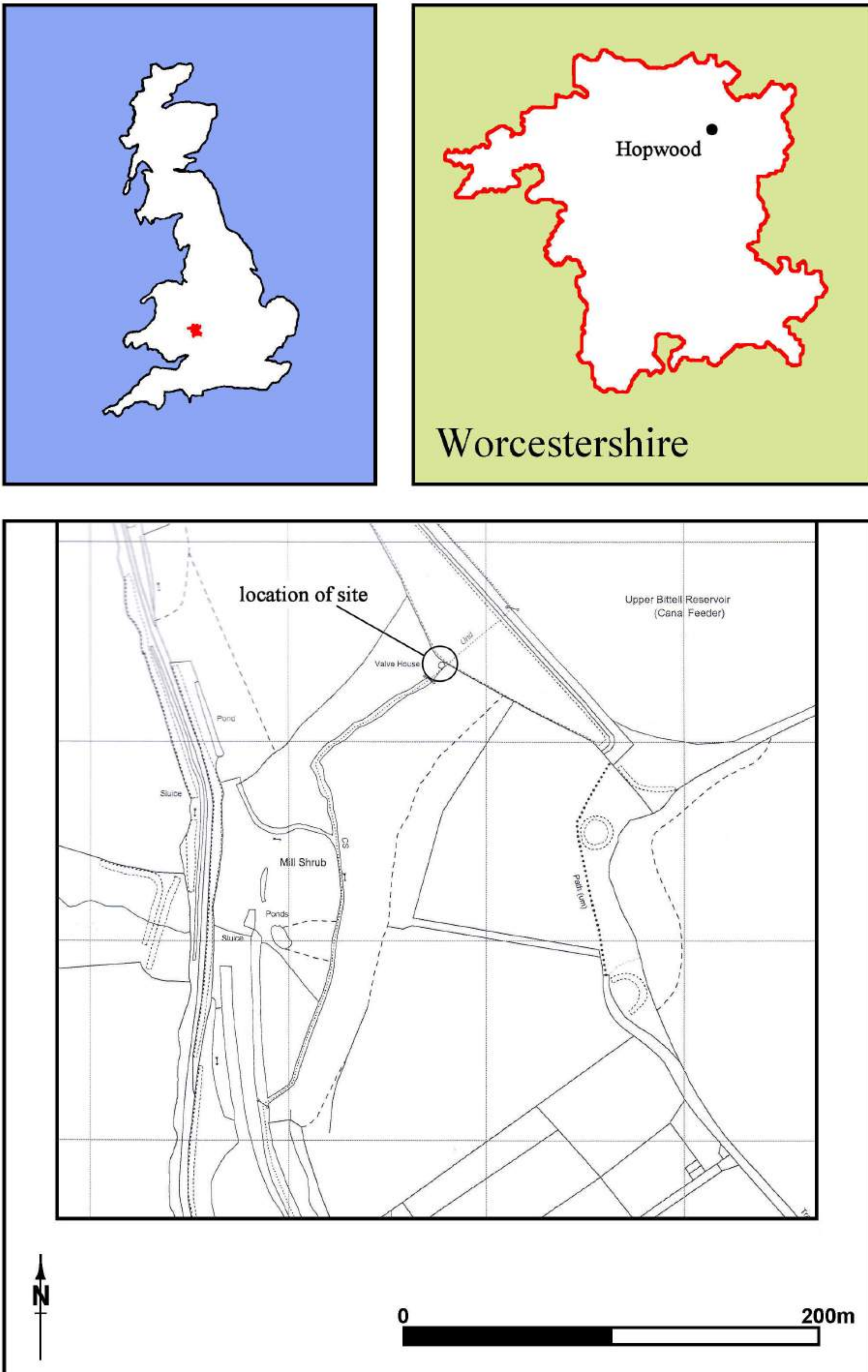
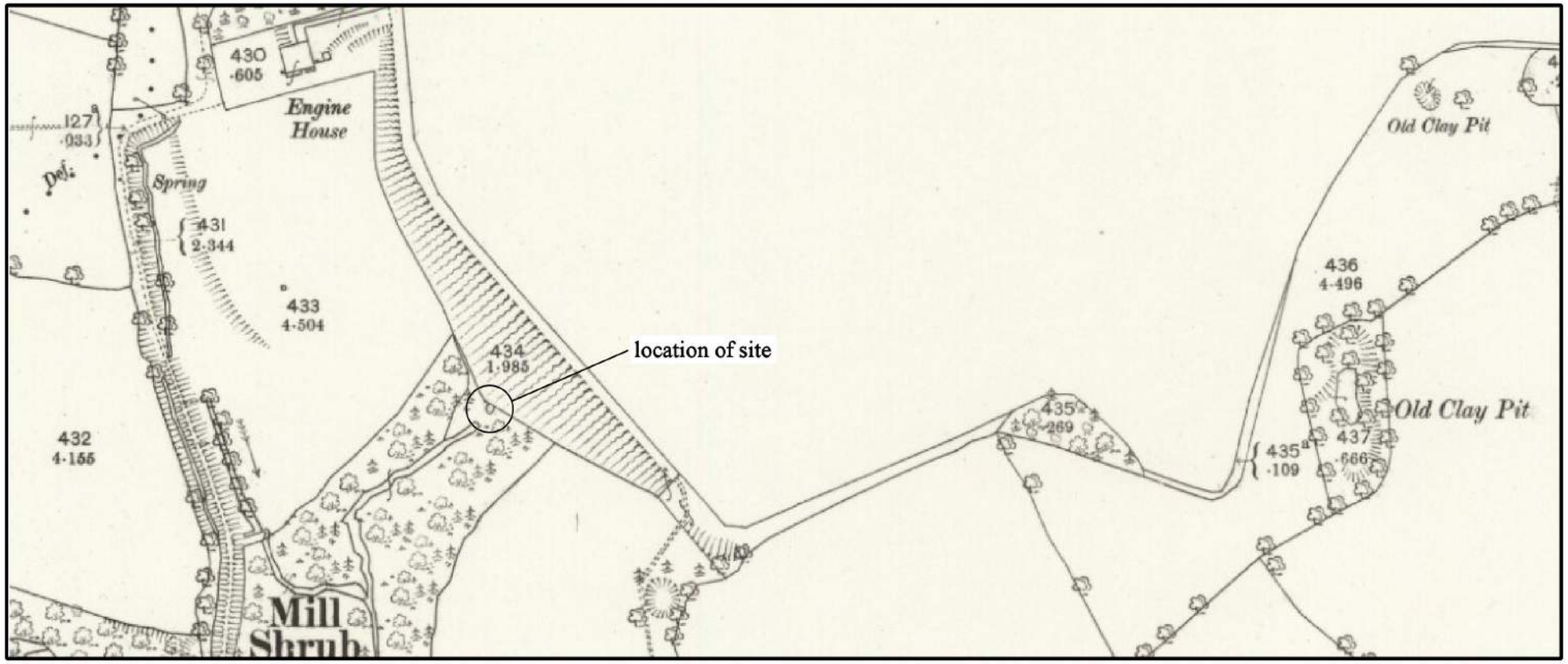


Fig 1: Location of site

1884



1904

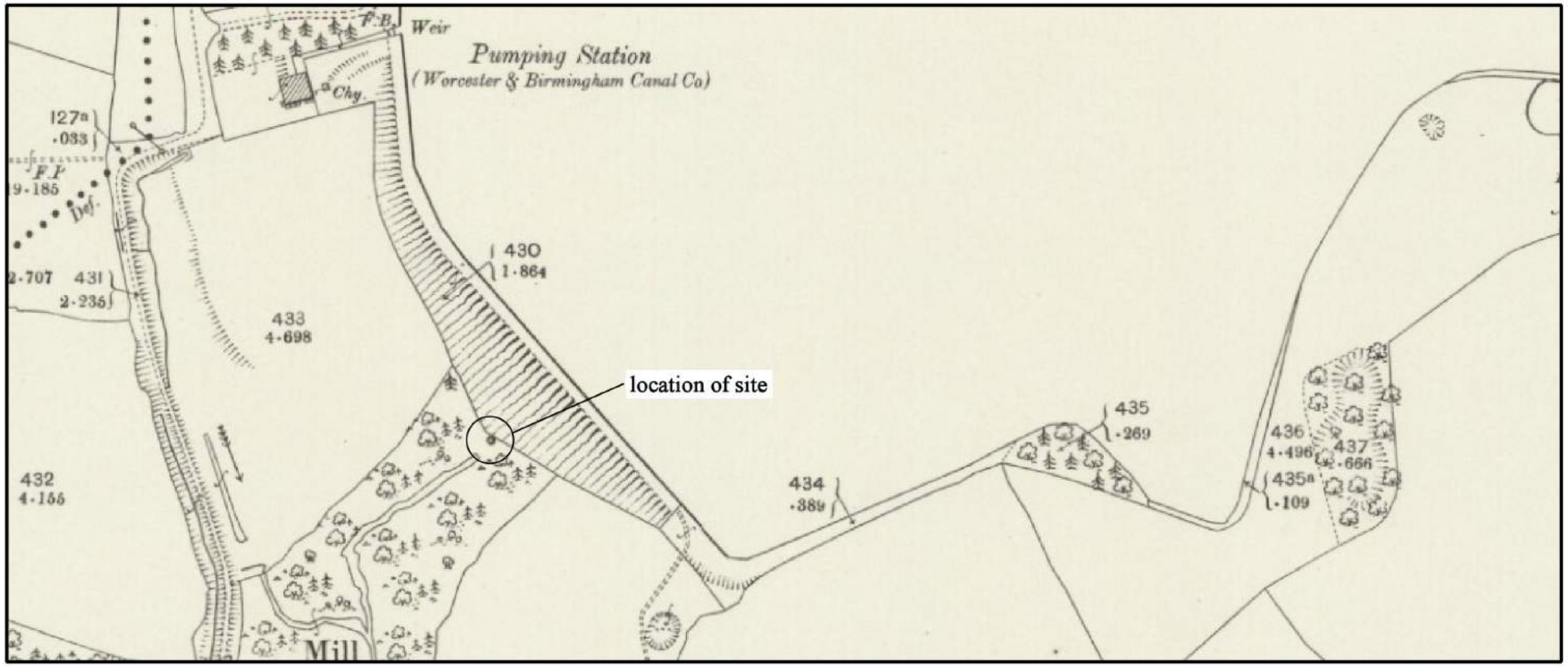


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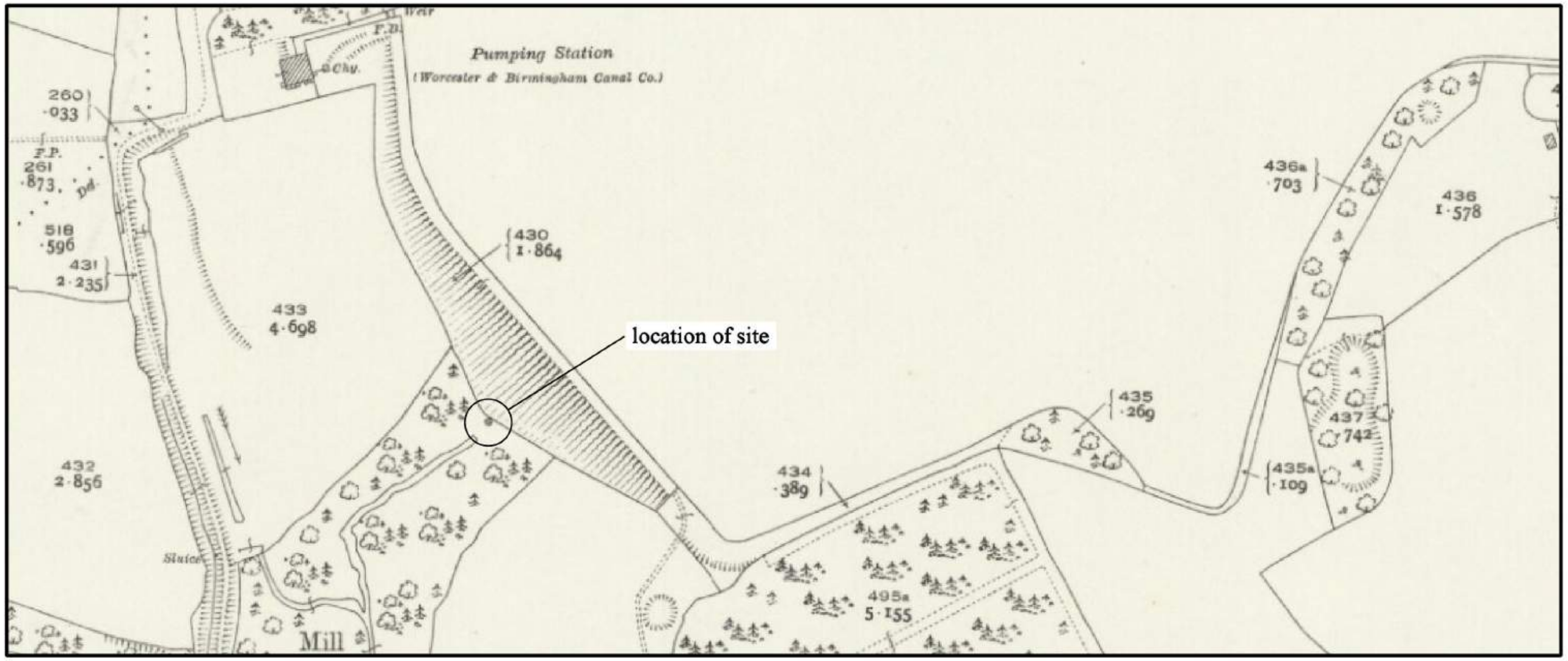
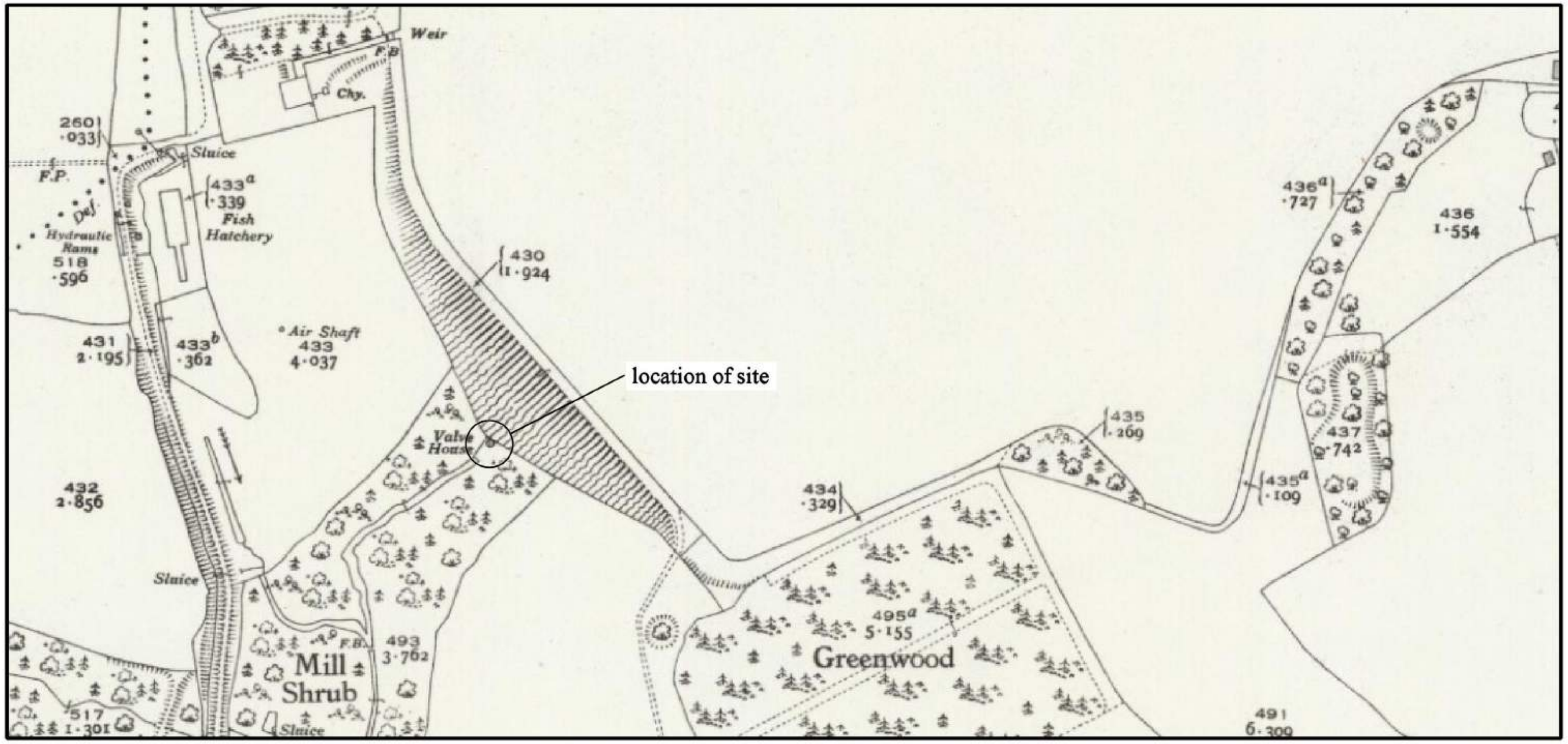
Fig 2.1: Historic mapping

0 200m

1927



1938



0 200m

Fig 2.2: Historic mapping

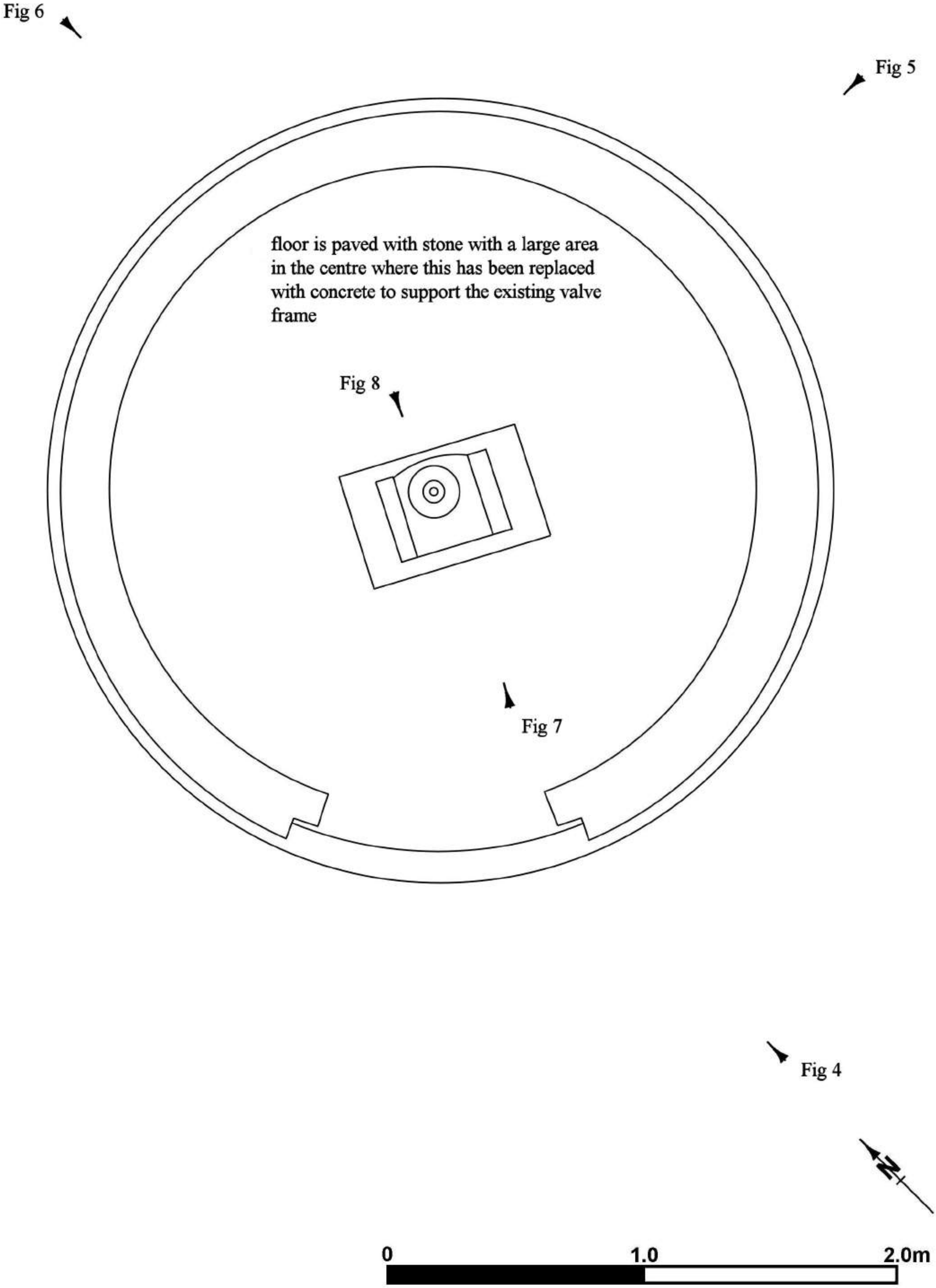


Fig 3.1: Plan of valve house

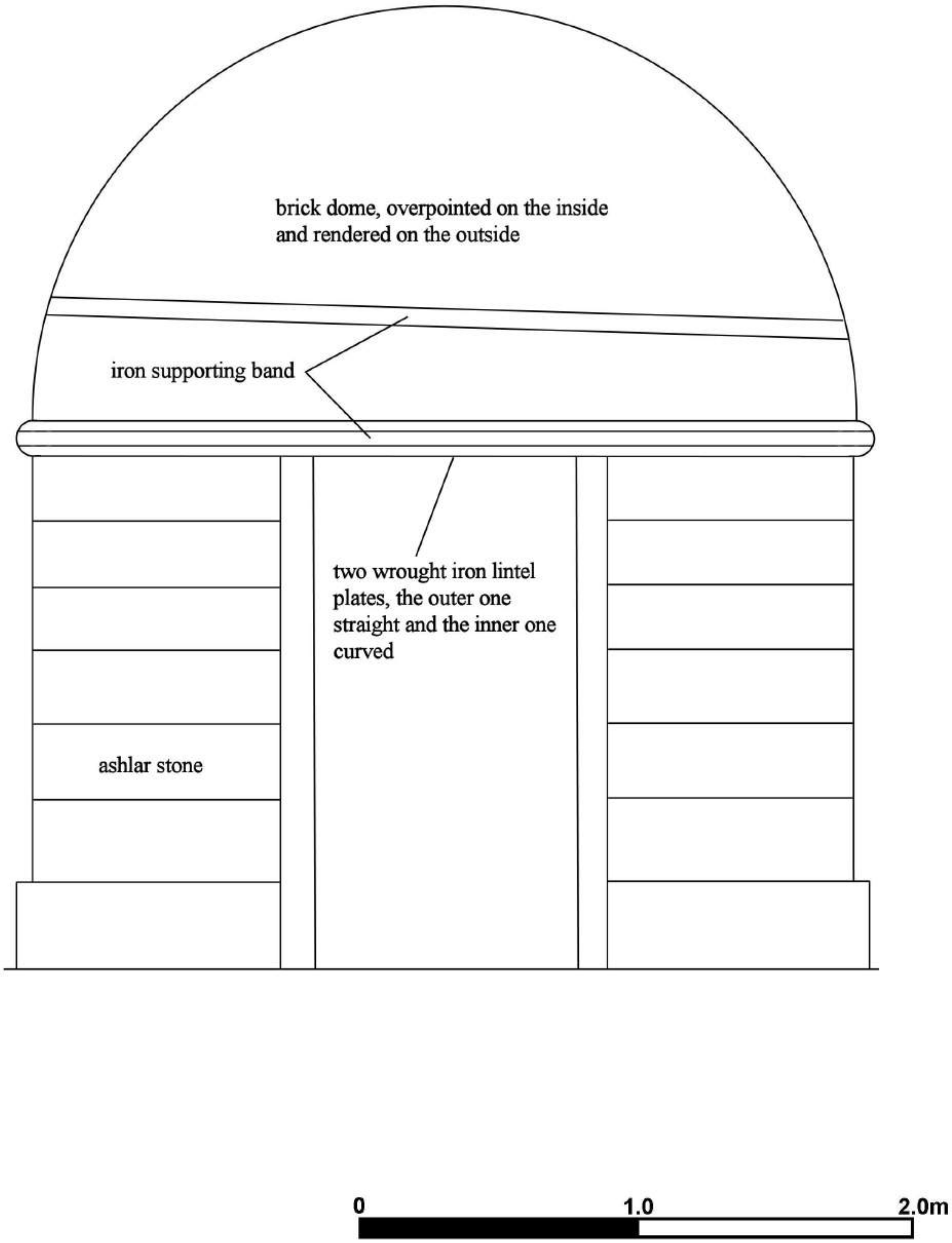


Fig 3.2: South-west elevation of valve house

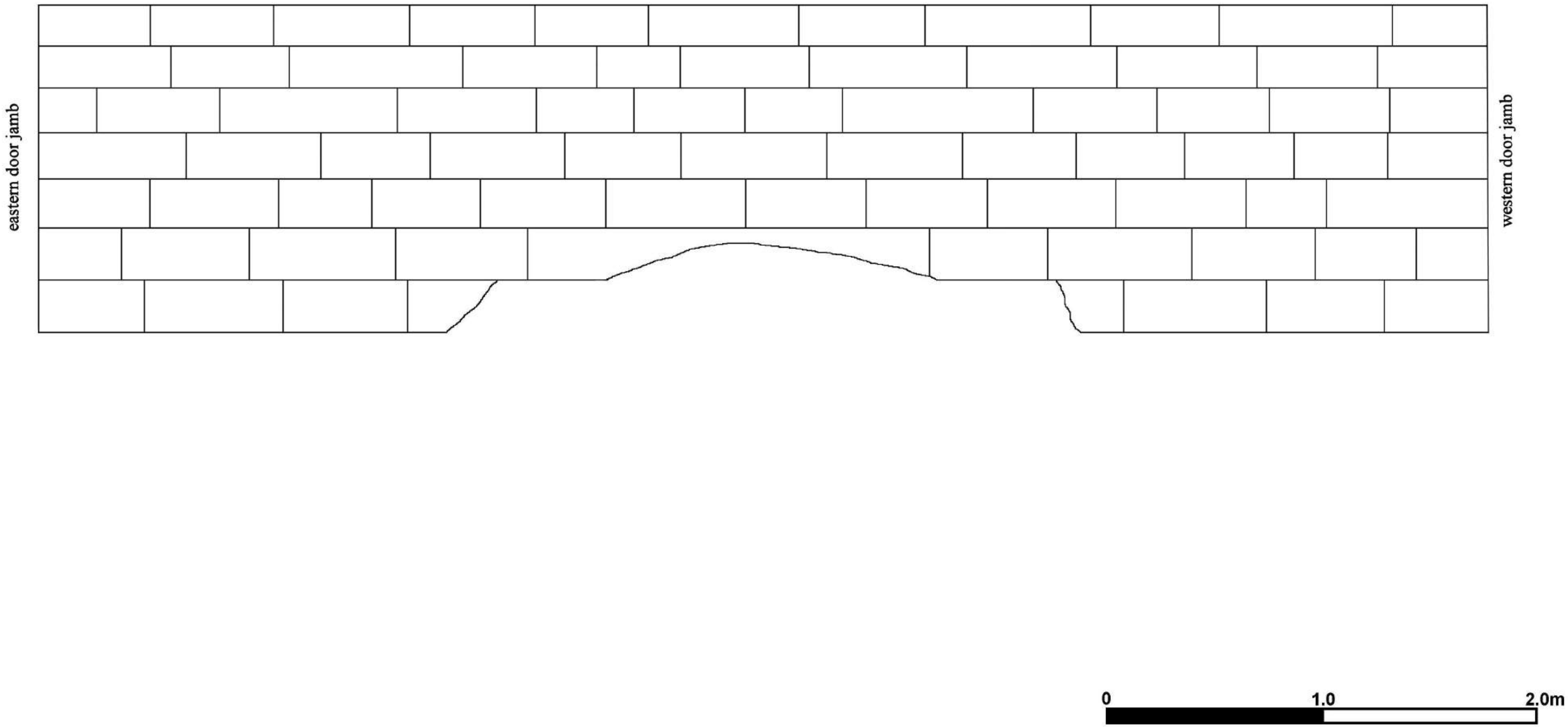


Fig 3.3: Developed elevation of valve house wall showing component stones

Fig 4: View from the south

Fig 5: View from the north

Fig 5: View from the east

Fig 6: View from the south

Fig 7: Detail of bolt securing one of the iron straps

Fig 8: View of the valve support

Fig 9: View of the valve base and pipe

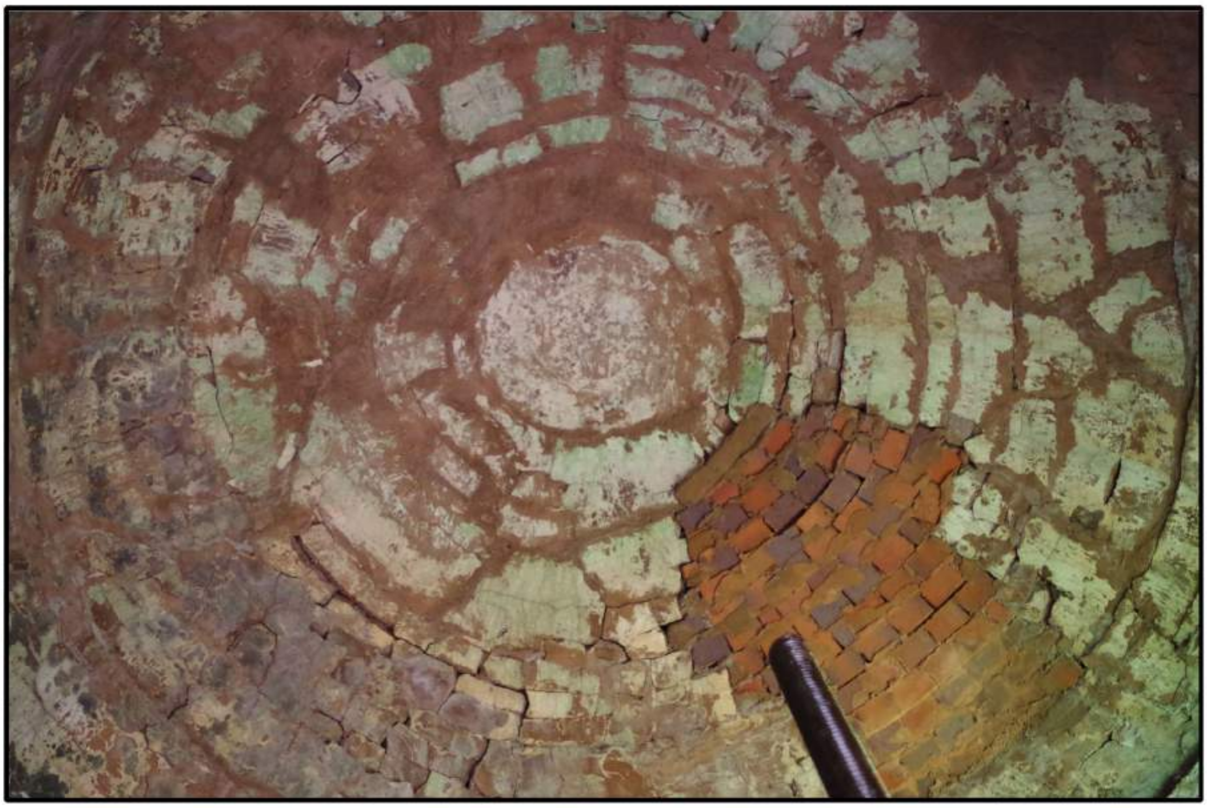


Fig 10: View of the inside of the dome

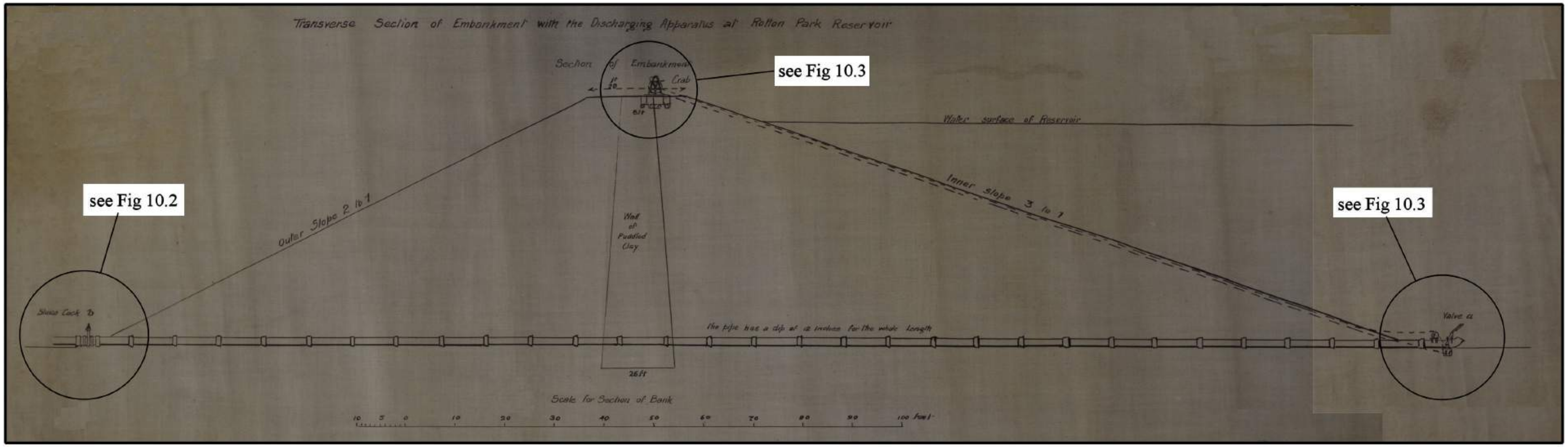


Fig 11.1: Rotten Park Reservoir, Birmingham Canal; transverse section of embankment, late 19th-early 20th century (BW 165/28/1/5/9)

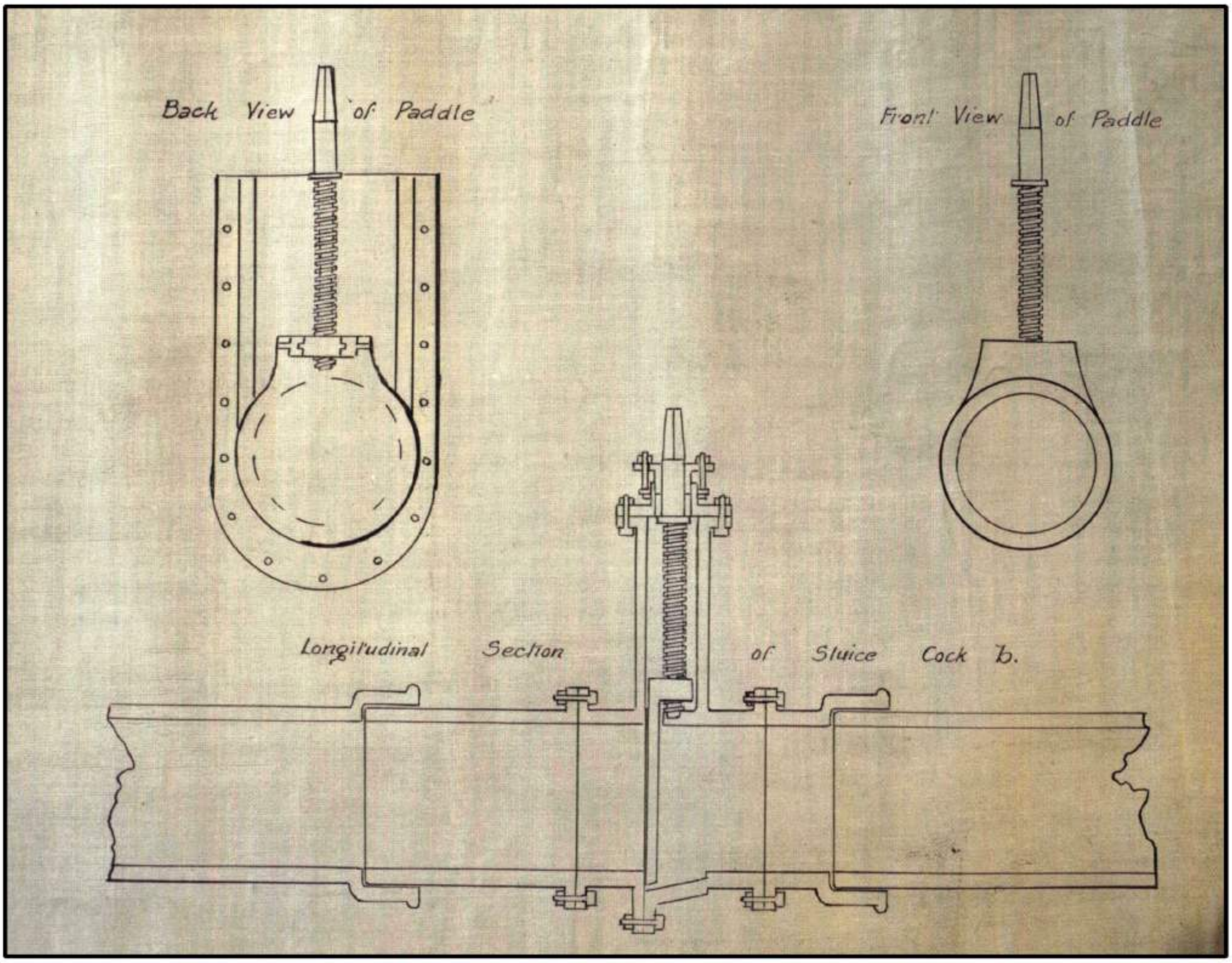


Fig 11.2: Rotten Park Reservoir, Birmingham Canal; detail of surface discharge apparatus, late 19th-early 20th century (BW 165/28/1/5/9)

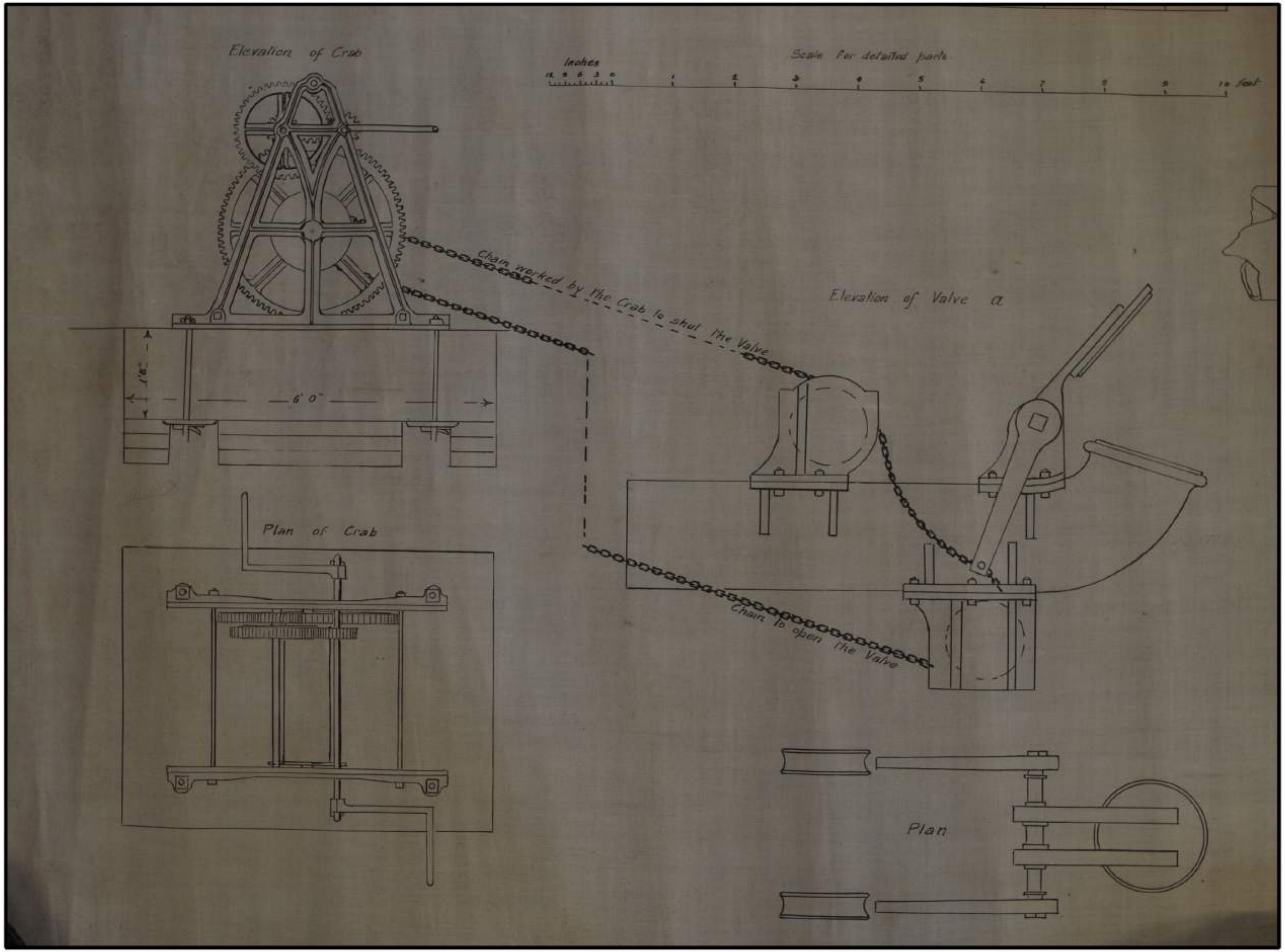
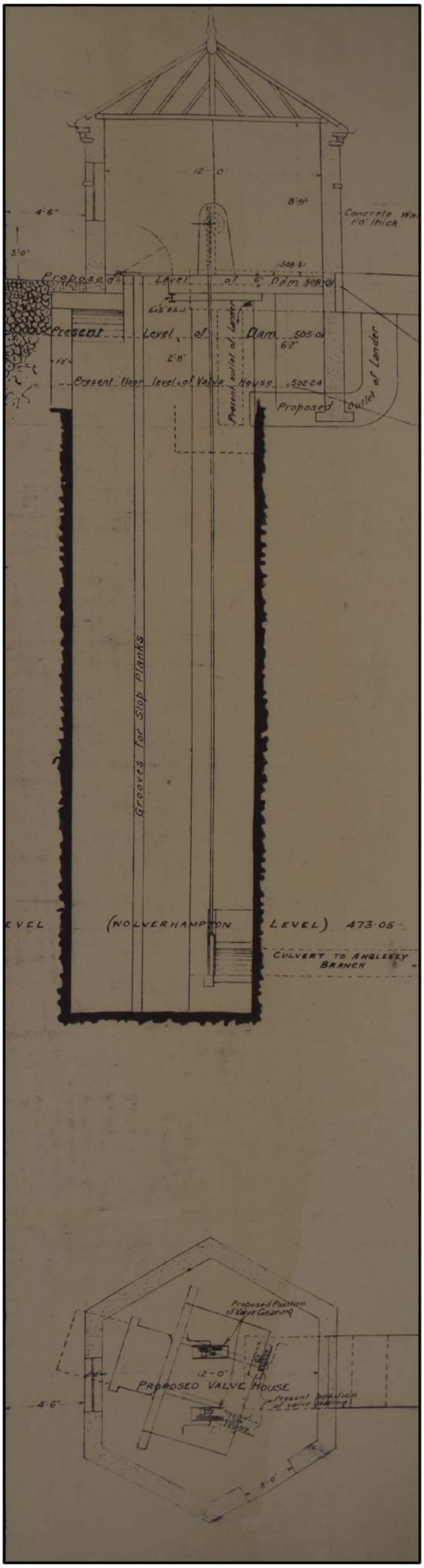


Fig 11.3: Rotten Park Reservoir, Birmingham Canal; detail of underwater discharge apparatus, late 19th-early 20th century (BW 165/28/1/5/9)



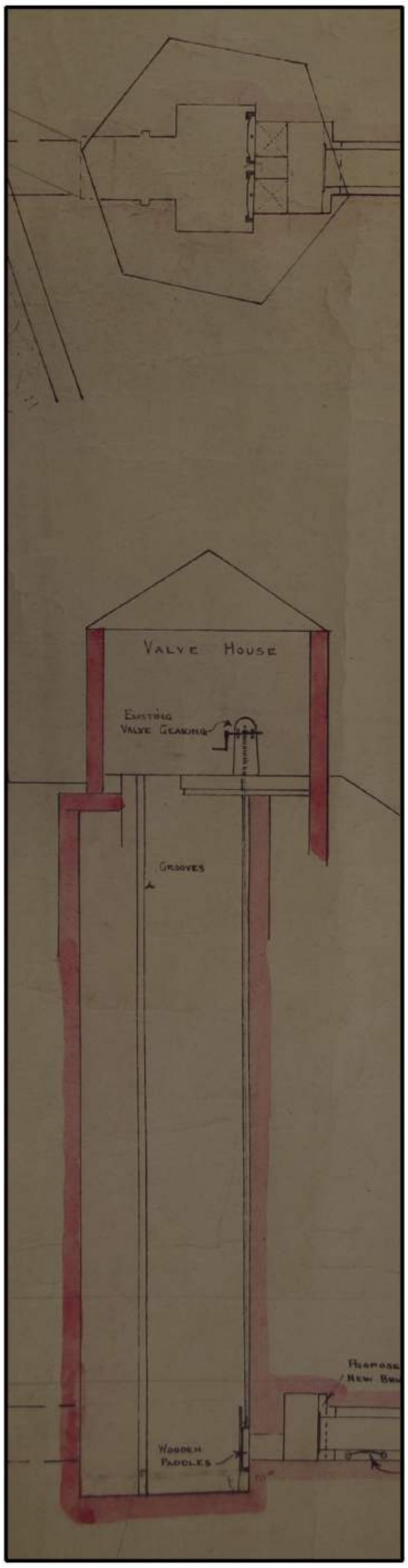


Fig 11.4: Designs for a valve house, Cannock Chase Reservoir (now Chasewater Reservoir), BW 165/28/1/3/45 and 43

Fig 11.5: Valve house at Belvide reservoir, Shropshire Union Canal