NAA

ARCHAEOLOGICAL MONITORING AND BUILDING RECORDING REPORT

TEES COTTAGE PUMPING STATION, DARLINGTON, COUNTY DURHAM

prepared for

Sanderson Weatherall

NAA 20/04
January 2020

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QUALITY ASSURANCE		
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Report Number	20–04	
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Issue 1 sent to client for review		13/01/20
Issue 2		

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Client Sanderson Weatherall LLP
Location Tees Cottage Pumping Station, County Durham
Planning Ref N/A
Grid Ref NZ 25885 13804
OASIS ID northern1_379806

TEES COTTAGE PUMPING STATION, DARLINGTON, COUNTY DURHAM
ARCHAEOLOGICAL INVESTIGATIONS
FINAL REPORT

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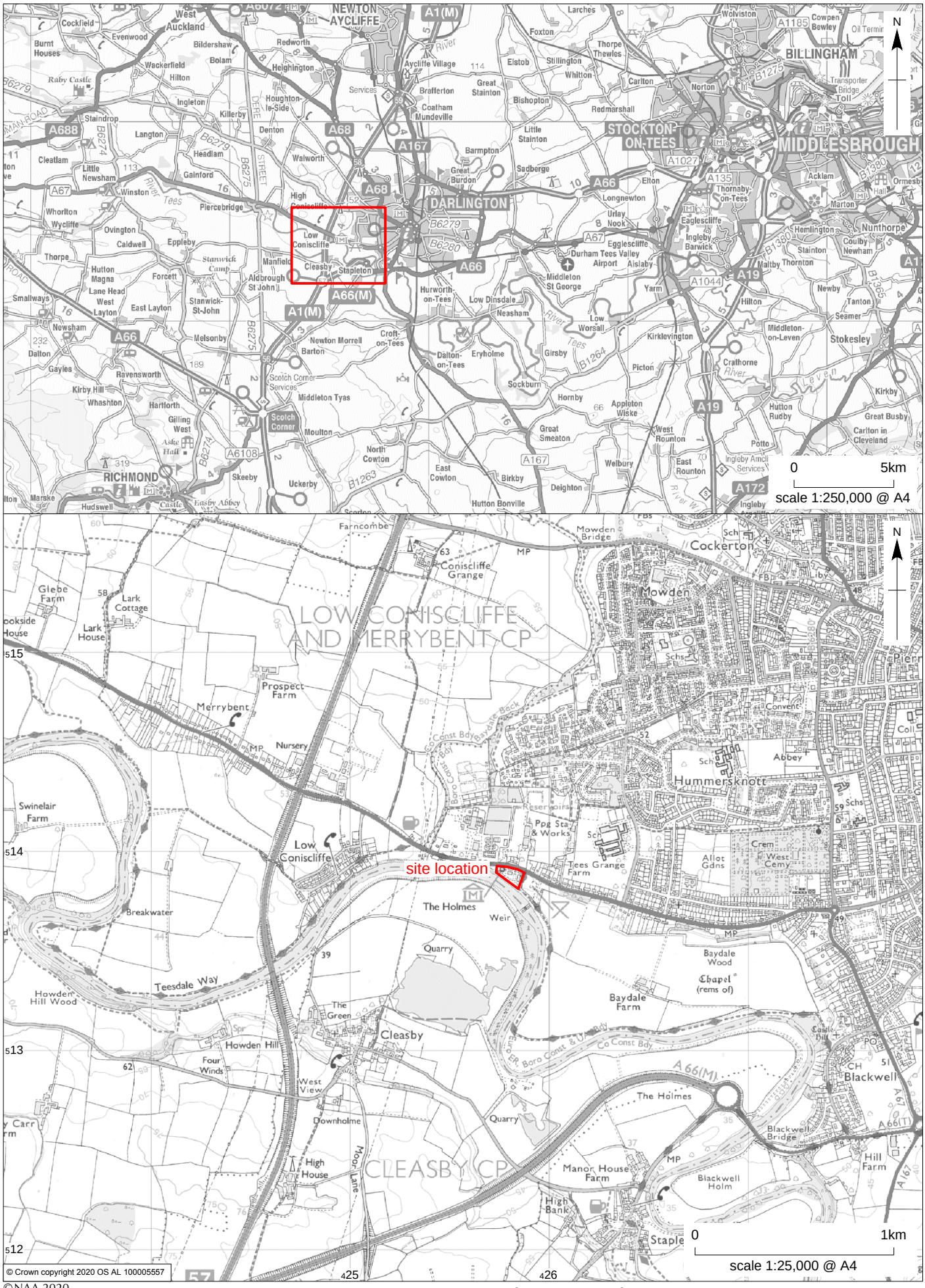

Tees Cottage Pumping Station, Darlington: site location *Figure 1*

TEES COTTAGE PUMPING STATION, DARLINGTON, COUNTY DURHAM
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Summary

Northern Archaeological Associates was commissioned by Sanderson Weatherall LLP, on behalf of Northumbrian Water, to conduct a short programme of archaeological monitoring, excavation and building recording during the replacement of timber flooring in the west engine house of Tees Cottage Pumping Station, Darlington.

The site is a scheduled monument (NHLE: 1002300); designated in 1984 as a prime example of a well-preserved and still operational municipal pumping station which charts the development of water-pumping technologies over a 100-year period. All work took place within the west engine house, which formed part of the original waterworks complex. Designed in 1849 by Thomas Hawksley, one of the leading British water engineers of the period, this building housed the 29hp compound rotary beam engine which remained in operation until decommissioned in 1906-7, when the pumping station was upgraded and a new engine house built. Subsequently, the west engine house was repurposed as a lathe workshop and a suspended timber floor was installed. A recent structural-conditions survey demonstrated that the floor suffered from extensive dry rot, and Scheduled Monument Consent was granted for remediation works comprising the temporary relocation of the lathe and replacement of the timber floor.

Removal of the timber floor exposed the flywheel pit associated with the original Gilkes, Wilson & Co rotary beam engine, together with a series of cross-walls and an access hatch to the basement area. Rubble deposits within the flywheel pit, presumably related to the decommissioning of the original engine, were removed under archaeological supervision. The base of a large brass bearing was recovered from the rubble and it probably relates to the original flywheel mechanism.

Following the removal of the rubble, a Level 2 building survey was conducted that comprised a photographic and drawn record of the interior elevations and plan of the basement rooms and flywheel pit. Brick archways, iron pipes, pumping mechanism, flywheel pit and anchor plates associated with the original beam engine, were all recorded.

The siting of scaffolding within the basement, erected as part of the remedial works, meant that not all of the rubble could be removed on health and safety grounds. There are no plans to

remove this material as part of the current programme of work, so no further recording work is recommended.

Acknowledgements

Our thanks must be extended to the volunteers of Tees Cottage Pumping Station Trust for their hospitality and dedication to maintaining this impressive monument to the industrial heritage of in Teesside. Special mention must be given to the Chairman of the Trust, David Smart, and the Secretary, George Beautyman, for sharing their extensive knowledge of the site and its operation. Thanks are also due to the Inspector of Ancient Monuments (North East), Lee MacFarlane, for her advice and support throughout the project.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates was commissioned by Sanderson Weatherall LLP, on behalf of Northumbrian Water, to conduct a short programme of archaeological monitoring, excavation and building recording during the replacement of timber flooring in the west engine house of Tees Cottage Pumping Station.

1.2 The site is a scheduled monument (NHLE: 1002300), designated in 1984 as a prime example of a well-preserved and operational municipal pumping station, charting the development of water-pumping technologies over a 100-year period. The original beam engine of the complex, located within the west engine house, was installed in 1849 and decommissioned in 1906-7, after which the building was repurposed as a lathe workshop and a suspended timber floor installed. A recent structural-conditions survey (Sanderson Weatherall 2018) demonstrated the floor to be suffering from extensive dry rot and Scheduled Monument Consent (SMC) (HE Ref. S00221369) was granted for remediation works comprising the temporary relocation of the lathe and replacement of the timber floor.

1.3 Removal of the timber floor revealed the floorplan of basement rooms and the flywheel pit associated with the original Gilkes, Wilson & Co rotary beam engine. Rubble was removed from the flywheel pit under archaeological supervision and a Level 2 Historic Building Survey conducted in accordance with Historic England guidelines (Historic England 2016).

1.4 Prior to any work commencing onsite a Written Scheme of Investigation (WSI) was prepared (NAA 2019) and approved by Lee McFarlane, Historic England Inspector of Ancient Monuments (North East). This fulfilled condition d of the SMC. The following report and archive are in accordance with condition i and an OASIS entry has been completed under conditions j (Entry Ref. northern1_379806). All archaeological conditions are now met.

2.0 AIMS AND OBJECTIVES

2.1 All work took place in the west engine house (Fig. 2) and was conducted over a five-day period in November 2019.

Archaeological monitoring

2.2 The aim of the archaeological monitoring was to identify and record any significant

material relating to the original operation of the west engine house during the removal of rubble from the exposed flywheel pit and rear section of the basement.

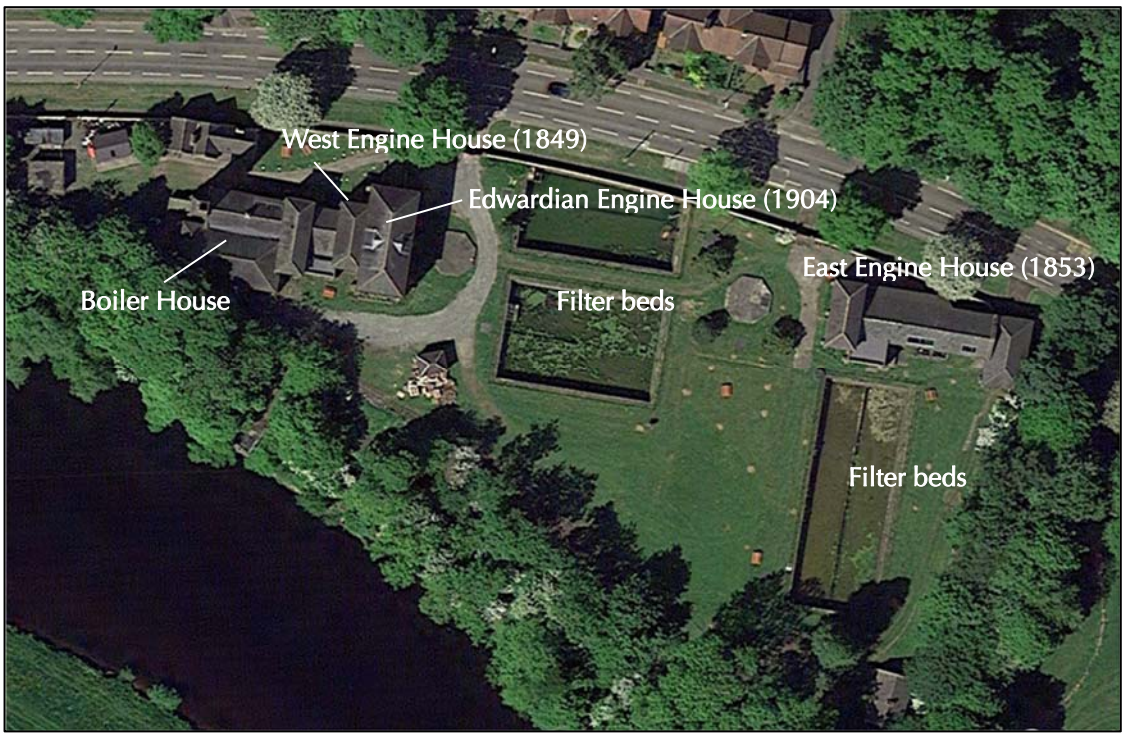

Figure 2: Google Earth aerial image showing the pumping station complex with key elements annotated.

2.3 The WSI had originally included provision for the excavation of a series of slots through silt deposits within the basement (NAA 2019). However, on access, no such deposits were encountered and this work proved unnecessary.

Building recording

2.4 The main aim of the Historic Building Survey was to provide a descriptive and analytical (Level 2 to 3) (Historic England 2016) record of the basement rooms to act as a permanent record of the building prior to the installation of the replacement floor.

2.5 The following objectives were identified and met:

- a photographic record of the basement rooms and flywheel pit;
- annotated floor plans and elevations of the basement rooms and flywheel pit;
- preparation of a digital archive;
- preparation of an illustrated report on the results of the archaeological monitoring and survey; and

- deposition of the report and digital archive with the Archaeology Data Service via OASIS.

3.0 METHODOLOGY

Archaeological monitoring

3.1 Substantial rubble deposits were removed from the flywheel pit under archaeological supervision by contractors working on behalf of Northumbrian Water. The monitoring took place over three days, from 11th to 13th November 2019, with further recording conducted on 20th November. Primarily, the rubble comprised fragments of brick, mortar and timber and contained generic iron brackets, nails and nuts. These were assessed and recorded by the archaeologist onsite where relevant but were not retained.

3.2 The only object of interest was a large brass base of a bearing, relating to the original flywheel mechanism. Due to the weight of the bearing, a winch had to be used to remove it from the flywheel pit.

3.3 The rubble extended beyond the flywheel pit into a room on the south side of the west engine house. Originally it was intended to clear this material, but the siting of the scaffolding on top of the rubble made its removal unsafe. Further archaeological monitoring may be required if the scaffolding is to be taken out and the rubble removed prior to the installation of the replacement floor. There are no plans to do this as part of the current schedule of work.

3.4 No silt deposits were encountered within the basement or the flywheel pit, making excavation unnecessary. It is also considered unlikely that any deposits requiring archaeological recording will be present beneath the rubble deposit left in situ on the south side of the basement.

Building recording

3.5 The confined nature of the basement rooms and flywheel pit meant that both archaeologist and contractor were required to have 'Confined Space Entry' training. A hard hat, high-visibility personal protective equipment (PPE), a safety harness, gas monitor and dust mask were worn at all times when recording in the basement areas.

3.6 The scaffolding erected within the basement rooms, below the level of the previous timber floor, caused significant constraint in terms of accessibility. It also limited

opportunity to photograph the wall elevations. Two halogen floodlights were provided to light the spaces below ground and supplement the ground-floor sodium lights.

3.7 Each wall elevation, floor and feature were assigned a unique identification number (context number). A full list of contexts is included in this report as Appendix A.

3.8 Where possible, digital photographs were taken of entire wall elevations. These included a graduated photographic scale where viable. Individual architectural elements were photographed in detail. 'Structure from Motion' (SFM) photogrammetry was used to record full elevations, with varying degrees of success due to the location of scaffolding.

3.9 The digital photographs were supplemented by a hand-drawn scale plan at 1:20 and measured sketches of the elevations (Historic England 2016). Measurements were taken using hand tapes and a laser measurer.

3.10 A digital archive of all the material was created and deposited with this report with the Archaeology Data Service (ADS). An OASIS entry has also been completed (Entry Ref. northern1_379806).

4.0 LOCATION, TOPOGRAPHY AND GEOLOGY

Location

4.1 Tees Cottage Pumping Station is located on the south side of Coniscliffe Road (A67), approximately 4km south-west of Darlington town centre and 2km south-east of Low Coniscliffe (Fig. 1; NGR NZ 25885 13804).

4.2 The property is owned by Northumbrian Water, which operates the Broken Scar Water Treatment Works on the opposite side of the road, approximately 200m to the north-west. The site is leased to the Tees Cottage Pumping Station Trust, a voluntary organisation that maintains and runs the complex as a heritage centre, holding 'steaming' events that are open to the public five weekends each year.

Geology and soils

4.3 The site lies within an area of sandstone, mudstone and magnesian limestone all belonging to the Permian and Triassic period (BGS 1977). The drift geology is largely

composed of boulder clay and morainic drift, with alluvium, glacial sands and gravels, and river terrace deposits being present within the valley of the River Tees (*ibid.*).

4.4 The soils of the area generally comprise the stagnogley soils of the Crewe Association, but the river meander contains deep, well-drained coarse loamy brown earths of the Wick 1 Association (Jarvis *et al.* 1984).

Topography and land use

4.5 The pumping station complex covers approximately 0.7ha of river terrace on the north bank of the River Tees. The station opened in 1849–50, prior to which the site was meadow land. Today the area is primarily used for recreation purposes, with events held at the complex throughout the year. Immediately to the east is the Broken Scar picnic site.

Designations

4.6 The Tees Cottage Pumping Station is a Scheduled Monument, given statutory protection under the Ancient Monuments and Archaeological Areas Act 1979. This is the highest level of protection that can be placed on a heritage site. Listed as 'Coniscliffe Road Waterworks' (NHLE No: 1002300), the site was designated in June 1984 in recognition of its national importance to the country's industrial and social history. The original listing makes specific reference to the significance of the 1904 compound rotary beam engine, cited as the last surviving engine of its type in a waterworks, and the suction gas-pumping plant at the station, described as 'unique' (old county listing DA 139).

Previous archaeological work

4.7 Archaeo-Environment (2018) prepared a review of the history of the pumping station as part of the River Tees Rediscovered Landscape Partnership Scheme. This document has been referred to in the following section. No other archaeological work is known to have been conducted at the site.

5.0 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

5.1 The following timeline summarises key events in the history of the pumping station. It has been largely derived from the Archaeo-Environment report (2018) and is intended to place the results of the archaeological monitoring and building recording within the broader context of the overall development of the site.

Table 1: *Timeline indicating key events in the development of the pumping station*

Date	Event
1845	The Darlington Gas & Water Company (DG&WC) founded to supply the townships of Darlington, Blackwell, Cockerton and Haughton-le-Skerne with supplies of clean water and electricity from gas.
1848	The DG&WC petition Parliament to establish a Waterworks in Darlington. The site at Tees Cottage was chosen for the new water works. This was ideally situated on the bank of the River Tees, and suitably upstream from the confluence with the Skerne to prevent polluted wastewater from Darlington being drawn into the system. The DG&WC had purchased the site from the Allan family of Blackwell Grange who held the Tees Cottage and Baydale estates. George Allan agreed that the Company could take water from the Tees *ad libitum* (as desired).
1849	Plans for the west engine house, boiler house, chimney, and service reservoir were prepared by the firm Thomas Hawksley of Nottingham and the proposed works submitted for tender. Hawksley was one of the leading British water engineers of the 19th century, associated directly with the design of approximately 150 water-supply schemes in the British Isles and overseas. The firm became long-term advisors to the pumping station, overseeing the construction of the complex and its early 20th-century expansion. Four of Hawksley's plans and elevations for the proposed pumping station are preserved in the Hawksley Archive at the Science Museum. The plans vary to a degree from the final structure 'as built' but provide a good indication of the basic layout of the engine house (Figs 3, 4). The cut-through section will be useful to inform the forthcoming survey as it shows the depth of the lower levels and details of the pipework.
1849–50	The pumping station was constructed and the 29hp compound rotary beam engine installed by Gilkes, Wilson & Co of Middlesbrough. Water was pumped from the River Tees through an intake and culvert, and fed into slow sand filter beds on the site, which purified the water before it was sent through a system of pipes and service reservoirs to the town.
1851	230 customers connected to the new supply after the first year of operation. This included the Stockton & Darlington Railway, Pease's Mills and several other mills and forges, as well as domestic customers. The beam engine was required to operate only 40 hours per week to maintain supply.
1852	The newly formed Stockton, Middlesbrough and Yarm Water Company (SM&YWC) began to use the pumping station in addition to the DG&WC. This resulted in a considerable increase in demand from the burgeoning new industrial centres. In August, the construction of

	another pumping engine at Tees Cottage is discussed at the annual meeting of directors.
1853	The east engine house (Fig. 2) was erected to house the new engine. This was a mirror image of the west engine house in its layout and style, and included its own filter beds. The work was supplied by Gilkes, Wilson & Co of Middlesbrough at a total cost of £1,997, and the engine first steamed in September 1853. The engines ran concurrently to meet demand.
1854	The DG&WC sold the west engine house to the newly formed Darlington Local Board of Health for £54,000. At the same time, the east engine house and its filter beds were sold to the SM&YWC.
1864	The 1849 west engine was overhauled, followed in 1868 by the second engine. New Lancashire boilers were installed in the west engine house to replace the 1849 boilers.
1876	Passing of the Stockton and Middlesbrough Corporations Waterworks Act established the new Stockton and Middlesbrough Water Company (SMWC). This was under the joint control of the Stockton and Middlesbrough Councils. It eventually became The Tees Valley and Cleveland Water Board, one of the largest water companies in Britain.
1900	Plans discussed for the expansion of the Tees Cottage pumping station and provision of a third engine. This was intended to provide the baseload at peak times, working in parallel with the two older engines.
1904	The new engine was installed, designed by Glenfield and Kennedy of Low Glencairn Street, Kilmarnock, to a specification provided by Thomas Hawksley. Many of the parts were cast by Teasdale Bros of Darlington, although the enormous 25-ton main beam, flywheel, engine cylinders and boiler shell where commissioned from Goodfellow of Manchester. The Edwardian engine was a 140hp two-cylinder compound rotary beam engine with an underfloor spray condenser taking steam from two manually stoked Lancashire boilers running at up to 100psi. The engine drove two main pumps – a 1,900 gallon-per-minute river abstraction lift pump and a 1,700 gallon-per-minute town delivery double acting bucket and ram pump. The Hawksley Archive includes a plan and elevation of the new engine house submitted in October 1900. It provides details of the layout of the new engine as an 'as built' plan of the old west engine house (Figs 5, 6). The drawings from 1900 are much clearer than the earlier drawing relating to the 1849 documents and, although later, will prove useful in informing the forthcoming building survey, the basic layout of the 1904 engine being like that of the earlier model.
1906–7	The west engine is reported as being in poor condition, requiring a £300 investment to bring it into satisfactory repair. Instead, the Waterworks Committee engineer recommends that it be replaced by a new suction

	gas plant at an initial cost of £850 but with an anticipated long-term saving of £123 per annum. This was approved by the Board and, by the end of 1907, a Fielding and Platt 65hp gas engine was installed.
1908	The decommissioned 1849 beam engine was sold.
1914	A 220hp gas engine was installed in the east engine house. The engine was built by Richard Hornsby & Sons of Grantham, the pumps by Hathorn, Davey & Co of Leeds and the gas producer plant by Richard Hornsby and Sons. The east engine and associated pumps and boilers were sold for scrap.
1926	Major upgrade of the works involving the installation of a set of electric-powered centrifugal pumps. The old gas and beam engine were retained as a backup to the new system.
1955–72	Further expansion work took place, bringing the overall capacity of the plant to 13 million gallons-per-day.
1974	Northumbrian Water took over the pumping station and Broken Scar Wastewater Treatment site.
1979	The pumping station closed, and plans were discussed to demolish the buildings. In November 1980, the pumping station was taken over by Tees Cottage Pumping Station, a charitable trust, which continues to maintain and operate the site, running various heritage and steaming events each year.

6.0 RESULTS

Archaeological monitoring of rubble removal from flywheel pit

6.1 As outlined in the methodology, the rubble removed from the flywheel pit primarily comprised broken bricks, mortar, rotten timber and generic iron items such as brackets, nuts and bolts. These were inspected and assessed by the archaeologist onsite but not retained.

6.2 The only item recovered of interest was the base of a large brass bearing, measuring 0.8m by 0.3m by 0.4m in height (Plate 1). Two holes for securing the bearing to the masonry were situated 0.6m apart at either end. The bearing would have housed the shaft for the flywheel and been mounted on an iron plate (**32**) secured to sandstone blocks to the east of the flywheel pit by anchoring mechanism **31** (Plate 2). This is discussed in more detail in sections 6.17 and 6.18.

Plate 1: base of a brass bearing recovered from the flywheel pit.

*Plate 2: sandstone blocks to the east of the flywheel pit and iron plate **32** for mounting the recovered bearing base.*

Building recording

6.3 The building recording comprised digital photography and measured sketches and plans of each elevation within the basement area, below the level of the removed timber floor. The basement level has been split into three separate areas; the pumping chamber, flywheel pit, and southern room (Fig. 7). Each of these will be discussed separately.

6.4 All the buildings within the pumping station complex were Gothic Revival in style, constructed primarily of red brick with masonry details around window and door surrounds and a Welsh slate roof. Red brick was also used for internal dividing walls, with large square sandstone lintels supporting architectural elements and the machinery gantry. The sizes of the architectural elements varied, although the red bricks were generally of a standard size, measuring 0.23m by 0.13m by 0.08m unless otherwise stated.

The pumping chamber (Figs. 7-11)

6.5 The pumping chamber was situated to the east of the flywheel pit and originally housed two pumps; one for drawing river water and the other fresh water from the filter beds. The basement room was accessed at ground-floor level by a small hatch (**111**; 0.87m by 0.67m) in the north-eastern corner of the original sandstone flooring (**110**). The hatch and sandstone flooring were revealed only after the removal of the later timber floor. Sandstone floor **110** measured 2.75m by 1.8m and was supported underneath on iron beams (Plate 3).

6.6 The pumping chamber measured 4.7m by 1.95m, with a floor level approximately 3.45m below that of the ground floor. No machinery remained; however, the original Thomas Hawksley plans show that the space would have housed two cylindrical pumps attached to the crankshaft of the rotary beam engine, an arrangement which is mirrored in the later Edwardian beam hall to the east.

6.7 All internal walls of the pumping chamber and sub-basement (**60**) were of brick laid in English bond. The internal walls were 0.8m thick and capped by large blocks of sandstone, on top of which would be anchored architectural supports and mechanical elements relating to the beam and flywheel. The anchoring mechanisms were situated within the brickwork, accounting for the thickness of the internal walls, and were recorded in the east-facing elevation of the west wall (**30**, **31**) (Fig. 10).

*Plate 3: underside of the original sandstone floor surface (**110**) of the west engine house.*

6.8 On the north side of the pumping chamber (**50,** Fig. 7) the floor comprised an area of red brick paving (**52**), measuring 2.7m by 1.85m. The bricks were laid 'on bed' in irregular courses to form the floor surface, with two rowlock courses laid along the south and west edges. A 0.5m-wide channel (**51**), accommodating a 0.2m-diameter iron pipe, ran on a diagonal north-west to south-east alignment through the brick floor (**52**). The iron pipe descended vertically into a sub-basement chamber (**60**) at the southern limit of the brick floor (Plate 4).

6.9 At the south end of the pumping chamber was a void measuring 2.0m by 1.85m which was crossed by four iron girders (**53**) suspended above a sub-basement chamber (**60**) on large sandstone blocks (Fig. 7). The iron girders were H-profile and comprised two distinct types. The larger girders to the north and south measured 0.24m wide to the west, narrowing to 0.13m wide at the east. The smaller girders were located between

the two larger girders and measured 0.1m in width. They were separated from each other by 1.50m (Plate 5).

*Plate 4: iron pipe **51** running north-west to south-east through brick floor surface **52.***

*Plate 5: iron girders **53** over sub-basement level **60**.*

6.10 The sub-basement chamber (**60**) consisted of four brick walls, set in English bond, and a brick-paved floor in the manner of **52**. The floor was set 0.77m below **52**. A rectangular opening (**61**) was located in the south-east corner of the sub-basement chamber floor and measured 0.25m by 0.7m and 0.66m in depth. The east wall featured a squat brick archway (**63,** Plate 6) which would have originally exited through the east wall of the west engine house. A square opening (**62**) was also recorded in the south wall containing the base of a steel rod and square iron anchor plate.

6.11 The sub-basement level would have housed the water pipes supplying the pumps, exiting the space via openings **61** and brick archway **63.** The path of iron pipe **51** was obscured by the floor of the sub-basement, but it is likely that it also related to water transfer.

6.12 Brick floor **52** and the floor of sub-basement **60** were both covered by a thin, black

concreted deposit (<0.01m thickness) and debris from the removal of the timber floor above.

*Plate 6: opening **62** in sub-basement floor showing brick arch **63** in the east wall.*

6.13 The east wall of the pumping chamber (**10,** Fig. 8) measured 2.7m by 3.45m in height to the level of the original floor (**110**). The brickwork stepped out by 0.1m to form a ledge, 0.9m above brick floor **52**. Two iron pipes (**13**), each measuring 0.03m in diameter, descended vertically from the upper floor, 0.4m and 1.4m from the south wall of the pumping chamber. These probably relate to the operation of the original pump machinery. Their upper extents have been truncated by the installation of the workshop floor when the west engine house was repurposed. Two roughly square recesses (**11**, **12**) were later additions to the east wall, with the bricks crudely removed. The upper recess (**11**) was filled with a deposit of brown hemp-like material, while lower recess **12** had been utilised as a support for the modern scaffolding. Their original purpose is unclear.

6.14 The south wall of the pumping chamber (**20**, Fig.9) measured 1.85m by 3.35m in height from the iron girders (**53**) to the level of the ground floor. It formed the dividing wall between the pumping chamber and southern basement room. Architectural elements

recorded in association with the south wall also continued through to the south-facing elevation (**70**) of the southern room.

6.15 A round arch (**22**), measuring 0.54m in height and 0.41m in width, was recorded located 0.13m from the eastern limit of wall **20**. This was situated 2.1m above the height of the iron girders (**52**) and continued through to elevation **70**. At the western limit, 2.04m from the level of the iron girders, was an iron fitting (**23**) secured by two large bolts, which continued through to elevation **70.** This was set within a recess in the brickwork, which was partially obscured by extensive dry rot. As such, the complete form of feature **23** could not be seen.

6.16 Set centrally in wall **20** were the partial remains of a second, larger round arch (**21**). This had been bricked up with only the eastern portion remaining exposed (Plate 7). An iron hook within the brickwork appeared to be a later addition. The form of the archway in its entirety could be seen in elevation **70**, where it had been left open. This was recorded as feature **71.** The arch itself comprised four courses of red brick, laid header, with an overall span of 1.8m, the aperture within measuring 0.8m in width and 1.35m in height. At the base of the arch was a protruding brick ledge, 0.1m in width, that ran across the entirety of elevation **70**. The base of archway **71** sat on top of a large sandstone block, 0.3m in thickness, extending to the east end of wall **70** (Plate 8).

*Plate 7: remains of bricked up arch **21** in the south wall of the pumping chamber.*

*Plate 8: archway **71** in north wall of the southern room, southern egress of arch **21**.*

6.17 The west wall of the pumping chamber (**30,** Fig. 10) measured 4.7m in width and 3.45m in height and contained four anchoring points (**31**) to secure the flywheel and crankshaft mechanism and probably a centrifugal governor (Plate 13), as seen in the Edwardian beam hall.

6.18 A pair of steel rods (**33**), each 0.03m in diameter, and situated 0.6m apart, were sited in vertical recesses (**34**) in the brickwork and descended into two square niches (**36**, **37**), 0.23m above floor level. Above these were two large sandstone blocks (**35**), each measuring 0.4m by 1.15m, with a further block on the top of the wall. Square iron plates, threaded onto each iron rod at the base, would be tightened using a spanner against the underside of the sandstone blocks and secured with a nut to stop the machinery anchored atop the wall from moving (D. Smart *pers. comm,* Plate 10).

6.19 The tops of the steel rods could be seen protruding from the upper sandstone blocks on top of wall **30** at ground floor level (Plate 2) and were also threaded, indicating the points to which mechanical components were secured. A second anchor plate could be seen flush with the underside of the sandstone block within the northernmost niche and a third, smaller niche, containing a fourth square anchor plate located at the south end of wall **30**, 1.13m above floor level (Plate 9).

*Plate 9: anchoring mechanism **31** within west wall (**30**) of the pumping chamber, facing south-west.*

*Plate 10: detail of anchoring mechanism **31**, niche **36**, showing crank handle beneath the square anchor plate.*

6.20 The tops of the two parallel steel rods were visible in the brickwork of elevation **30**. These were set in an iron plate secured to the top of a large sandstone block (**32**). This marked the original location of the flywheel shaft and the recovered bearing (Plate 2). The size of the plate (0.8m by 0.3m) and distance between the tops of the iron rods (0.6m) corresponds with the dimensions of the base of the wheel bearing retrieved from the rubble within the flywheel pit.

6.21 The north wall (**40**, Fig.11) measured 1.85m by 3.45m in height. The brick ledge noted in relation to the east wall (**10**) continued on this side at a height of 0.9m above brick floor **52**. The main feature of the north wall was a square opening (**41**) in the brickwork on the west side. This measured 0.60m by 0.63m in height and 0.46m in depth and was capped with a sandstone lintel measuring 1.04m by 0.3m. The archway aligned with the northern visible extent of iron pipe and channel **51**, which continued under the brick flooring at the base of **41**.

6.22 A small square recess (**42**) was recorded 1.7m above floor level; situated 0.3m from the eastern edge of elevation **40**. It measured 0.26m by 0.3m and contained a hollow iron pipe 0.08m in diameter. This recess probably related to the original layout of the

pumping chamber, the pipe being cut off when the pumps were removed. The iron pipes (**13**) along the eastern elevation (**10**) have also been cut off at the top of the wall. This was undoubtedly to accommodate the new floor when the west engine house was repurposed as a lathe workshop.

The flywheel pit *(Fig. 12)*

6.23 The flywheel pit (**100**) was located on the west side of the engine house. It stretched along the west wall for 5.6m from the north-west corner of the building and measured 0.5m in width and extended down 3.6m from the level of the ground floor. At the base, the brickwork stepped inwards at the east and west ends to a width of 0.3m. The ledge along the west wall was stepped at its centre to accommodate the circular profile of the bottom of the flywheel (Plate 11).

*Plate 11: interior of flywheel pit **100**, looking north, showing internal brick ledge and stepping within the east-facing elevation to accommodate the profile of the flywheel.*

6.24 In the centre of the west wall was a sandstone lintel (2m by 0.38m) and bricked up aperture (**101**). This was the second anchor point for the flywheel shaft, mirroring the location of iron anchor plate (**32**), located in the niche on top of the west wall of the pumping chamber (Plate 12).

*Plate 12: sandstone lintel and bricked up aperture **101** marking the original location of the western flywheel bearing. Iron mount for the eastern bearing (**32**) is situated in the niche in the foreground.*

6.25 A semi-circular scar visible above the flywheel pit on the east-facing elevation (**102**, Fig. 12) marks the location of a metal fixture comprising a series of small holes. These allowed a metal rod to be inserted to manually crank the flywheel and start the beam engine (D. Smart and G. Beautyman *pers. comm*). A comparable fixture can still be seen related to the in situ 1906-7 flywheel in the surviving beam hall (Plate 13). The diameter of the semi-circular wall scar was 4.2m. indicating that the original flywheel would have measured in excess of this, likely reflecting the length of the flywheel pit at 5.6m.

Plate 13: wall fixture relating to manual cranking of the flywheel in the Edwardian beam hall. Centrifugal governor visible on the left side of the photograph.

*Plate 14: recesses **103** with iron anchor plates, at the base of the flywheel pit.*

6.26 At the base of the flywheel pit, two recesses were recorded in the brickwork of the west wall. Each measured 0.44m in width and capped by a large sandstone lintel 2.13m in

length and 0.38m wide (**103**). Within each recess was a square anchor plate attached to the underside of the sandstone lintel. This was the same arrangement seen in the east-facing elevation of the pumping chamber (**31**). The recesses were situated directly below the lintel and bricked-up aperture for the western flywheel mount (**101**) and are likely to relate to the anchoring of a second wheel bearing, now removed (Plate 14).

The southern room

6.27 The southern room within the west engine house measured 3.20m in length and 1.35m in width, running east to west to the rear of the pumping chamber, and adjoining the flywheel pit at the south end. As with the other spaces described, a stepped ledge stood proud of the brickwork along the north (**70**) and south (**90**) walls, decreasing the overall width of the rear room at its lower extent to 1.08m. Scaffolding in this area meant that it was unsafe for the majority of the rubble deposit within to be removed and therefore the floor level was not exposed. The south-facing elevation (**70**) has been discussed previously in conjunction with wall **20** of the pumping chamber.

6.28 The east wall of the southern room (**80**) featured a third round arch (**81**) of comparable construction to **71** in south-facing elevation **70**, displaying four courses of bricks, laid header, spanning 1.2m. The aperture within the arch measured 0.6m in width and 0.36m in height and would have originally provided an egress for pipework through the east wall of the west engine house. This was sealed when the new beam hall was added in the early 20th century (Plate 15).

6.29 Approximately 1.4m above the apex of arch **81** was a large sandstone block (**82**) set into the brickwork, measuring 1.2m in length and 0.3m in thickness. No other features were visible in association with **82**, although the block potentially related to a gantry supporting the pump machinery or beam as discussed above in relation to anchoring mechanism **31** (see 6.17 and 6.18). It is plausible that niches containing anchor plates relating to **82** exist below the level of the rubble still in situ in the southern room.

6.30 The south wall of the southern room (**90**) comprised uninterrupted brickwork, with the uniform ledge running the 3.2m length of the elevation, 0.9m above the upper level of the rubble deposit. Central to the elevation, located just above the level of the rubble, was a large sandstone block (**91**) measuring 1.5m by 0.47m. This sat above a square recess measuring 1.17m in width, although the full extent of the feature was obscured by rubble. Approximately 2.15m above sandstone block **91**, a number of bricks had

been removed exposing an internal iron rod within wall **90**. This was presumably part of a comparable anchoring mechanism to those recorded within the pumping chamber and flywheel pit, although the upper and lower portions of the feature were missing.

*Plate 15: archway **81** in the east wall (**80**) (west-facing elevation) of the southern room.*

7.0 DISCUSSION

7.1 Given there are no 'as built' drawings of the original Gilkes, Wilson & Co beam engine, and that none of the main components remain in situ, it is difficult to interpret the exact layout and operation of the basement rooms from the surviving architectural and archaeological features. However, the preliminary plans of the engine house, prepared in 1849 (Figs. 3 and 4) do provide a base for interpretive discussion, even though they differ slightly in layout from the final design as executed.

7.2 Notably, the survey plan of the basement (Fig. 7) closely matches the proposed layout shown on the 1849 plans, comprising southern room, flywheel pit along the west wall and a room to the east, apparently containing the pumping machinery (Fig. 13). This, together with the section through the building (Fig. 14) provides important documentary evidence as to the location and function of the features recorded during the survey and has informed the discussion below.

7.3 In addition, a great deal can also be inferred about the Victorian engine house and associated machinery from the surviving rotary compound beam engine still standing and operational in the adjacent Edwardian beam hall (Figs 2,5 and 6). This appears to have been of the same design as its predecessors in the west and east engine houses, although much larger in size and output.

Plate 16: in situ bearing securing the flywheel within the western wall of the flywheel pit in the Edwardian beam hall.

7.4 The base of the bearing, recovered from the flywheel pit during archaeological monitoring, demonstrates marked similarities with the larger examples securing the flywheel in the surviving beam hall (Plate 16). These too are anchored to large sandstone blocks, one situated within a niche in the west wall of the flywheel pit and the second atop the east dividing wall of the basement pumping chamber. The anchor mechanisms

that is used to secure the machinery to the support structure is also identical to that observed in the west engine house, comprising steel rods, attached to iron anchor plates set within square recesses and tightened to the underside of sandstone lintels using a handle, secured with a large nut.

7.5 Other anchor points recorded on top of the wall **20** of the pumping chamber appear to correspond on the 1849 elevation to the location of two Doric metal columns supporting the first floor of the west engine house, between which the arms of the original beam would operate (Fig. 7, Figs. 13 and 14).

7.6 Also relating to the original flywheel was the semi-circular wall scar **102** on the west wall of the engine house, which measured 4.2m in diameter. This was only visible above ground-floor level, with no scarring visible in the wheel pit itself. In a comparable location in the neighbouring beam hall, following the upper profile of the flywheel rim, was a curving metal fixture, fixed to the wall. This had holes along its length (Plate 13) and was used to manually crank the flywheel to start the beam engine, by inserting a metal lever into the holes and bracing it against a spoke of the flywheel to turn it (D. Smart, *pers. comm,*). The presence of and equivalent feature in the west engine house would explain wall scar **102**. The diameter of the wall scar indicates that the original flywheel had a diameter in excess of 4.2m and is comparable to the length of the flywheel pit, which measures 5.6m.

7.7 As in the west engine house, the in-situ flywheel in the beam hall is located within a pit along the west wall. The crankshaft powered by the flywheel drives the northern arm descending from the beam, which links to the supply and redistribution of water for the town and river pumps. These are situated in a basement room to the east of the flywheel pit. It is likely that the 'pumping chamber', as labelled during the current work in the west engine house, contained a similar arrangement of pumping machinery, only on a smaller scale (Plate 18).

7.8 The 1849 plans show a 12-inch pipe running north to south across the pumping chamber (Fig. 13). This would have entered the building through the square opening (**41**), beneath the ground floor entrance to the west engine house, and is shown exiting through a round arch. The measurements of this match those of arch **71** recorded in the south-facing elevation of the southern room. At this point the pipe is shown to exit the southern room via the east wall, which account for brick archway **81**, the aperture of which was substantial enough to have accommodated a 12-inch pipe. The iron pipe

still in situ (**51**) running through a channel in brick floor (**52**) is of a smaller diameter (0.2m) and follows a slight north-west to south-east alignment before descending below the floor of sub-basement **60**. This smaller pipe, and the channel excavated through brick floor **52**, appears to be a later addition to the pumping chamber and perhaps relate to the period where the Gilkes, Wilson & Co engine served as a secondary engine to supplement the larger Edwardian engine after its completion in 1907.

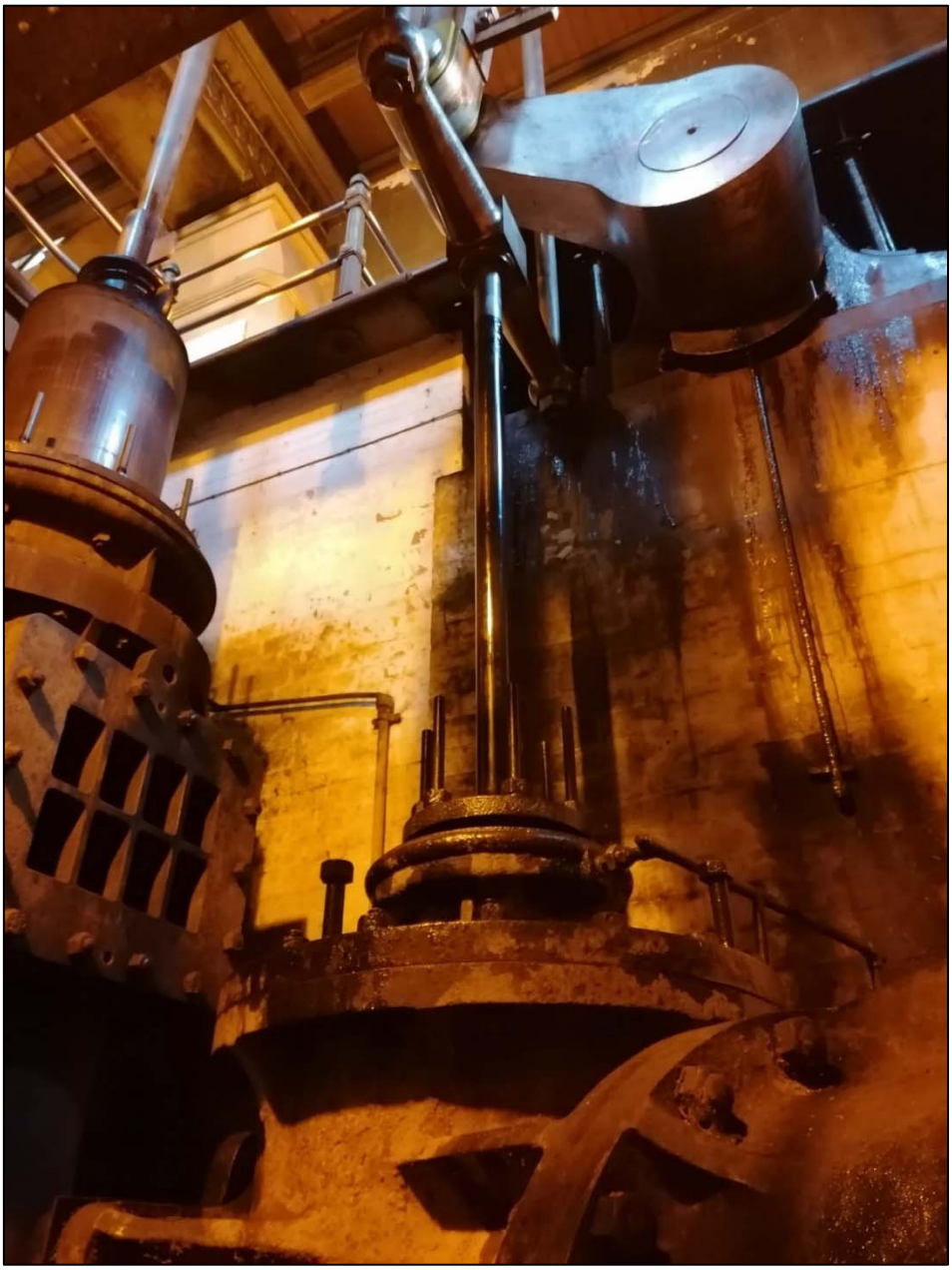

Plate 17: crankshaft (above) and 'town' (left) and 'river' (right) water pumps for the operational Edwardian beam engine

7.9 The southern room is shown on the 1849 plans to house two circular objects, probably the high- and low-pressure cylinders which would draw the steam from the boilers to drive the southern arm of the beam. The surviving examples in the neighbouring beam hall are also located to the south of the pumping chamber, beneath the southern arm of the beam.

7.10 On the 1849 plan, an opening can be seen central to the south wall within the southern room, which appears to correspond to the recess and sandstone lintel (**91**) recorded in wall **90**. The recess is shown to open into an additional room to the south containing a large tank, which is currently concealed beneath the floor and metal staircase. This could potentially be the location of a vacuum pump and condensing unit linked to the high- and low-pressure cylinders, a '19-inch pump' is documented in this location at a sub-basement level on the 1849 section (Fig. 14).

7.11 The current scheme of archaeological monitoring and building recording has provided a number of insights into the layout of the west engine house and form of the original Gilkes, Wilson & Co beam engine. The discovery of an original brass bearing and its mounting plate have confirmed the location of the flywheel crankshaft, while the recording of the basement elevations has corroborated a number of architectural elements seen on the 1849 plans pertaining to the siting of machinery and pipework from the original engine and pumps.

8.0 ARCHIVE DEPOSITION

8.1 The digital archive and report have been deposited on the Archaeology Data Service via OASIS (Entry Ref. northern1_379806)

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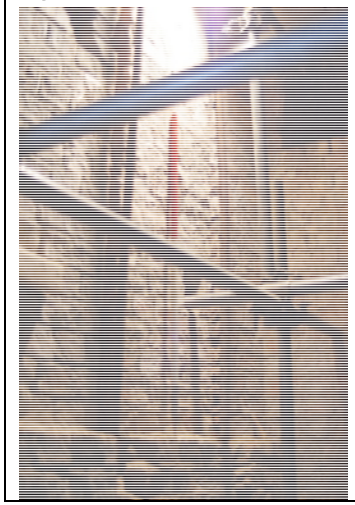
APPENDIX A

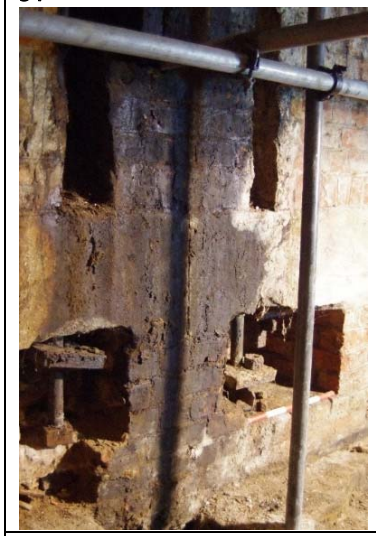
CONTEXT CATALOGUE

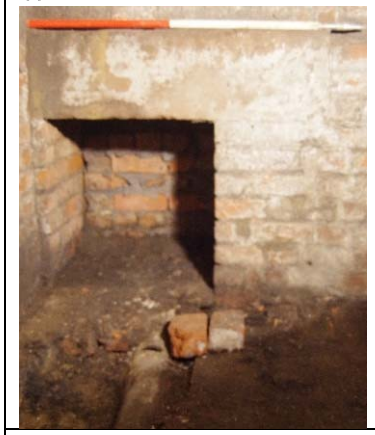
Context Number	Description	Components	Measurements	Notes
10	East wall of the pumping chamber	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **11**, **12, 13**	4.7m x 3.45m	
11 	Roughly square recess in upper portion of east wall 10, containing hemp 'matting' material		0.36m x 0.36m	Likely a later addition, after the decommissioning and removal of the original pumping machinery.
12 	Aperture in east wall 10, possibly to accommodate earlier scaffolding		0.3m x 0.3m x 0.37m depth	Bricks possibly removed to accommodate scaffolding.

Context Number	Description	Components	Measurements	Notes
13 	Two iron pipes at the southern end of east wall **10**		Pipes 0.03m diameter, in excess of 3.5m in length	Relating to the original use of the pumping chamber, the tops of the iron pipes were truncated during the repurposing of the west engine house as a workshop.

Context Number	Description	Components	Measurements	Notes
20	South wall of pumping chamber	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **21, 22, 23**	1.85m x 3.35m height	South-facing elevation numbered **70** in southern room.
21 	East section of bricked up archway	Four courses of red brick, laid header	0.52m x 0.72m	Seen complete as archway **71** within wall elevation **70**.

Context Number	Description	Components	Measurements	Notes
22 	Brick archway in the upper east corner of wall **20**		Aperture = 0.41m width x 0.64m height	Continues through to wall **70** as archway **72**. Likely housed pipework relating to the water pumping machinery.
23 	Iron fitting at the upper western corner of wall **20**	Two large iron bolts at the base, securing T-shaped fitting to the brickwork	0.5m width at base, 0.15m width at top, 0.6m in length.	Recorded on the south-facing elevation **70** of southern room as feature **72**.

Context Number	Description	Components	Measurements	Notes
30	West wall elevation of pumping chamber	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **31**, **32**	4.7m x 3.45m height	
31 	Anchoring mechanism and sandstone lintels within wall **30**, related to the flywheel	**35** Two sandstone blocks **33** Two steel rods **34** Recesses to allow for the tightening of the steel rods Three square/rectangular niches for anchor plates	1.15m x 0.4m 0.05m diameter 0.1m diameter **36** 0.63m x 0.4m **37** 0.54m x 0.4m **38** 0.3m x 0.3m	Two steel rods anchored within sandstone blocks and vertical recesses in the brickwork. These protrude through iron plate **32** on top of wall **30**. Mechanism of square iron plates and handle at the base of the rods for tightening and anchoring components of the flywheel. Three recesses in total containing four separate anchors.
32 	Iron plate above wall **30**, corresponding to anchoring mechanism **31**		0.8m x 0.3m, square holes situated 0.6m apart	Vertical sides and flat base with two square holes accommodating the tops of threaded steel anchoring rods. Anchoring point for the recovered flywheel bearing base.

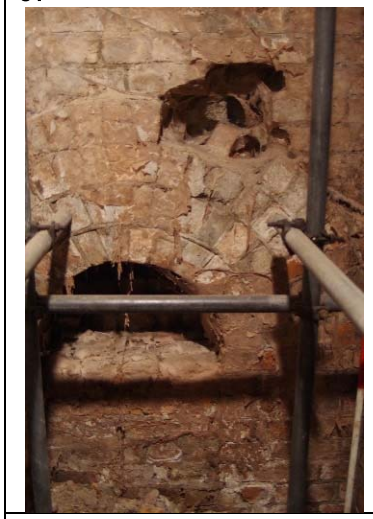
Context Number	Description	Components	Measurements	Notes
40	North wall of pumping chamber	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **41**, **42**	1.85m x 3.45m height	
41 	Sandstone lintel-capped square opening in the lower left-hand corner of wall **40**	Sandstone lintel Brick alcove	1.04m x 0.3m 0.63m x 0.60m x 0.46m depth	Square opening that would have originally held a 12-inch pipe, as shown on the original 1849 plans. Pipe **51** and flooring **52**, along with rear brickwork within the archway are later additions.
42 	Recess at the east end of wall 40, containing 80mm diameter iron pipe	Recess Iron pipe	0.26m x 0.26m 0.08m diameter	Crude execution of the recess indicates that this was not an original feature of the west engine house and has been inserted after the initial construction of the pumping chamber. Possibly relates to the later usage of the original engine as a reserve after the implementation of the larger Edwardian engine in the beam hall.

Context Number	Description	Components	Measurements	Notes
50	Upper floor level of pumping chamber	Channel containing iron pipe **51**, Red brick floor (0.23m x 0.13m x 0.08m) **52**, Iron girders **53**	1.85m x 4.7m	
51 	Iron pipe set within channel in brick floor **52**	Iron pipe Channel	0.2m diameter x >3m length 0.5m diameter x 2.7m length x 0.2m depth	Iron pipe and brick channel appear to have once been underneath floor **52**. Both the pipe and channel and brick floor are later additions to the engine room, presumably after the original 12-inch diameter iron pipe, seen on the original 1849 plans, was removed.
52 (For photo, see **51**)	Brick floor covering northern half of the pumping chamber floor	Red brick (0.23m x 0.13m x 0.08m), laid flat in irregular courses. 2 rowlock courses along the southern and western edge, laid on edge, stretcher	1.85m x 2.7m	A single course of bricks, laid flat across the northern extent of engine room floor **50**, presumably on top of an original floor surface.
53 	Four iron girders ent to clientforming the southern half of the pumping chamber floor level. These are supported on large sandstone blocks	H-profile iron girders Outer girders Inner girders Sandstone blocks	2m x 1.85m 0.13m – 0.24m width x 0.35m thickness 0.1m width x 0.35m thickness 0.3 – 0.5m x >1m length	The girders presumably supported the pump machinery and allowed access for the associated pipework into the sub-basement.

Context	Description	Components	Measurements	Notes
60	Sub-basement level below iron girders and sandstone blocks.	Red brick walls and floor (0.23m x 0.13m x 0.08m) Floor of red brick laid flat. Four walls, 5 courses, English bond	1.85m x 2m 1.85m x 2m 0.45m height, 2m and 1.85m width	
61 	Rectangular opening in south-east corner of brick sub-basement floor	Red brick (0.23m x 0.13m x 0.08m) Brick arch **63**	0.25m x 0.7m x 0.66m depth	Rectangular hole in the sub-basement floor containing brick arch 63. Perhaps an egress for waste water.
62 	Square recess in southern wall of sub-basement containing anchoring mechanism	Recess Iron mechanism consisting of a steel rod, square plate and securing nut	0.4m x 0.3m	Anchoring mechanism related to the tip of a steel rod protruding from the top of wall **20**.
63 (For photo see **61**)	Brick archway in the east wall of **61**	Four courses of brick laid header, on end.	0.25m x 0.75m x 0.66m height	See **61.**

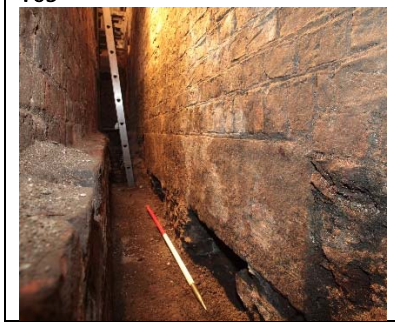
Context	Description	Components	Measurements	Notes
70	North wall of southern room. South-facing elevation of wall 20	Red brick (0.23m x 0.13m x 0.08m). English bond. Features 71, 72, 73	2.70m x 3.5m (height from in-situ rubble deposit)	
71 	Brick archway visible in elevation 70. Constructed on top of a large sandstone block	Red brick archway, 4 courses, bricks laid header, on end. Sandstone block	1.8m width x 1.83m height. Aperture 0.8m width x 1.35m height 0.3m thickness >1.5m length	Southern egress of bricked up arch 21 in the south wall (20) of the pumping chamber. Outlet for 12-inch iron pipe shown on the 1849 plan.
72 	Southern egress of brick archway 22 within wall 20/70	Red brick, apex of archway comprises single course of brick laid header, on end	0.64m x 0.41m	See 22.

Context	Description	Components	Measurements	Notes
73 	South-facing side of iron fitting 23			Southern side of iron fitting 23, obscured by dry rot. Function unknown.

Context	Description	Components	Measurements	Notes
80	East wall of southern room	Red brick (0.23m x 0.13m x 0.08m). English bond. Features 81, 82	1.35m x 3.5m (height from in-situ rubble deposit)	
81 	Squat brick archway in wall 80	Red brick archway, 4 courses, bricks laid header, on end.	1.2m width x 0.85m height. Aperture 0.6m width x 0.36m height	Squat brick archway, shown on original 1849 plans as western egress for 12-inch iron pipe after it exited the pumping chamber via archway 71.
82	Sandstone lintel towards the top of wall 80	Sandstone lintel	1.2m x 0.3m	Sandstone lintel towards the top of wall elevation 80, function unknown. Surmounted by three courses of red brick, English bond and three rough courses of bricks relating to the later floor of the lathe workshop.

Context	Description	Components	Measurements	Notes
90	South wall of southern room	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **91**, **92**	3.2m x 3.8m height (from top of in-situ rubble deposit.	
91 *No photos due to poor lighting*	Sandstone lintel and top of square recess in wall 90	Sandstone lintel Recess	1.5m x 0.47m 1.17m x 0.2m (height from top of in-situ rubble deposit)	This feature possibly corresponds to an opening shown within the south wall on the 1849 plans, leading to a further southern room which is currently concealed under the existing flooring and rear staircase.
92 *No photos due to poor lighting*	Recess in the brickwork at the top of wall **90** containing square-profile iron bar	Recess Iron bar	0.3m x 0.26m 0.05m diameter	The iron bar is integral within the original brickwork and is probably related to an anchoring mechanism for machinery, such as those documented within the pumping chamber (**31**). The niche for the anchoring plate is likely located below the level of the rubble within the southern room.

Context	Description	Components	Measurements	Notes
100 	Flywheel pit	Red brick (0.23m x 0.13m x 0.08m). English bond. Features **101**, **102**, **103**	5.6m x 0.5m width x 3.6m depth	The profile of the flywheel pit steps inwards from both the west and east elevations to a width of 0.3m, approximately 0.4m above the base. The western ledge has in turn been stepped to accommodate the circular profile of the flywheel.

Context	Description	Components	Measurements	Notes
101 	Bricked-up aperture and sandstone lintel	Ten courses of re-used brick, roughly laid in English bond. Sandstone lintel	1.8m width 1.1m height at apex 2m x 0.38m	The original location for the western flywheel bearing which would have sat atop the sandstone lintel. Presumably the metal fittings were removed when the original beam engine was decommissioned and the niche bricked up.
102 See Figure 10	Semi-circular wall scar	Scarring on the upper brickwork above the flywheel pit	4.2m diameter	Scarring likely related to fixtures to facilitate manual cranking of the flywheel using a lever. As seen fixed to the wall behind the flywheel in the neighbouring Edwardian beam hall.
103 	Two square recesses and sandstone lintel	Sandstone lintel Recesses	2.13m x 0.38m 0.44m width x 0.20m height	Each recess contained an iron anchoring mechanism as seen in the pumping chamber (**31**). Potentially the anchoring points for the western flywheel bearing.

Context	Description	Components	Measurements	Notes
110	Original sandstone floor of west engine house	Angular sandstone flagstones	2.75m x 1.8m	Angular, square flagstones, supported beneath by iron girders.
111	Wooden access hatch to the pumping chamber, located in NE corner of floor **110**	Wooden surround and hatch	0.87m x 0.63m	Wooden access hatch.

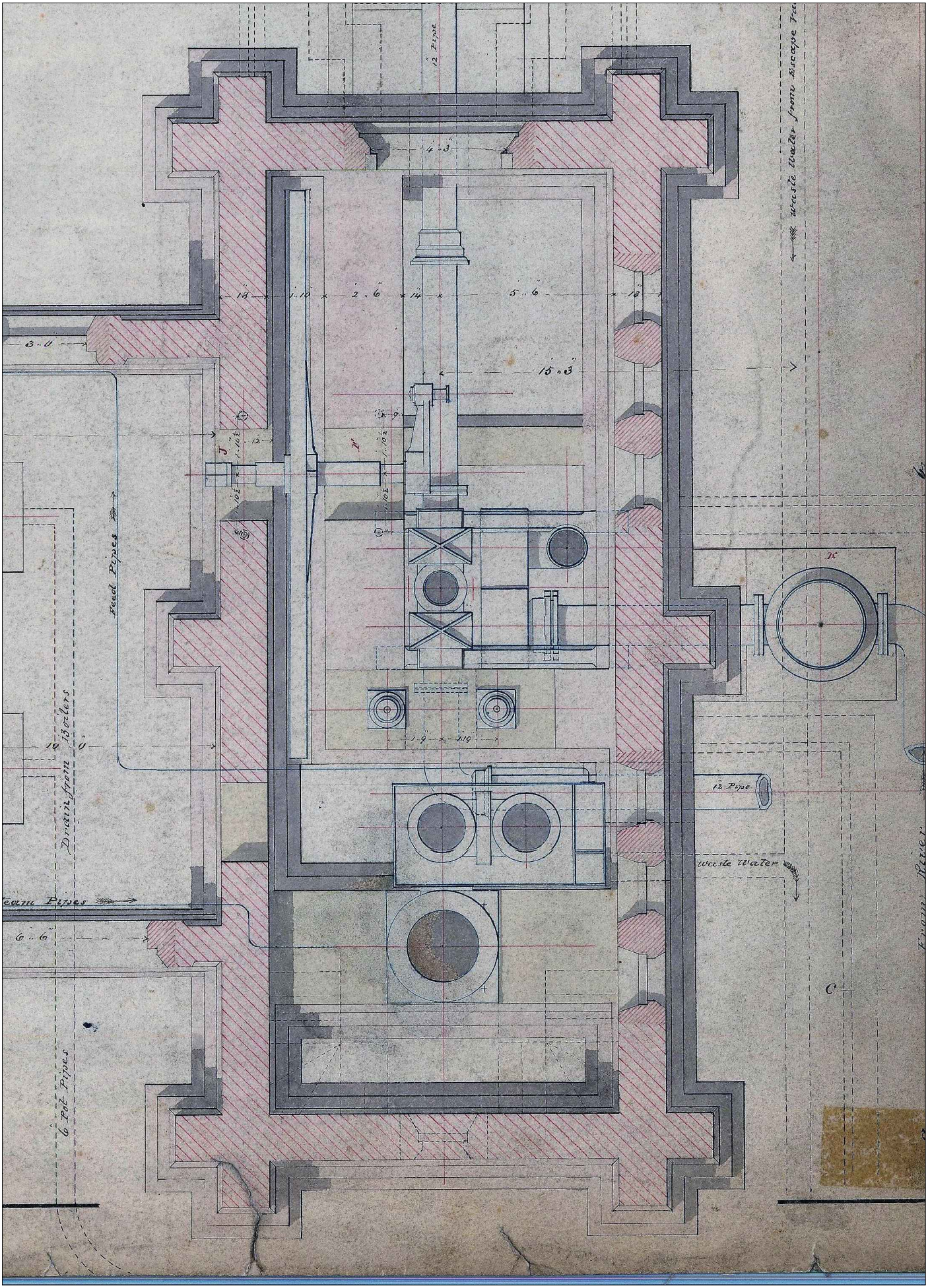


Figure 3

Tees Cottage Pumping Station: plan of proposed west engine house, 1849 (c) Science Museum

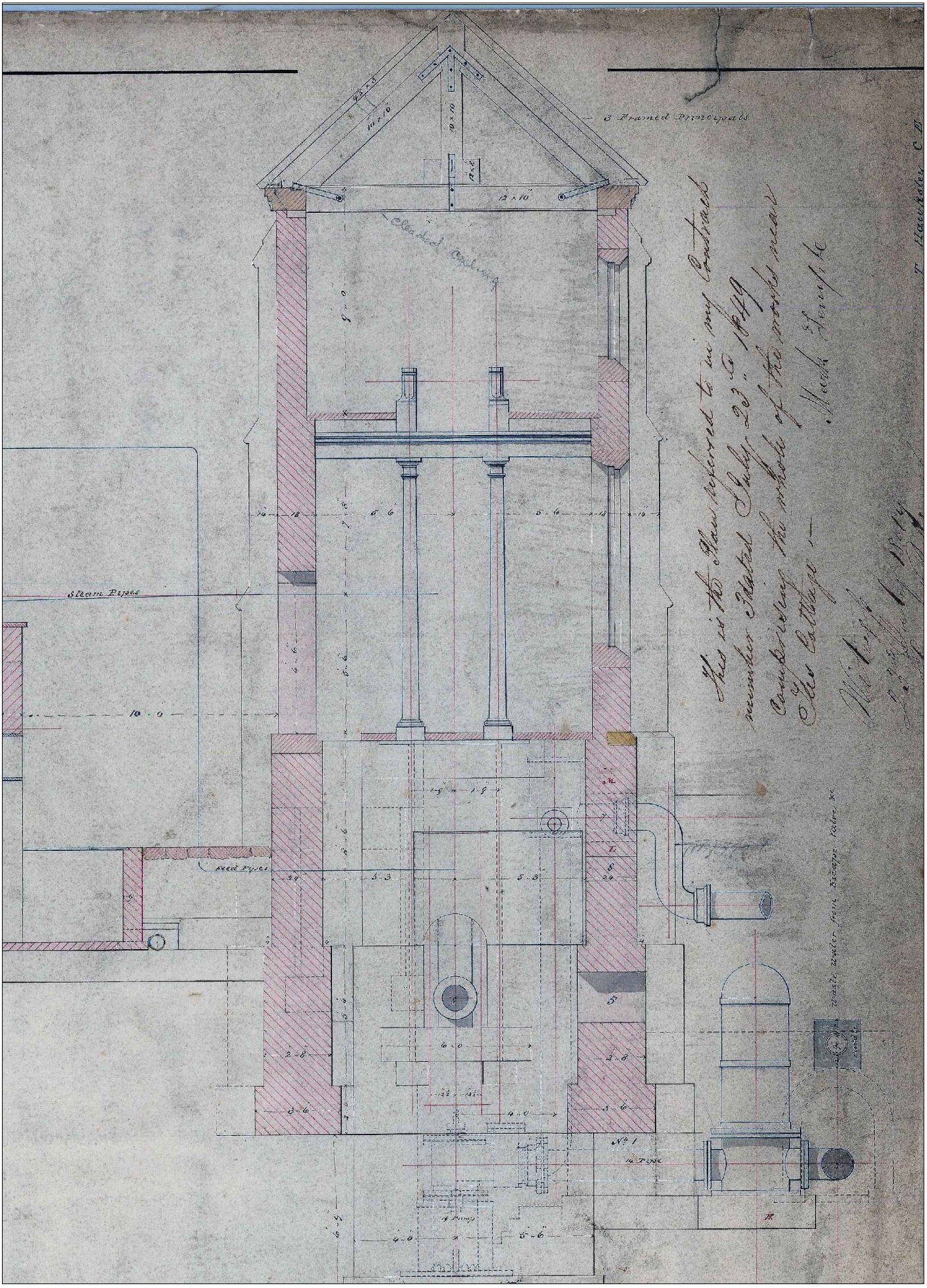
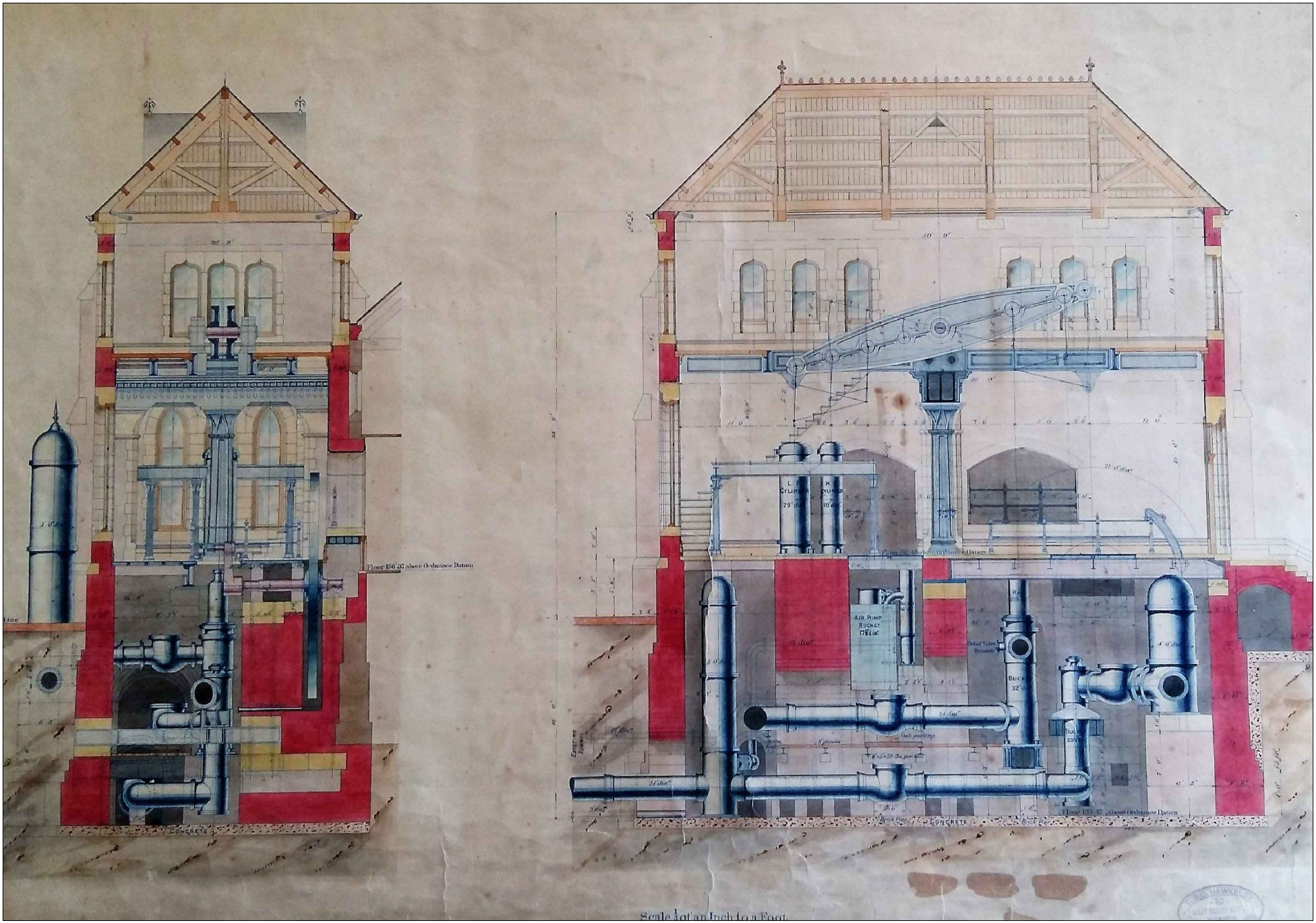
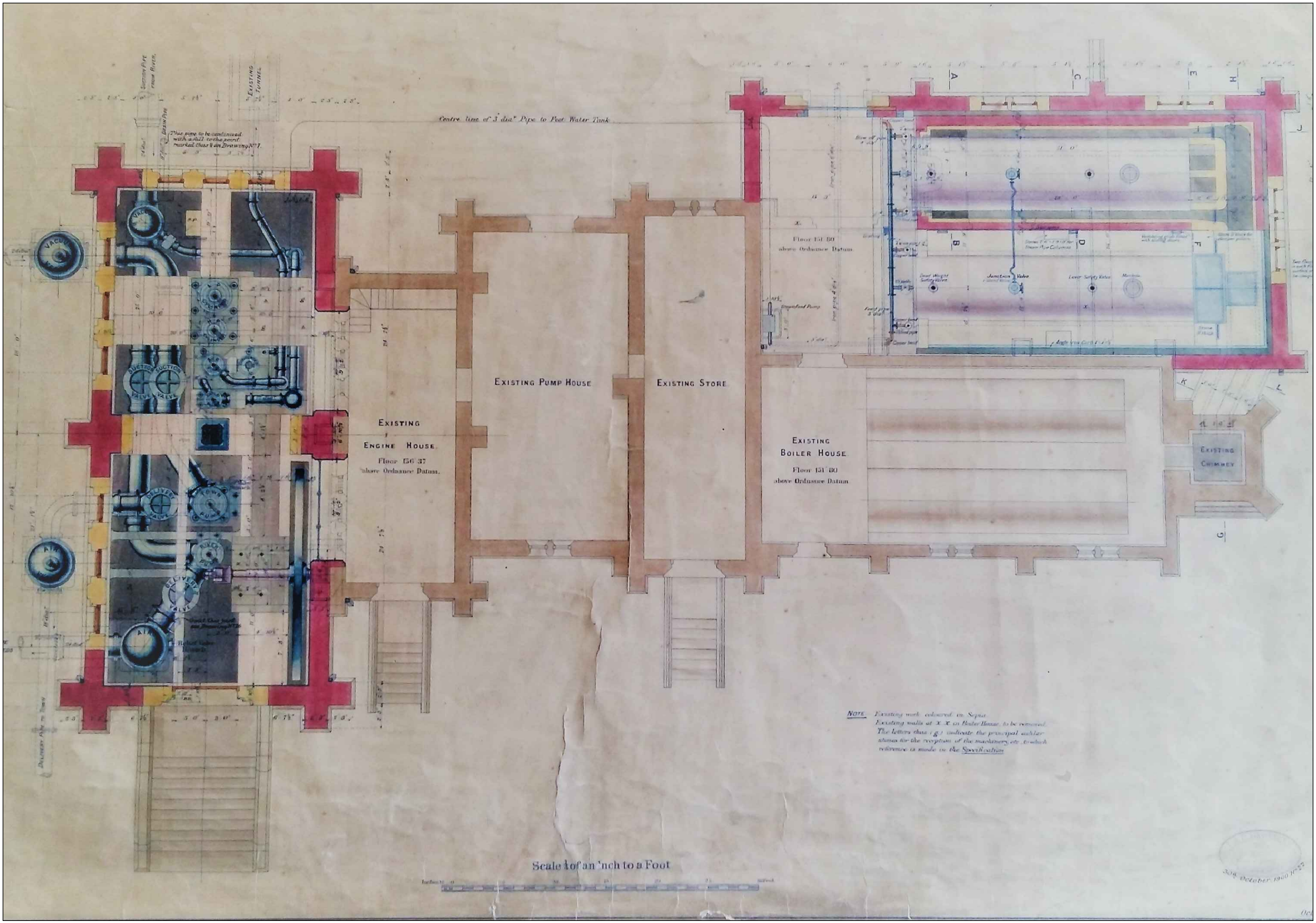


Figure 4

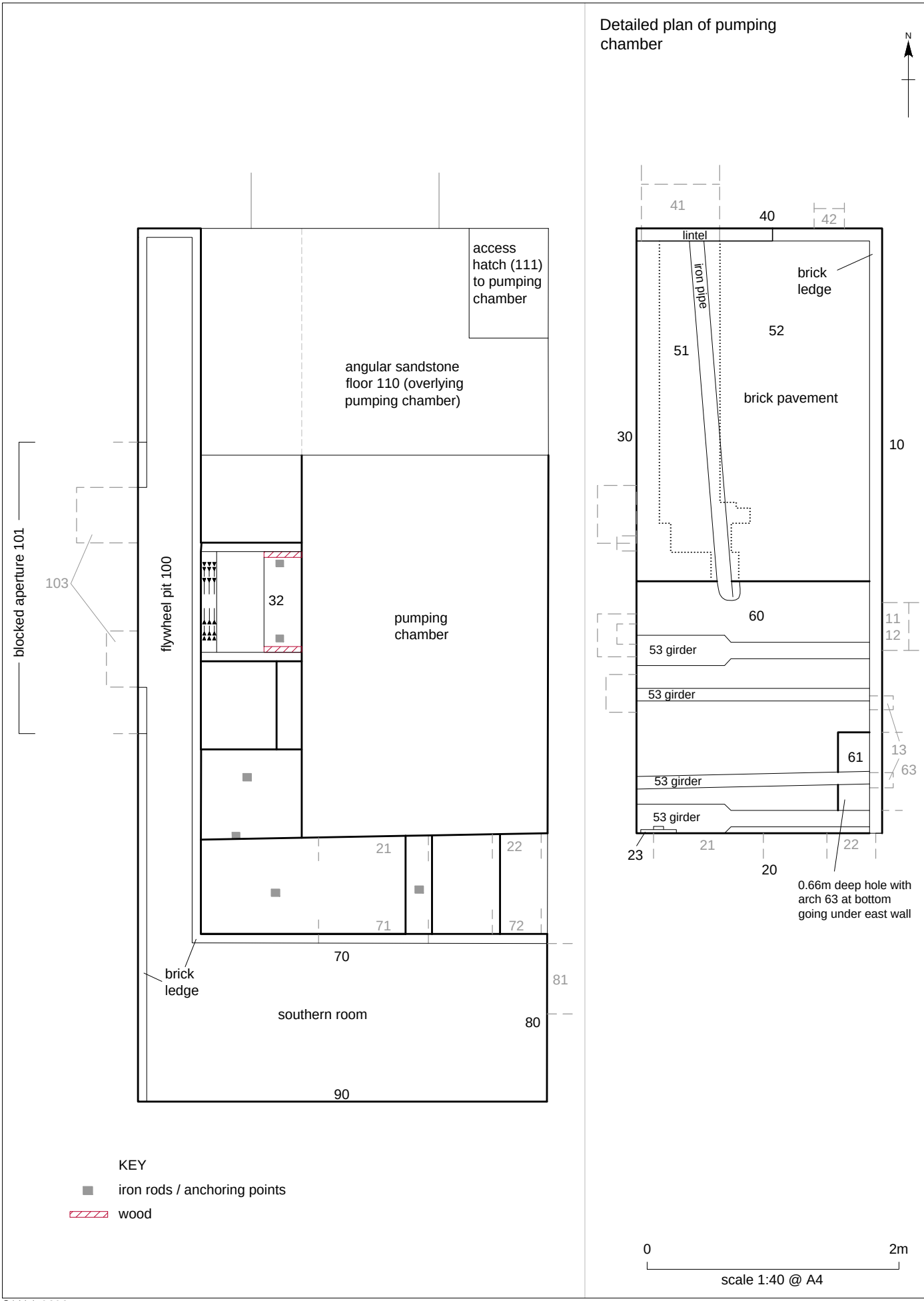
Tees Cottage Pumping Station: section through proposed west engine house, 1849 (c) Science Museum



Tees Cottage Pumping Station: 1900 section through the Edwardian beam engine from the Hawksley Archive (c) Science Museum **Figure 5**



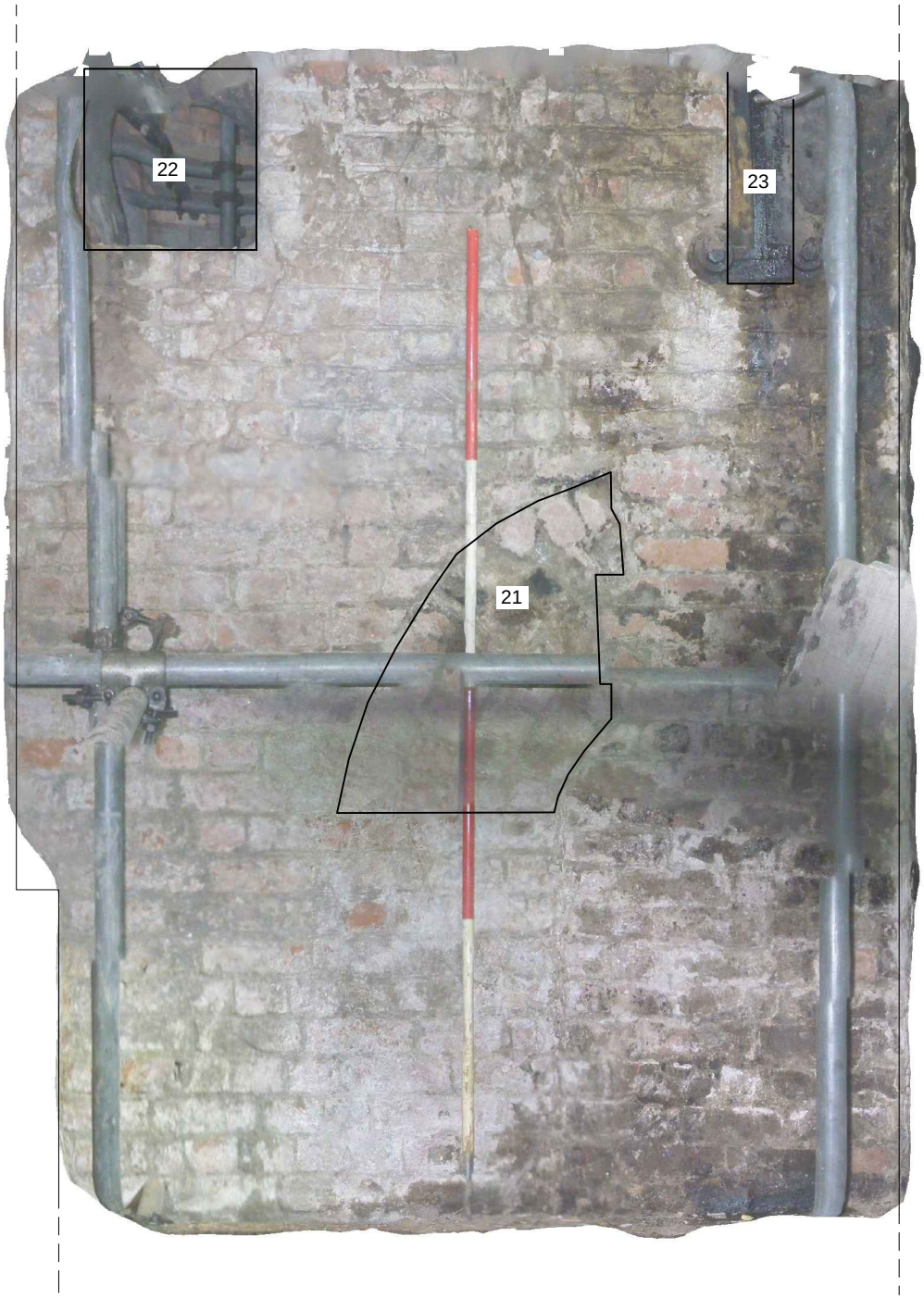
Tees Cottage Pumping Station: 1900 plan of the Edwardian beam engine from the Hawksley Archive (c) Science Museum *Figure 6*



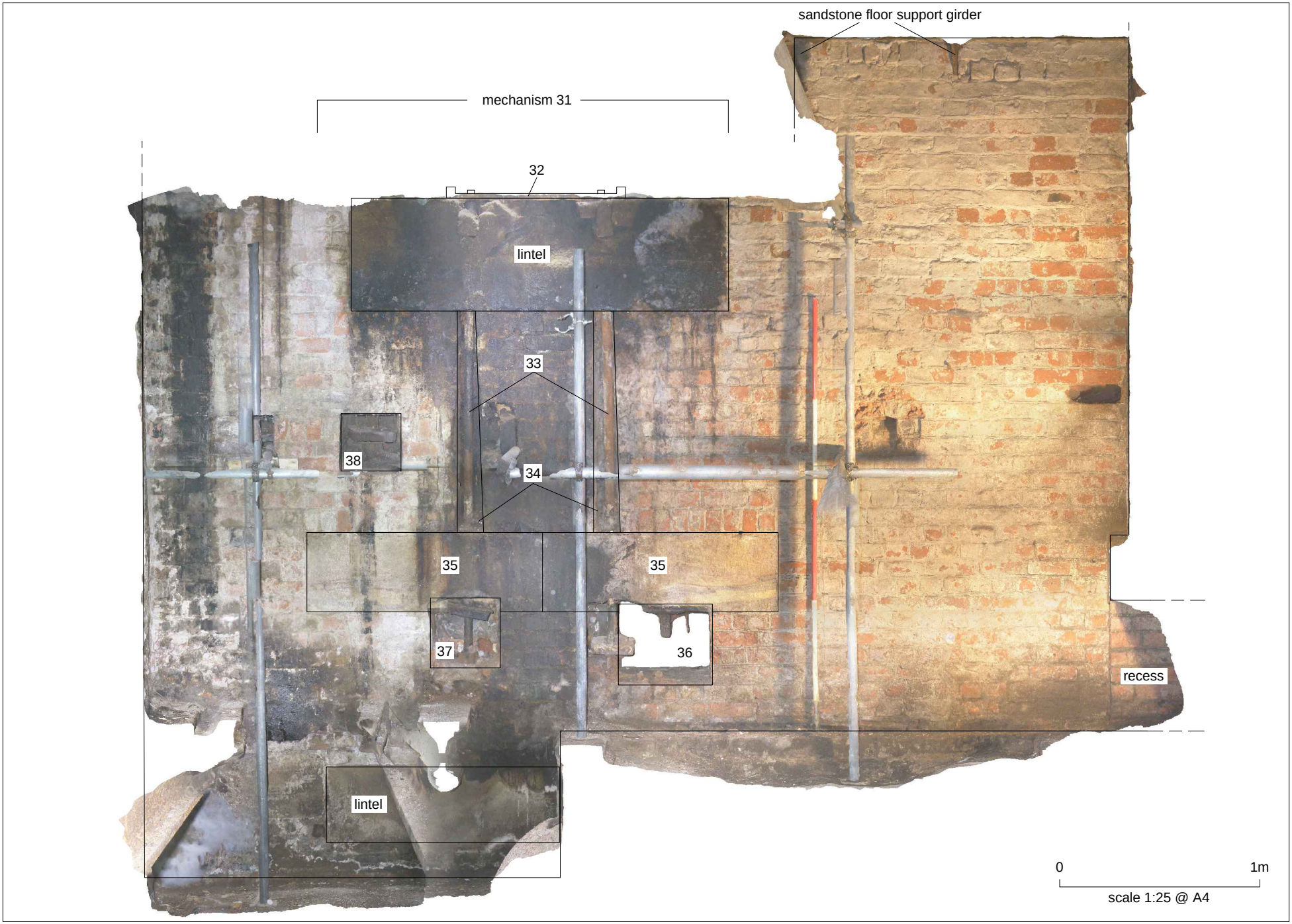
Tees Cottage Pumping Station: plan of the west engine house *Figure 7*

Tees Cottage Pumping Station: pumping chamber east wall (10)

Figure 8

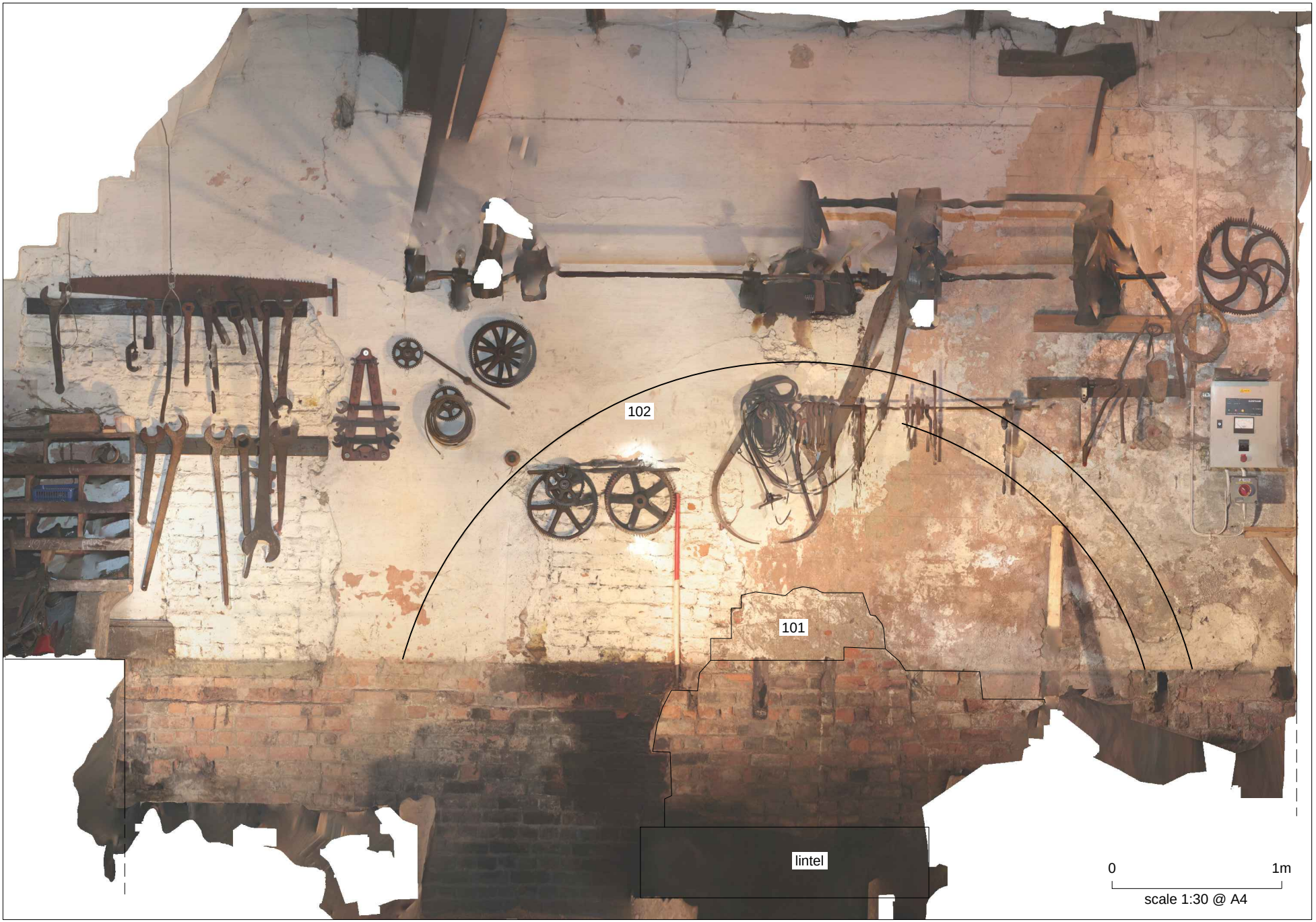


Tees Cottage Pumping Station: pumping chamber south wall (20) *Figure 9*



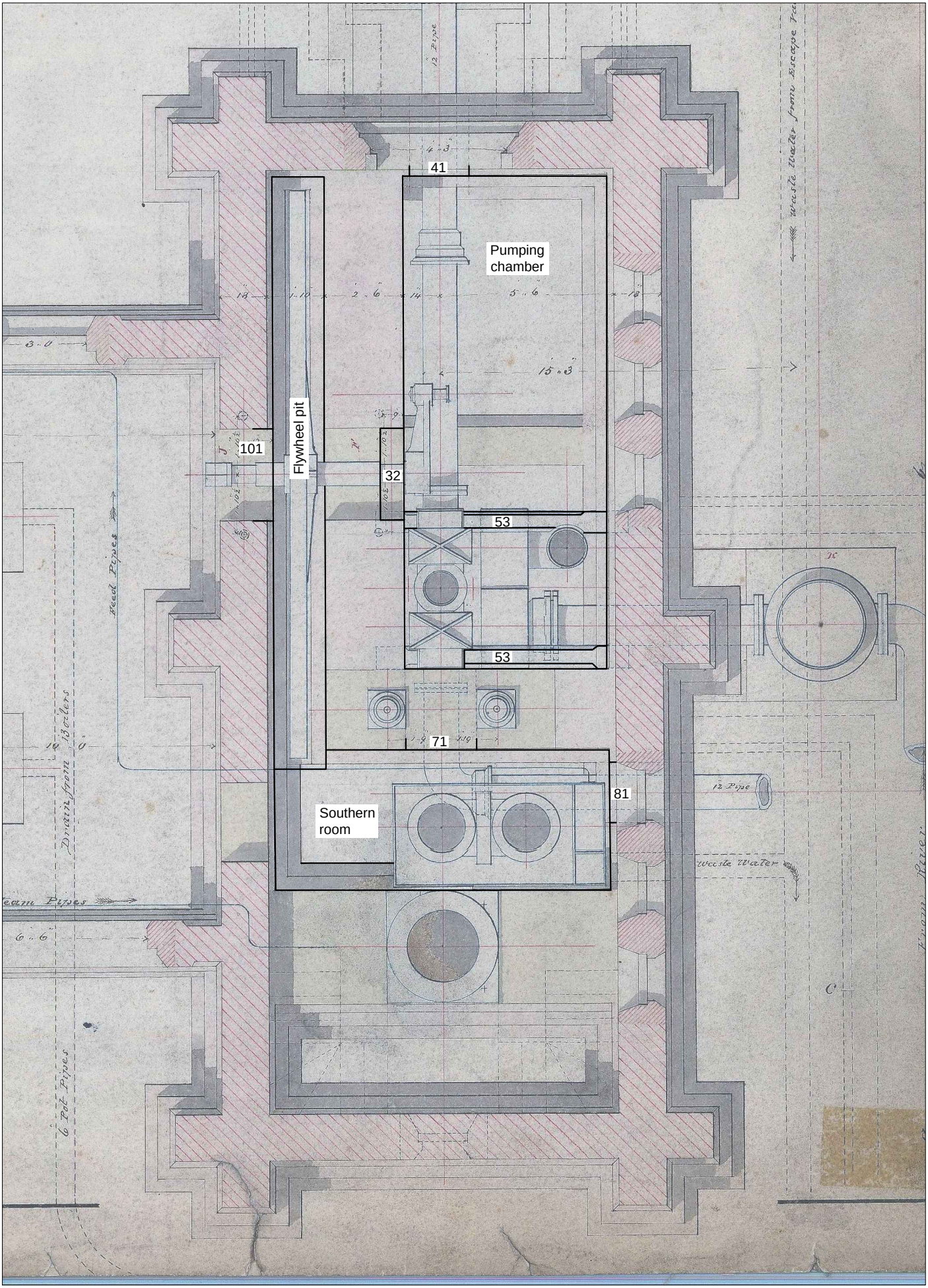
Tees Cottage Pumping Station: pumping chamber west wall (30) showing feature (31) *Figure 10*

Tees Cottage Pumping Station: pumping chamber north wall (40) *Figure 11*



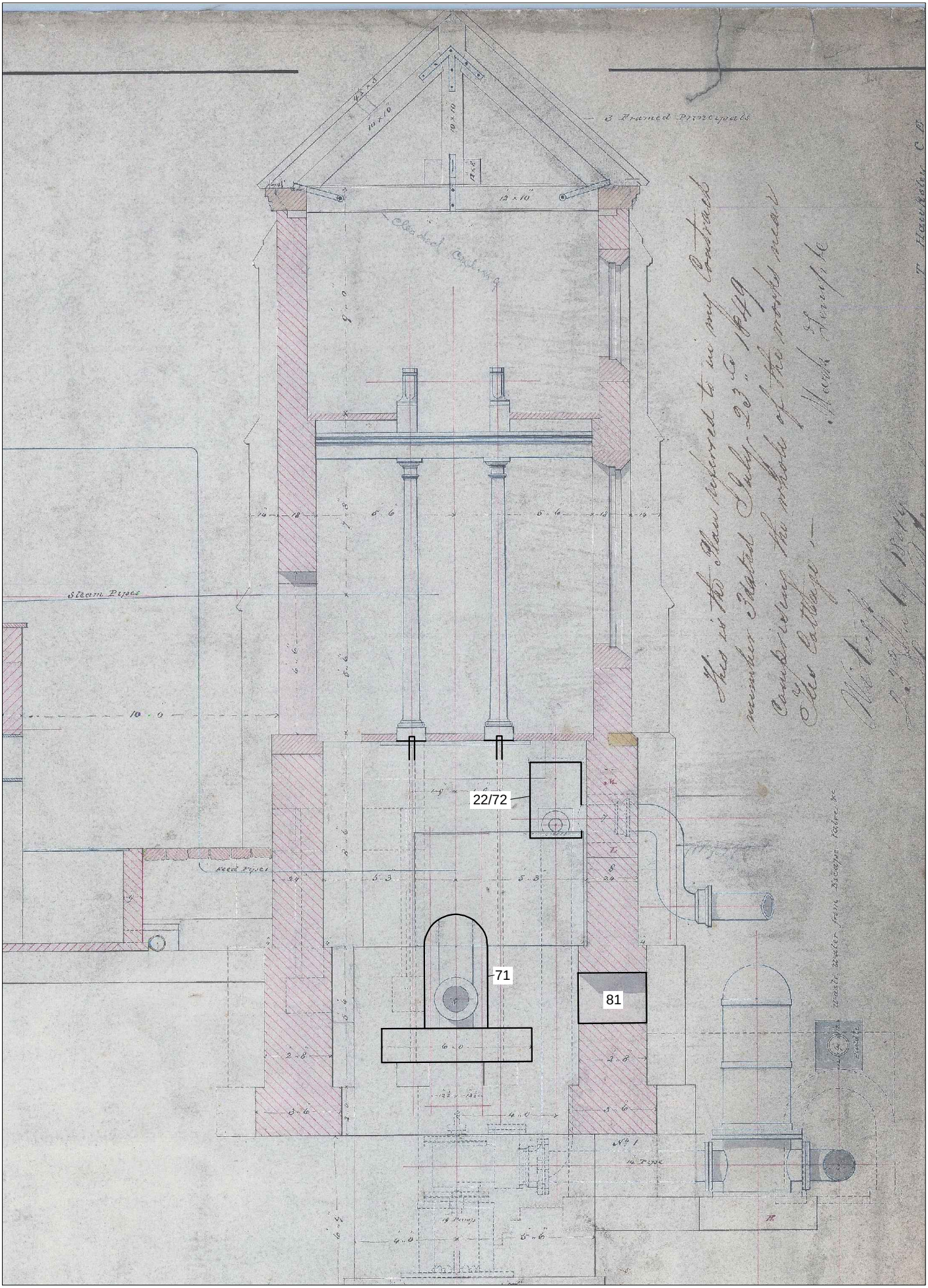
Tees Cottage Pumping Station: upper west wall of flywheel pit

Figure 12



Tees Cottage Pumping Station: 1849 plan of proposed west engine house, overlain with features recorded in current survey (c) Science Museum

Figure 13



Tees Cottage Pumping Station: 1849 section through west engine house, overlain with features recorded in current survey (c) Science Museum *Figure 14*