

FIELDWORK AT THE KILLHOPE BUDDLE HOUSE
KILLHOPE LEAD MINING MUSEUM
COUNTY DURHAM

REPORT ON AN ARCHAEOLOGICAL EVALUATION
CARRIED OUT IN NOVEMBER 2012



by

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SUMMARY

A programme of archaeological evaluation trenching and historic buildings recording was conducted in November 2012 at the Buddle House, the most easterly existing building of the early modern industrial complex at Killhope, now a lead mining museum.

Building recording showed the buddle house to be a complex structure, though largely rebuilt from mid-wall height. Excavations carried out in the building interior provided evidence for good survival of sub-surface wooden features in three locations and it is considered likely that other such remains survive elsewhere within the building.

In Trench 1 were revealed the remains of what is best interpreted as a small convex buddle, connected to an over-head launder, the supports for which were excavated in Trench 2, while in Trench 3 remains best interpreted as the substructure and drainage arrangements for a concave buddle were excavated.

The suggested presence of two different kinds of buddle, if correct, is not entirely surprising given the date of construction of the buddle house, in 1877, only a few years after the first publication of plans for a concave buddle. It is possible, therefore, that it was decided to experiment with the newer type of buddle whilst installing the older type as security. It may also have been found that the two types worked well in tandem, with one being used, effectively, as a kind of Classifier and the second refining its products. A further, speculative suggestion is that the remains found in Trench 1 represent the partial remains of a convex buddle rather larger than the excavated remains suggest, which pre-dates the construction of the buddle house. Further excavation on the site may allow further refinement of these interpretational scenarios.

In addition to the remains of buddles, there sections of well-preserved box drains were uncovered in two trenches and is considered likely that these and other box drains survive virtually intact within the floor of the buddle house. The floor surface within which these surviving wooden features are located is made from an earthen deposit containing shale and other waste materials probably derived from the early workings of the site, which has been used to provide a level platform for the working area of the buddle house.

It is recommended that the remains of the convex buddle uncovered in Trench 1 should be fully exposed by excavation in order to determine its full size and the nature of all its components, and that it should be preserved by controlled air drying in order to allow its eventual display. It is recommended that the remains of the putative concave buddle uncovered in Trench 3 should be further exposed and recorded if significant ground disturbance is proposed in that area, or if sub-surface hydrological conditions are likely to change as a result of drainage works, but the condition of these remains does not merit their permanent display.

1. INTRODUCTION

1.1 Location and Purpose of Evaluation

A programme of archaeological evaluation trenching and historic buildings recording was conducted in November 2012 within the Buddle House, the most easterly existing building of the early modern industrial complex at Killhope, now a lead mining museum located in the north-west corner of County Durham (NGR NY 82699 42975) in upper Weardale, close to the border with Cumbria at Nenthead.

The Killhope complex, legally protected as a Scheduled Ancient Monument owned and managed as the North of England Lead Mining Museum by Durham County Council, is one of the most popular visitor attractions in the North Pennines, with a range of facilities and attractions including working components of a lead mine and ore processing facility, as well as display areas. Plans are currently being developed for the redevelopment of parts of the site, including the former Buddle House, currently used for general storage, as an education room. Prior to the evaluation, weathered timbers protruded from the earthen floor of the Buddle House close to its east door, suggesting that original machinery may survive buried beneath the present ground surface. The current evaluation, which is subject to Scheduled Monument Consent granted by English Heritage, has been designed to establish whether, and, if so, in what state, the remains of machinery associated with the buddling process survive in the earthen floor of the building. The evaluation is thus likely to have a significant impact upon the nature of developments permitted within the Buddle House and is, therefore, of key importance to the future management of the site, as well as being of considerable research interest in its own right.

The evaluation consisted of the excavation of three trenches located strategically within the interior of the building, and was directed by Richard Carlton of the Archaeological Practice with assistance from Paul Frodsham (North Pennines AONB Historic Environment Officer) and Marc Johnstone from the Archaeological Practice team. Additional advice was provided throughout the course of excavation by Mike Bouse, current manager of the North of England Lead Mining Museum, and Ian Forbes, its former manager. Rob Young, English Heritage Inspector of Monuments arranged the SMC for the work and inspected the excavations immediately following the completion of work.

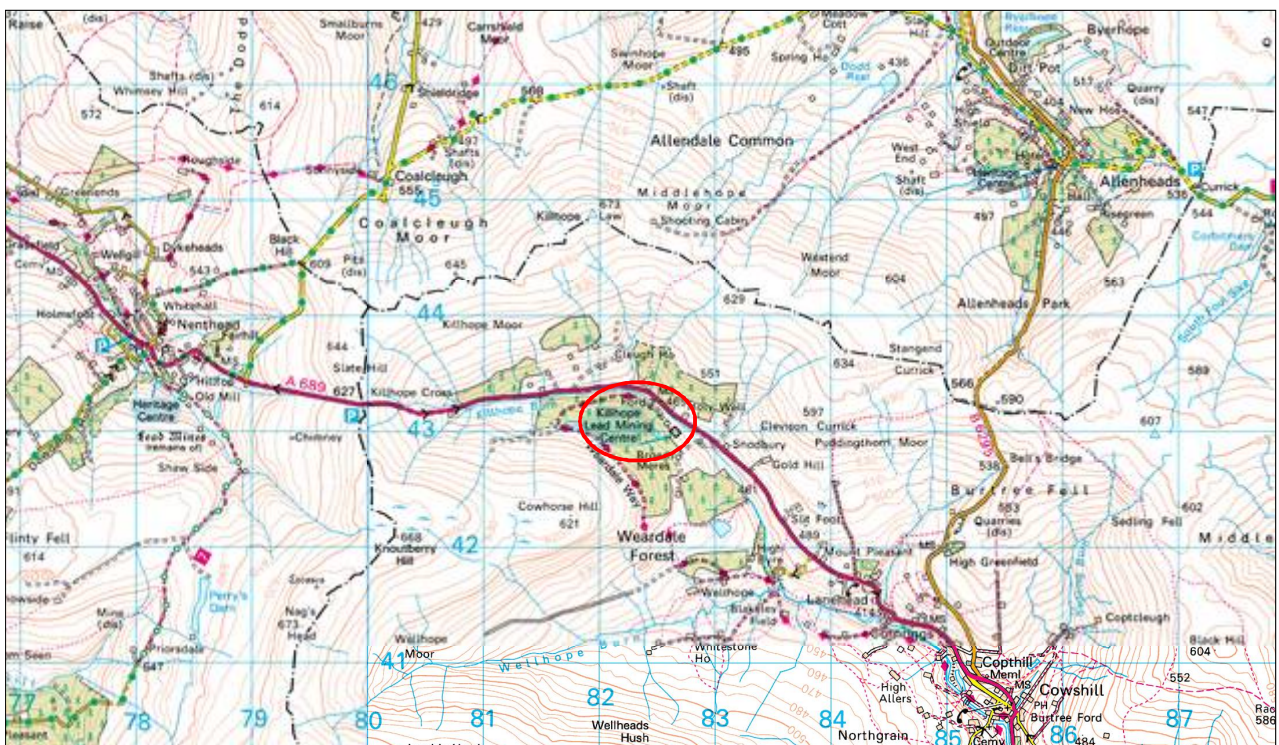
In addition to the investigation of the floor, a detailed floor plan of the building was produced as part of an historic buildings survey undertaken by Peter Ryder, who also advised volunteers on the production of elevation plans using analytical observation and standard, manual surveying techniques.

1.2 Cultural Heritage Background

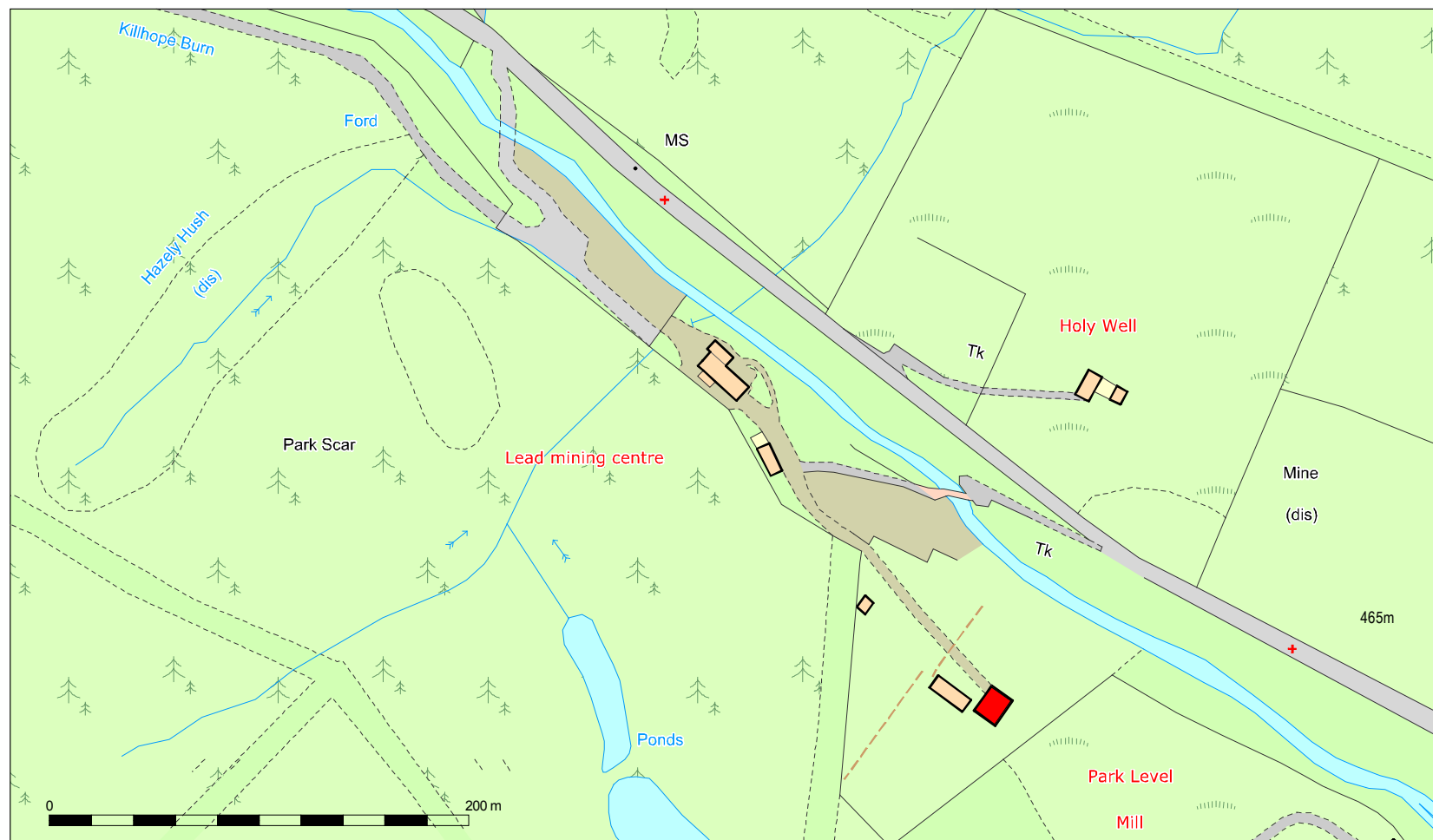
The early history and prehistory of human activity in upper Weardale is attested by flint scatters and finds such as the Heatheryburn Bronze Age collection of gold and other objects, while two altars to Silvanus and a handful of coins confirm a Roman presence, although the extent to which the Romans exploited the lead ores of the upper valley is unknown. Whitley Castle, a Roman auxiliary fort overlooking the South Tyne Valley to the north of Alston in



Illus. 01: Map showing the location of Killhope (circled in red) in north-east England.



Illus. 02: Map showing the location of Killhope (circled in red) at the northwestern border of County Durham with Cumbria (to the west) and Northumberland (to the north).



Illus. 03:
 Map showing the location of the Buddle House (infilled red) at the south-east end of the Killhope Lead Mining Museum complex.

Cumbria, has long been thought to have been positioned to control the lead resources of the area, and Hadrian's Wall divides the northern fringe of the North Pennine lead field, from the less mineral rich Northumbrian hills to the north. However, it is likely that human settlement and activity in the very uppermost part of the valley was at a low-level, mainly seasonal or intermittent, for most of the period since the last Ice Age, although the small towns of Stanhope and Wolsingham lower down the valley appear to have existed as Anglo-Saxon settlements before the Norman Conquest, following which part of Weardale, between Eastgate and Westgate, became a forested hunting preserve of the Bishops of Durham,¹ with the upper dale later farmed as extensive cattle ranges, or vaccaries. In the post-medieval period the precariousness of life in such an environmentally marginal area was made even more tenuous by raiding from the Borderlands to the north: a ballad, *The Rookhope Ryde*, describes in some detail how in 1569 Weardale men drove out a party of cattle-raiders from the Tyne Valley.

Along with extensive stock farming, the most significant economic activity pursued in the upper valley from at least the immediate post-Conquest period, but probably much earlier, was lead mining - silver mines are recorded from the nearby area of Alston Moor in the 12th century, but there is evidence that the Romans mined lead in the region and continuous low-level production might be assumed thereafter, although Bede, writing at Jarrow, mentions only lead miners from Swaledale to the south. The Bishops of Durham – who owned the mineral rights to the valley until recent times; the miners and companies of the industrial period being lessees - exploited lead and silver deposits in Durham's dales; in Henry II's reign lead was shipped from South Tynedale and from at least 1400 German metallurgists introduced new lead extracting skills to the North. In the 16th century Sir William Bowes owned extensive lead mining interests in Teesdale and Weardale and operated a smelting mill but it was not until the late 17th century that the industry expanded. The Blacketts, a Tyneside coal owning family were mining lead in the Allendales near Hexham in 1684, and a few years later they leased land in Weardale from the Bishop of Durham. The London Lead Company was mining around Alston from 1696 and in the following century extensively mined in the Derwent Valley, Weardale and Teesdale.

Lead mining in Weardale, part of the much wider North Pennine lead field, reached its greatest levels during the 18th and 19th centuries, particularly in the period from about 1750 to 1850, when the London Lead and Beaumont Companies dominated mining throughout the region and the North Pennine lead field was arguably the most important in the world. The industrial revolution had stimulated the demand for lead for use in roofing, piping, casting, building materials, lead shot, paint-bases and glazing, and lead works began to open on Tyneside in places such as Elswick, Blaydon, and Byker Bridge, with Newcastle the main point of export for lead from the Durham dales, carried there by teams of Galloway ponies along packhorse routes. The Carriers' Way north from Killhope, where it terminates - alongside the A689 Alston to Durham road, the highest "A" road in England where it breasts Killhope Cross, on the county boundary - was principally one of the main commercial arteries for the lead trade. It leaves Killhope mine as a footpath, climbing up through the woods before changing to bridleway status (its correct designation) at the county boundary, joining the Allenheads-Coalcleugh road then crossing this road and continuing towards Allenheads and Dukesfield.²

¹ A Royal Charter of 1109 granted to the Bishop of Durham the Forests between Tyne and Tees, the Forest of Weardale being one of them.

² Although Dukesfield was abandoned just before Killhope opened, it sourced ores from other sites in upper Weardale and Allendale.

By the late eighteenth century, bell pits and hushing techniques had been replaced as the preferred method of mining by tunnelled shafts ('levels'), which were excavated into hillsides along veins. In the late eighteenth and early nineteenth century hydraulic machinery was extensively introduced - Killhope Mine, which opened in the 1850s, saw the introduction of a 30 feet diameter wheel in 1878 which hauled tubs of ore up to the crushing mill while other wheels worked jiggers, buddles and separators. By the 1850s, cheaper ore was available from the United States, Germany and Spain, leading to the closure of many Northern mines in the 1870s and forcing smaller concerns to give up their leases, though the Weardale Lead Company continued lead mining and smelting until 1931. Twenty eight separate lead smelting operations were active in the region during the height of mining in the 19th century, but by 1919 the last major commercial mine had closed (Killhope having reopened during World War One). Killhope Wheel is a lone survivor of the water-powered ore crushing and washing systems that were once common in the North Pennines, surviving as the most imposing reminder of the last major period of lead-mining in the Northern Dales.

Much has been written about the methods and social context of lead-mining in the North Pennines, which differs considerably in both respects to contemporary coal-mining in more lowland districts of the region, particularly those closer to the east coast. Amongst the many publications on the subject, the best overview of the history of the site is 'Life and Lead at Killhope' by Ian Forbes, while an earlier detailed history of Killhope is provided in Cranstone's report on his work carried out at the site in the 1980s.



Illus. 04: View of the ore processing plant from the north.



Illus. 04: View of the Buddle House and attached Classifier (left) from the north-west.

2. KILLHOPE LEAD MINE AND BUDDLE HOUSE

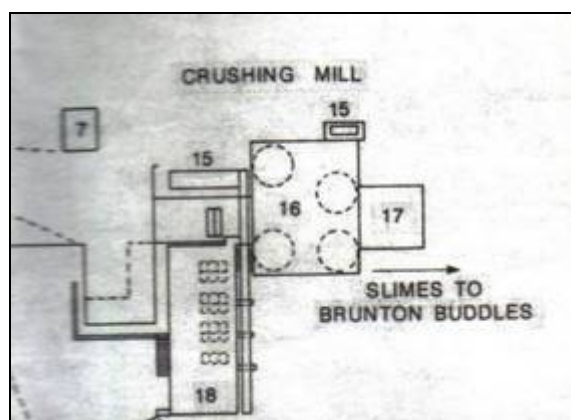
2.1 Introduction

Killhope lead Mining Museum is the best-preserved lead mining site in Britain, centred on a Victorian lead mining complex known as Park Level Mine and Park Level Mill. Opened in 1853, but deserted by the end of the First World War, the mine at Killhope was most prosperous in the late 1870s when it was among the ten richest lead mines in Britain. After nearly 70 years of abandonment, Killhope opened as a visitor attraction in 1984, since when the museum has won many awards for its interpretation of the lead industry.

2.2 The Buddle House

To meet increased levels of production, a new crushing and separation plant was built in 1876-78 to deal with mixed ores from the washing rakes of Park Level and Killhopehead. This was fully-mechanised and powered by a large water wheel with two smaller ones, fed via a complex system of reservoirs and leats. Known as Park Level Mill, this complex, which includes the Buddle House, dominates the Killhope landscape.

The purpose of the Buddle House was to house machinery through which the finest particles of lead ore were separated from waste materials and retained. Fine bouse, too small for 'jigging' within the neighbouring jigger house, flowed in a stream of water through an overhead trough to the Buddle house. On its way it passed through a 'classifier', a large cone-shaped stone structure into the top of which water and fine ore from the jigger house flowed at one side. Most of the water and some of the lighter waste was carried over the top at the other side, whilst the heavier ore-rich material sank to the bottom of the pyramid from where a pipe led it to the buddles. On the basis of plans for similar complexes of buildings elsewhere - notably at Groverake, between Allenheads and Rookhope in Weardale, where the lead mines were worked by the Beaumont Company - suggest that there were four buddles in operation, driven by their own small water wheel against the north wall of the Buddle House.



Illus. 06: Plan of Groverake with four buddles shown in the Buddle House [16] next to the Classifier [17] and Jigger House [18].

The buddles in use in the North Pennines during the middle and later part of the 19th century were of two designs, the earlier and most common type being convex, and the later, less common variant being the concave buddle. The early, convex buddle was designed with a wooden superstructure like a large upturned saucer, onto the high centre of which was fed a slurry of fine bouse, while revolving brushes distributed this evenly around the whole 'saucer'. The heavier ore settled out first, nearer the middle, whilst the lighter waste was carried towards the edge. After a time the machine was stopped and the different bands, of increasing purity towards the centre, were dug out. The water used in all the processes was led to the settling tanks where any remaining solids held in suspension were settled out. The late, concave variant operated more like the Classifier described above, with slurry entering at a point on the upper edge and solids settling on the sides and at the bottom of the apparatus, the water draining away through a central drain.

The following detailed extract, describing the functioning of a convex buddle, is derived from *Machinery for Metalliferous Mines: A practical treatise for mining engineers, metallurgists and managers of mines*, by E. Henry Davies (1902):

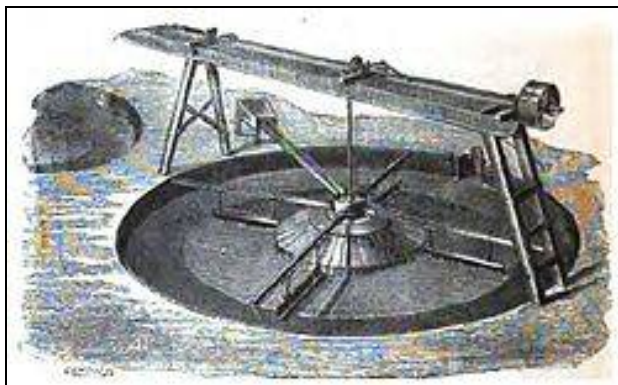
The concentrating machine for slimes, which has hitherto been a great favourite, is the round buddle, and this was perhaps due to the great simplicity of its construction, which permitted its being made out of the odds and ends of machinery usually to be found on a mine. The fixed and revolving cast-iron heads, shafting, bevel wheels, and driving pulleys, are usually procured from a firm of machinery makers.

The buddle itself consists of a shallow circular pit formed in the ground from 14 ft. to 22 ft. diameter, and from 1 ft. to 1½ ft. deep. The poorer the slimes the greater the diameter, and as the product from the buddle always requires re-treatment, it is usual to concentrate first in a machine of small diameter, and then to re-treat the concentrates thus produced in one of a larger diameter. The sides of the buddle pit are formed of stone or brick, set in mortar, and the floor, which has an inclination outwards of 1 in 30, is made either of smooth planed boards or cement run upon a layer of concrete. The centre head is from 6 ft. to 10 ft. in diameter, and may even be less. A revolving head is fixed to the shaft, and this carries four arms. The revolving head receives the slime waters from the trough, and distributes them on an even layer over the fixed head; the liquid stream, which should be in a uniform thin film, falls over the edge of the fixed head, and distributes itself outwards over the sloping floor of the buddle towards the circumference, depositing in its passage the rich ore it contains, according to its specific gravity, the richest first, close to the fixed head, and the poorest at the circumference. To each of the four arms a board is attached, carrying a cloth or a series of brushes, which sweep round and smooth out each successive layer of mineral as soon as it is formed. In some cases sprays of fresh water are used instead of the cloths or brushes, the number of revolutions in either case being 3 or 4 per minute.

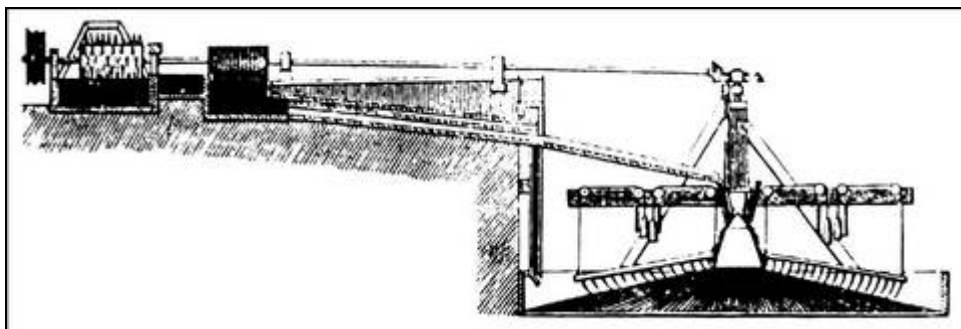
The outflow of the waste waters takes place through the small sluice gate shown in the circumference of the buddle. In the door of this sluice is a vertical line of holes, and, as the layer of mineral thickens on the floor, a plug is placed in the lowest hole, and so successively up the series, until the full thickness of the deposit equal to the height of the cone is reached. At this point the machine is stopped, a groove is cut from the cone to the circumference, and samples of the ore are taken and washed on a vanning shovel. By this means an idea is formed as to where the divisions should be made; for at the head the concentrates are rich in galena, and then follow the mixed ores, either of galena, blende,

and gangue, if blende is present, or of galena and gangue, if it is absent. Two qualities of the mixed ores are formed. Rings are formed around the deposit on the buddle to indicate the division lines. The rich heads are taken out and reworked once in another buddle, when they will be rich enough to be sent to the dolly tub. The middles are likewise re-treated, the ores of approximately the same percentage being treated in the same machine until all the mineral is abstracted, and the waste contains not more than $\frac{1}{2}$ per cent. of lead, and 1 to $1\frac{1}{2}$ per cent. of zinc. By successive re-treatment the minerals may thus be enriched up to 50 to 60 per cent. Pb., and when blende is present, to about 42 per cent. Zn. These concentrates may either be sold as they are, or further enriched in a dolly tub.

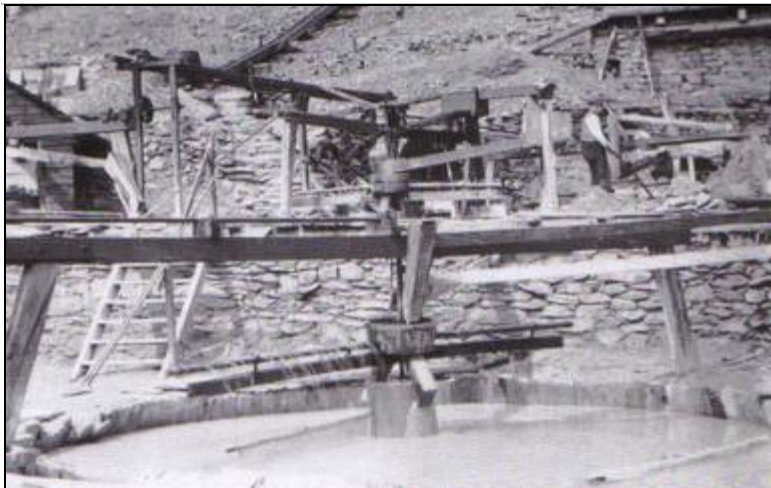
The great drawbacks to the round buddle are the facts that no clean products can be made straight away. The mineral must be handled several times, always a costly proceeding, and the machine must be stopped when full, and lie idle until emptied. A large number of buddles are always required to cope with the slimes from even a small mill, while in large mills, especially when blende is present, from sixteen to twenty would be needed.



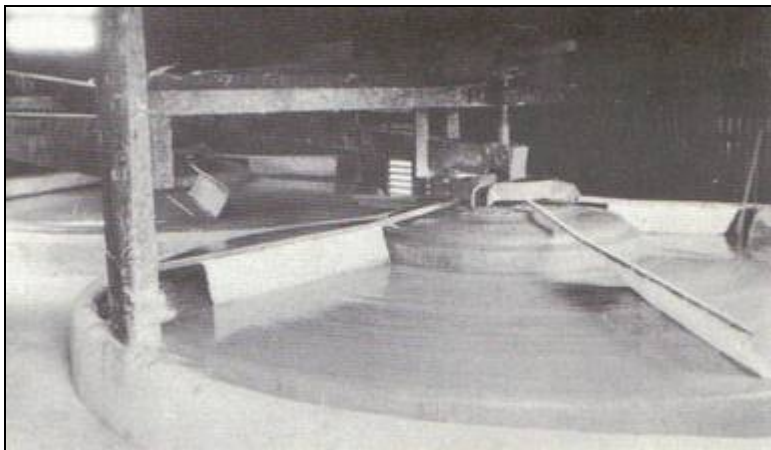
Illus. 07: Diagram of a working round buddle (Davies 1902)



Illus. 08: Cross-section of a working round buddle (<http://shropshiremines.org.uk/educpack/section4/separation.pdf>)



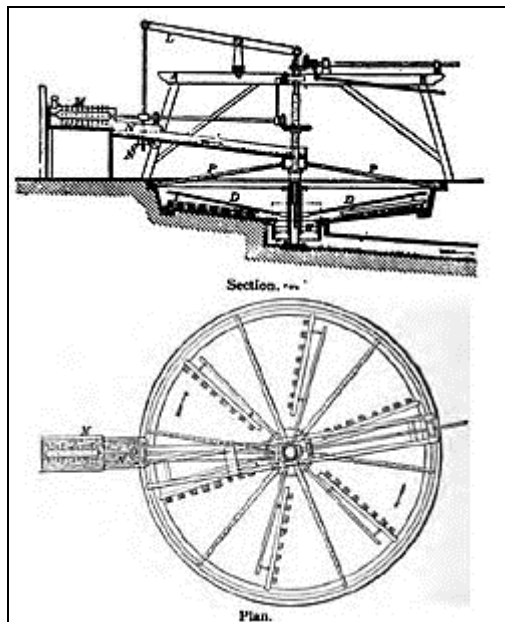
Illus. 09: Late 19th century buddle in operation.



Illus. 10: Buddle in operation showing the 'brushes' of Material when ensured even deposition of the solid component of the slurry around the sloping surface of the buddle.



Illus. 11: Digging out the waste component of the buddling process from the outer part of the buddle pit.



Illus. 12: Plan and Cross-section of a working concave buddle (Davies, 1902).

Prior to the current excavation it was not known which type of buddle was in operation at Killhope, nor if remains sufficient to determine that information could be uncovered and successfully recorded. A possible guide to the likely state of surviving remains was provided by illustrations of abandoned buddles elsewhere, such as in the illustration below shows an abandoned buddle with apparent traces of its removed machinery visible as pieces of wood, with signs of a possible central hub support.



Illus. 13: An abandoned buddle with apparent traces of removed machinery and signs of a possible central hub support.

No clues regarding the design or size of the buddles operating at Killhope are found in any of the documentation associated with the working history of the mine, although Ian Forbes has provided information on the date of construction and subsequent history of the Buddle House itself, much of it revealed in 19th century documentary records:

- 24th July 1877: “cutting out for foundations of building over circular buddles”
- Half year ending Dec 1877: “Ed. English walling foundation for part of buddle house, classifier and wheel case. Walling high part of buddle house...”
- 1878 Half year ending 30th June Ed. English “flagging in buddle house”
- Jan 23rd 1880 East end of buddle house has settled down 4 or 5 inches
- April 27th: the slime not right on account of cilender is wore too wide in the holes”
- May 6th “the circular buddle working all right since they the new cilander in”
- Walls taken to lower height and consolidated c.1981
- Re-roofed late 1980s

A number of photographs are available showing the condition of the buddle house following almost a century of abandonment (Illus. 14, below) and during major re-building works in the 1980s (Illus. 15).



Illus. 14: Interior view of the north wall of the Buddle House prior to repair and reconstruction in the 1980s.



Illus. 15: View of the buddle house (left of view) during reconstruction in the 1980s.

3. EVALUATION PROGRAMME

2.1 Aims

The aims of the programme of excavation were to investigate buried remains within the floor of the Killhope Buddle House, to determine the character, date and phasing of those remains and, as far as possible, their function, extent, and state of preservation.

It was proposed to use the results of the excavation and interpretation programme to inform the future management of the Buddle House, including potential interpretation for the benefit of visitors. In that regard, the present report includes a brief assessment of the potential for further work, and observations regarding site management.

2.2 Methods

Fieldwork in November 2012 consisted of an historic buildings record produced in order to contribute to the analysis of the historical development of the building by describing and illustrating significant features and indicating phases of development. In addition, the programme of invasive work involved the excavation of three trenches distributed strategically within the Buddle House, located and planned manually and by digital survey.

The work was carried out using core staff of the Archaeological Practice Ltd., supplemented by specialists in relevant fields - notably Peter Ryder the buildings historian. These were assisted by over 20 volunteers, co-ordinated by Paul Frodsham from the North Pennines AONB - *Altogether Archaeology* project, who were guided by the professional personnel and provided reciprocal specialised knowledge in a range of relevant fields.

2.2.1 Building Record Survey

A measured survey and photographic recording of the building was carried out using digital photography, annotation of drawn elevations and plans to show historic features and phasing, sketches of architectural detail as appropriate, and background research using historic maps and records. Both exterior and interior were viewed, described, drawn and photographed, and a record presented which draws conclusions regarding the development and use of the building.

The measured, scaled plan and elevations of the building were produced following close observation by hand measurement transferred to drawing film. The photographic record included internal and external elevations of each upstanding wall in the building, along with any particular architectural features of merit, whether structural or decorative, considered relevant to the design, development and use of the building.

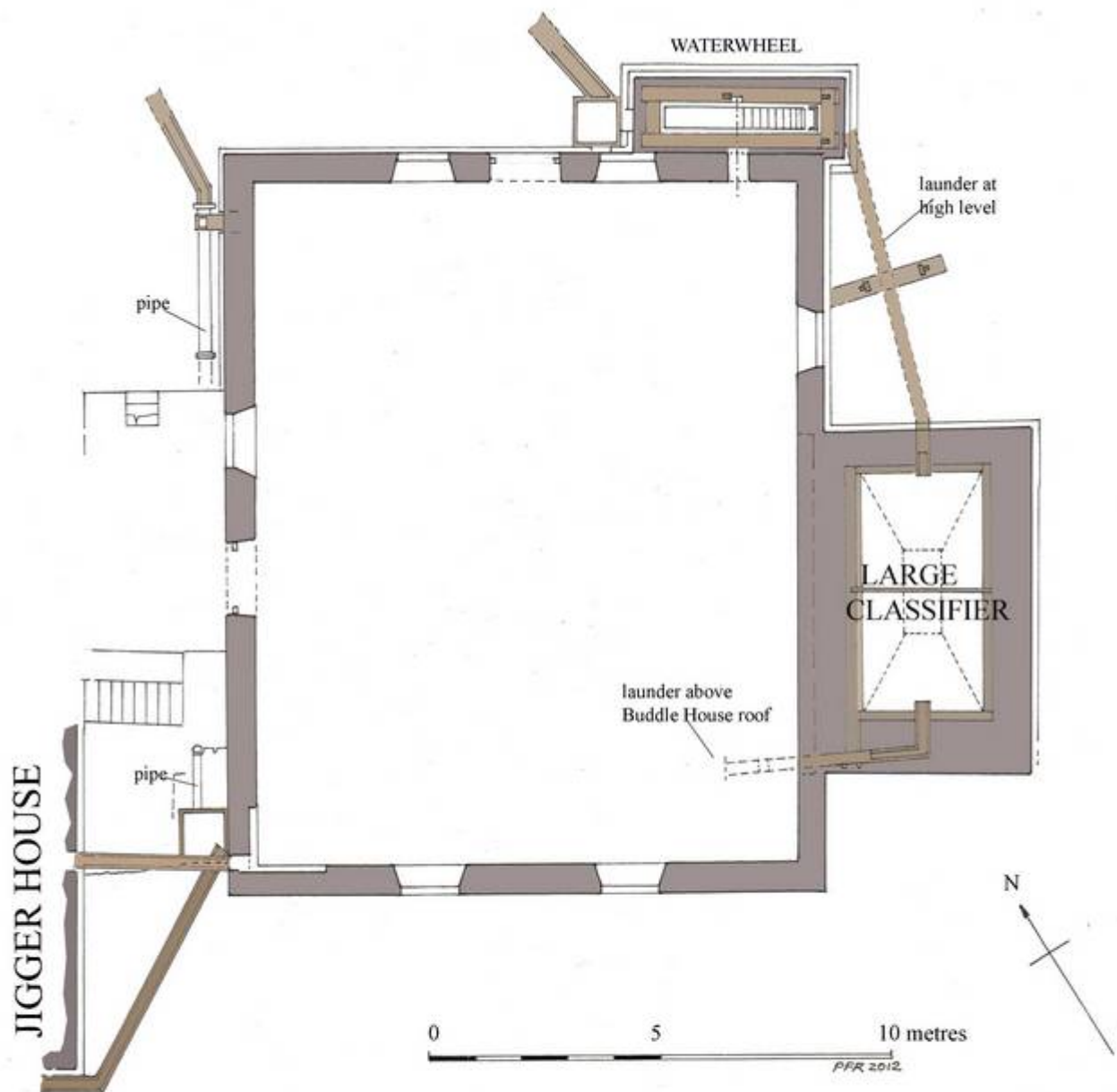
2.2.2 Archaeological Excavation

The purpose of the excavation was to evaluate areas of the Buddle House and features within it using a sampling strategy, rather than full excavation. Therefore, locations within the Buddle House were chosen where remains could be seen as visible features or their

presence was suspected on the basis of historic plans, but was constricted to a large degree by available floor space not covered by stored materials, and by safety and access considerations. At the time of excavation, the building was used for general storage, and access to the floor was restricted to areas cleared in advance.

The three sites chosen for evaluation were in the east and west corners of the building and adjacent to the door in the north-west wall. Prior to excavation, all trench locations were cleared of workshop equipment and the upper layers of overburden, comprising the most recent working floor levels, removed by hand. The spoil excavated from the trenches was stored primarily outside the building with smaller quantities next to the excavated areas, keeping top-soil and stones separate for effective back-filling.

The Trenches were excavated by hand to the top of archaeological deposits, with all trench faces subsequently cleaned and features revealed investigated and recorded as deemed appropriate. All excavated contexts were recorded in plan and section (where appropriate), with plans and sections drawn at approximate scales of 1:20. The trenches were accurately tied into the OS national grid and accurately levelled using a total station. The finds from the excavations were retained and recorded by context.



Illus. 16: Plan of the Killhope Buddle House and Classifier.



Illus. 17: North-west elevation of the Buddle House.



Illus. 18 North-east elevation of the Buddle House.



Illus. 19: South-east elevation of the Buddle House and Classifier (to left of view).



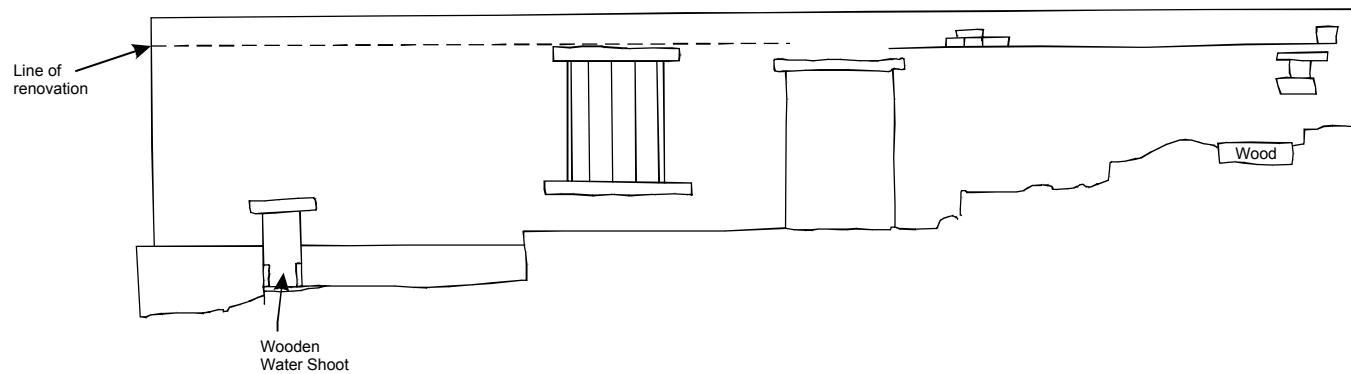
Illus. 20: The north-east and south-east elevations of the Buddle House viewed from the north-east.



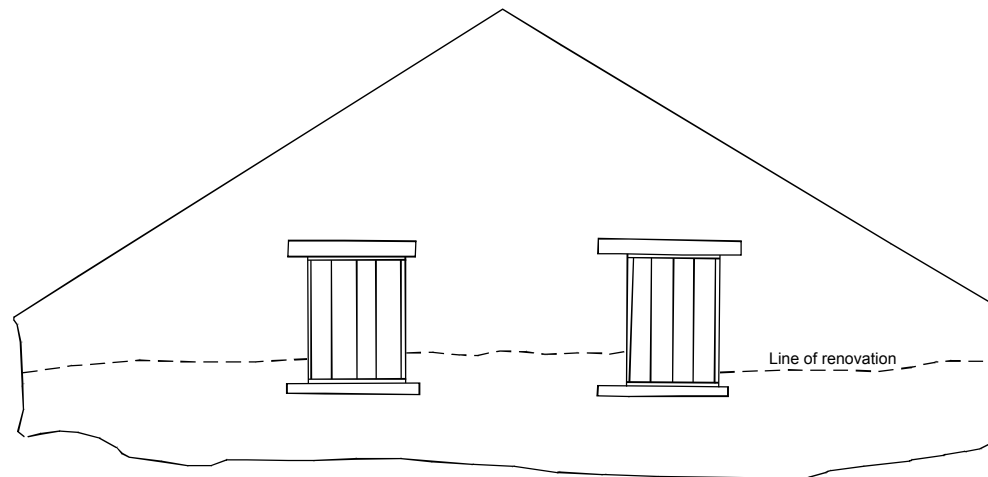
Illus. 21: The south-west elevation of the Buddle House.



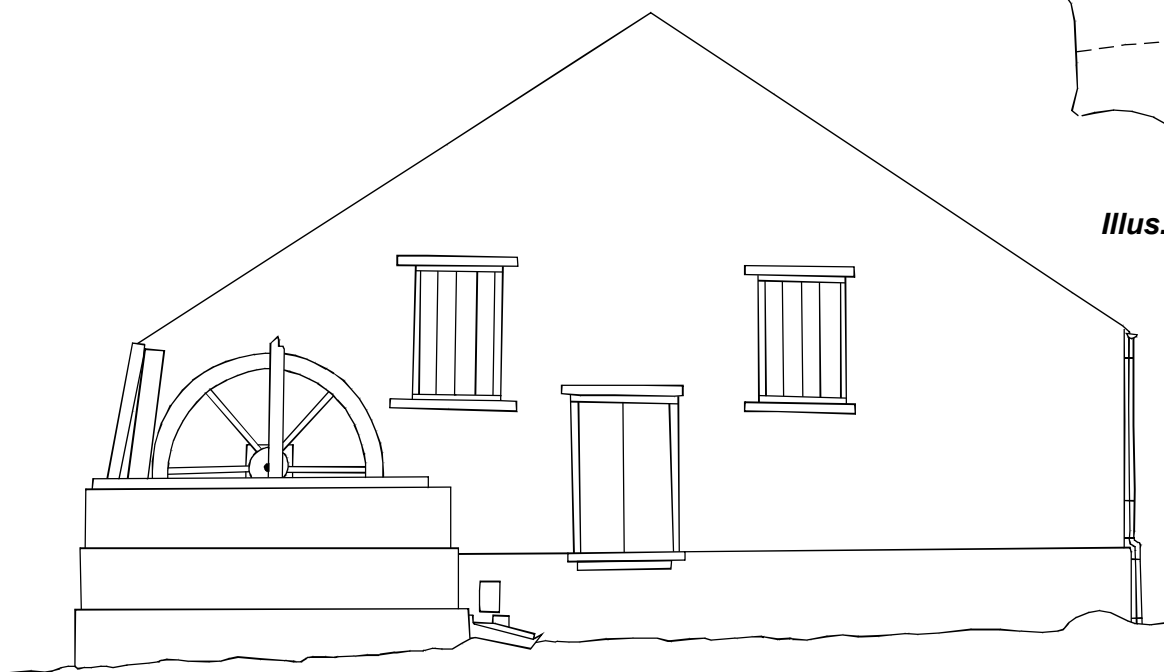
Illus. 22: View from the south-west of the he south-west and north-west elevations of the Buddle House showing drain and launder routes from the neighbouring Jigger House.



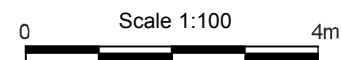
Illus. 23: North-west elevation of Buddle House exterior.

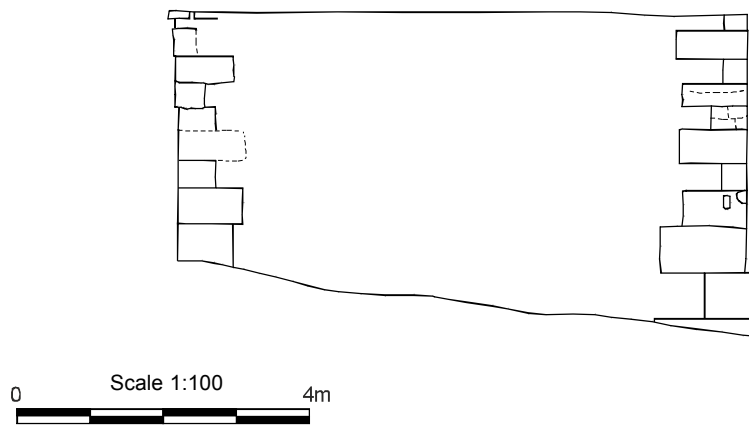


Illus. 25 South-west elevation of Buddle House exterior.

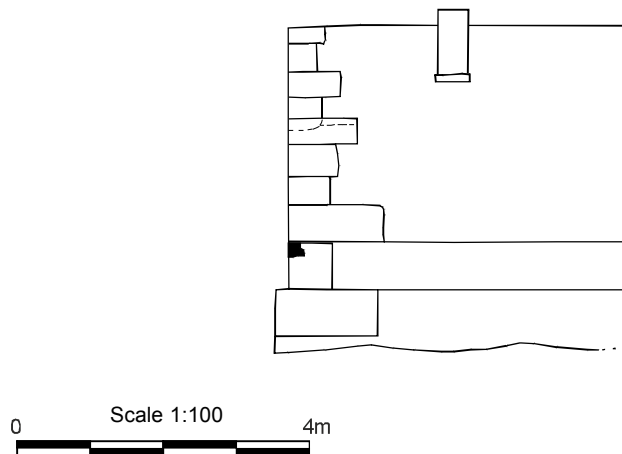


Illus. 24: North-east elevation of Buddle House exterior.

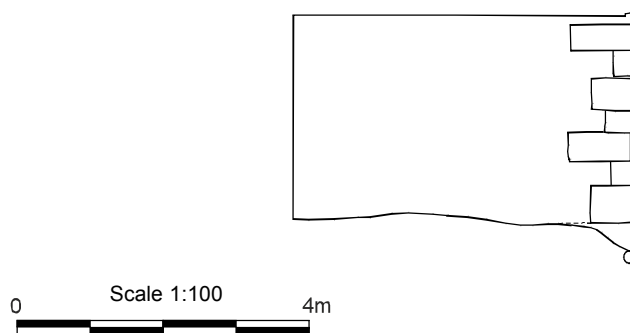




Illus. 26a: South-east elevation of Classifier exterior.



Illus. 26b: North-east elevation of Classifier exterior.



Illus. 26c: South-west elevation of Classifier exterior.

4. RESULTS OF EXCAVATION

4.1 Trench 1 – 4.60m (length) x 2.65m (width)

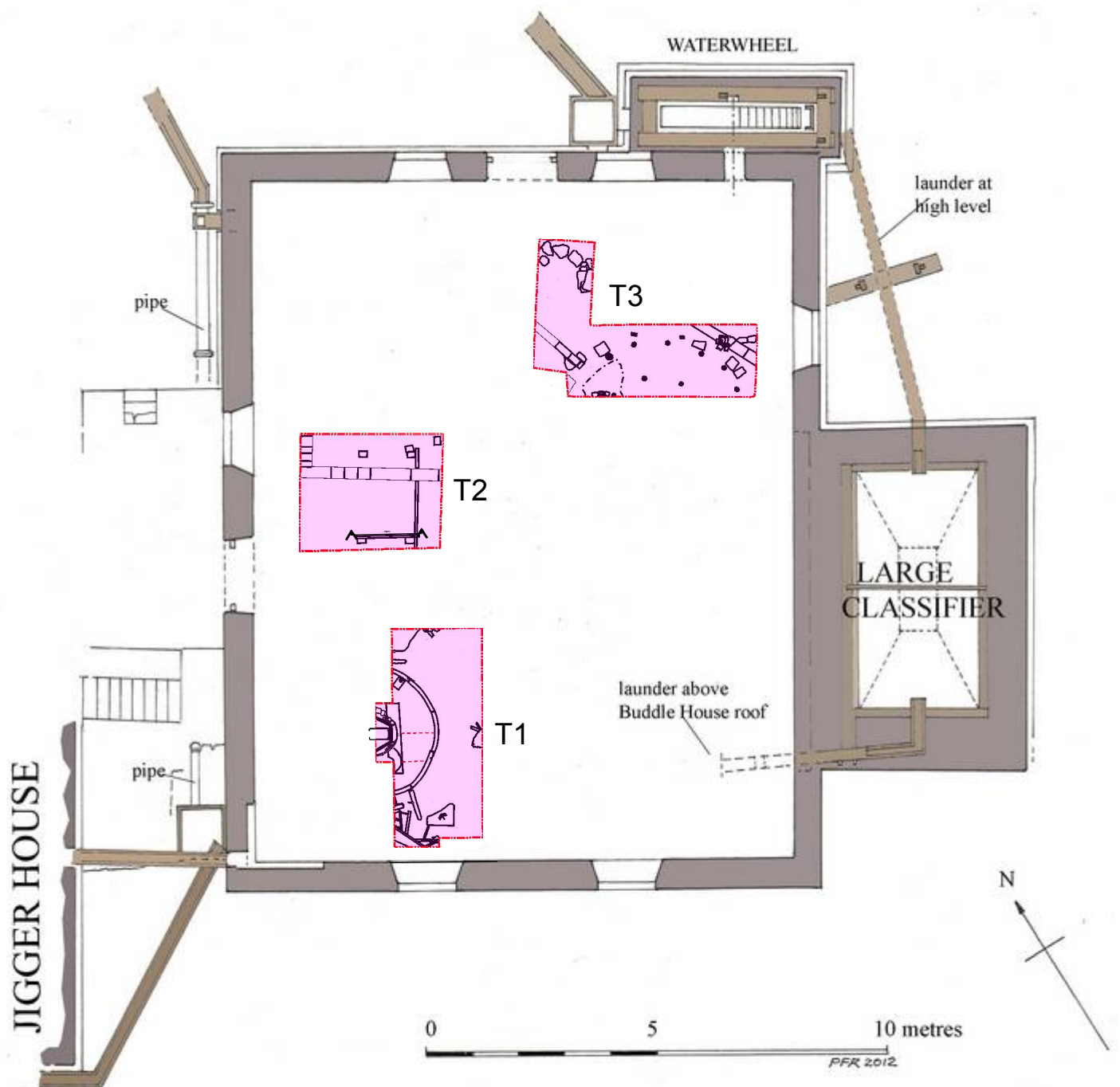
Description (*Illus. 32-39*)

Trench 1, positioned in the west corner of the Buddle House, was sited to investigate the suspected location of original buddle workings suggested by the arrangement shown on a plan of the buddle house at Killhope's sister site, Groverake, near Rookhope in Weardale. The trench was rectangular in plan, aligned south-west to north-east and positioned three metres from and parallel with the west wall of the Buddle House, with its south-west end 0.33m from the south wall.

Initial excavations revealed a very shallow layer of apparent mortar forming a rough surface just beneath the present ground level, and extending throughout the trench. Beneath this layer, a substantial deposit of collapsed roof timbers and associated roofing slates (02), were encountered throughout the trench, concentrated towards the south-west end. The most substantial deposit encountered throughout Trench 1 was a firm but friable, dark grey, shale-gravel mixed with loam (03) observed below the modern collapse and probably associated with made ground from the original construction of the building. A large broken sandstone flag (04) observed at the southwest end of the trench and sitting upon (03) may represent fragmentary remains of an original flagged floor, documented in historic documents but subsequently robbed out.

Cutting into (03) and visible in the north-western side of the trench, were the substantial remains of presumed buddle workings (05). This feature comprised of two distinct elements; the first took the form of a partial ring of timber, segmentally formed by five curved timber batons rather like a timber wheel. Each baton measured around 0.90m (length) x 0.08m (width) and had overlapping joints secured with broad iron nails. Heavily corroded iron fittings seemed to be attached to the exterior of the most easterly of these timber batons, and a socketed iron fitting containing a large bolt appeared just inside the north-eastern part of the suspected buddle. Just under half of this circular structure was exposed within the trench, with an estimated diameter of 3.05m (exactly 10 feet). It was calculated that the north-western edge of the buddle probably lies 0.94m south-east of the west wall of the building.

Within the parameters of the original trench dimensions, the second element of the suspected buddle feature (the cone or hub-support, labelled as the 'inner buddle') was only just visible in the south-east facing trench section, but was regarded of sufficient archaeological importance to explore in further detail by extending the trench a further 1.30m (length) x 0.40m (width) from a point 1.87m north-eastwards from the west corner of the trench. This feature constituted three further components. The first was a lower platform/foundation constructed from a substantial timber plank on which the buddle apparatus sat, measuring 1.55m (length) x 0.30m (width). Second was an elevated 'inner' wheel, measuring about 1m in diameter, constructed with two jointed skins of timber batons. The first skin of timber was curved on the outside and strengthened with sheet metal casing (now only partially visible on the southern side), and squared off on the inside from where a second skin of narrower timber batons was joined to it. Two heavily eroded, linear, cast iron fittings resembling handles, were observed to project vertically from the centre of two batons



Illus. 27: Trench location plan.



Illus. 28: View looking south-west at the start of excavations in Trench 1.



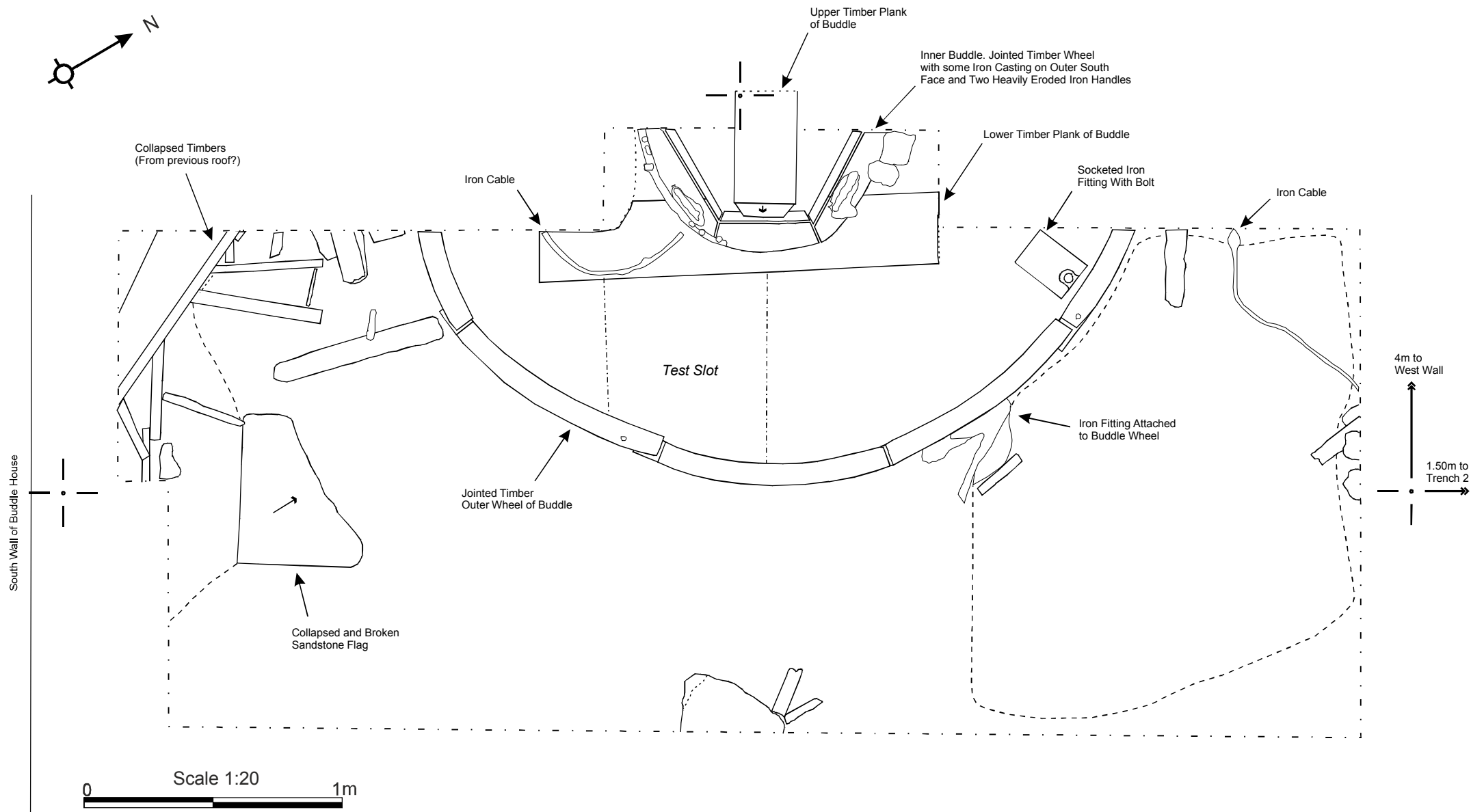
Illus. 31: View looking west at the start of excavations in Trench 2.



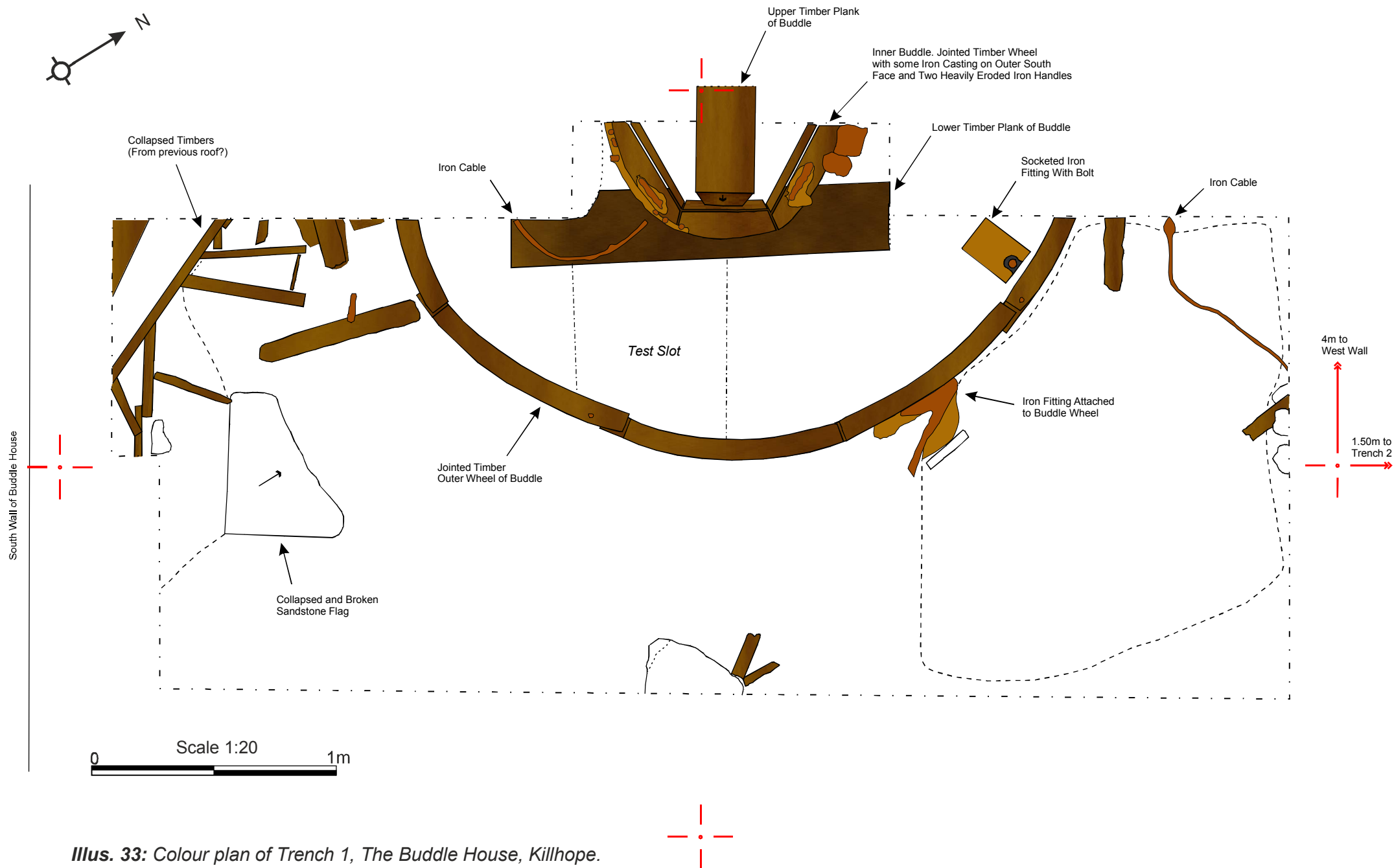
Illus. 30: View looking west during excavations in Trench 2.



Illus. 31: View looking east at the start of excavations in Trench 3.



Illus. 32: Line drawing plan of Trench 1, The Buddle House.



Illus. 33: Colour plan of Trench 1, The Buddle House, Killhope.



Illus. 34: View looking west during excavations in Trench 1.



Illus. 35: View looking southwest during excavations in Trench 1.



Illus. 36: View looking south during excavations in Trench 1.



Illus. 37: Elevated view looking south-west across Trench 1.



Illus. 38: View looking south-west at detail of buddle remains in Trench 1.



Illus. 39: View looking north-west at detail of buddle remains in Trench 1.

from the first outer skin of the inner buddle wheel, along with other possible iron fittings observed at the edge of the northern baton. This 'inner wheel' had been propped up on the north-east side by the insertion of thin wooden wedges between it and the underlying wooden platform (an observation consistent with actions designed to counteract the subsidence documented in the building, probably caused by settling of the infilled floor deposits, in early 1880). The third component of the buddle inner wheel, comprised of an upper timber plank, positioned upon the top of the timber wheel and almost at 90° to the lower foundation plank. This plank measured 0.50m (maximum length within parameters of trench) x 0.24m (width) and had a bevelled south-eastern face.

Interpretation

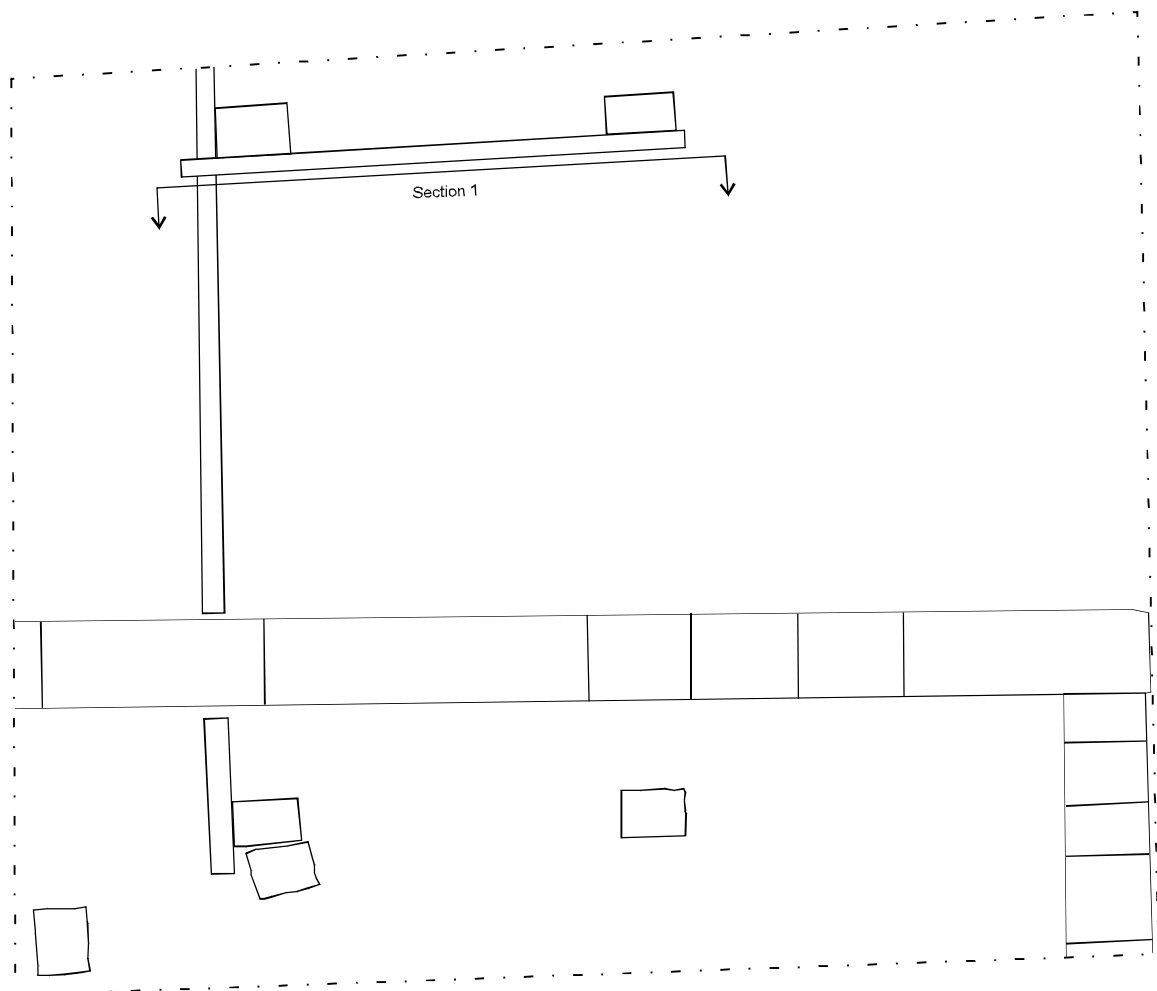
Although ostensibly the remains of a circular buddle of convex type, the interpretation of these remains is far from clear due to its relatively small size – the 10ft diameter of the 'outer' circle is considerably smaller than the figure of 15ft normally considered to be the smallest – and relatively slight form of construction – the wooden ring, as excavated and recorded, lies on the excavated surface rather than sitting within it and forming the walls of a circular pit. The possibility was considered that the scale of the feature could be greater, with the outer circular feature being intermediary (as suggested by Illus. 07, above), but no further remains were found in the south and east corners of the trench and the potential for expansion up to 15ft is in any case be constricted by the building walls. While most buddles previously recorded archaeologically, or reconstructed as part of museum sites, or seen on historic construction plans, are stone, few examples with wooden sub-structures appear to be known. However, the buddle shown on Illus. 10, with 'brushes' to ensure even deposition of the sorted slurry, is framed by a wooden sub-structure and, although impossible to scale accurately, appears relatively small. Therefore, it is suggested that the remains uncovered in Trench 1 are those of a convex type buddle, of small size, perhaps experimental to a degree, supplied by a pipe entering the north-west wall of the building near its west corner, where the remains of a corner recess suggest the possibility of a tank for agitating the slurry mixture before feeding it into the buddle. Other remains found in the buddle interior below roof slates and timbers from the original fallen roof include various timber and metal objects which recall the view of an abandoned buddle seen in Illus. 13 (above). They are suggestive of items including joints and struts that would have been required in the construction of the buddle hub, slurry supply conduit, brush arm, super-structure, etc., but their distribution formed no observable pattern suggestive of their original form. Within and outside the outer wooden ring were deposits of fine silts, presumably waste products of the sorting process, but flooding prevented their close inspection.

3.2 Trench 2 – 3m (length) x 2.50m (width)

Description (Illus. 40-47)

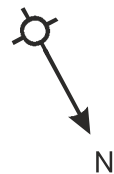
Trench 2 was strategically positioned to investigate the remains of four surviving timber uprights, now somewhat weathered but projecting out of the ground on the north-east side of a path leading from the centre of the buddle house to its door in the north-west side. The trench was located 1.70m north-east of Trench 1 and 1.0m south-east of, and parallel to, the north-west wall of the Buddle House. The trench was rectangular in plan and aligned south-east to north-west.

Excavations revealed a very shallow layer of mortar (01) forming a rough surface just beneath the present ground level, and extending throughout the trench. Below this, a firm but



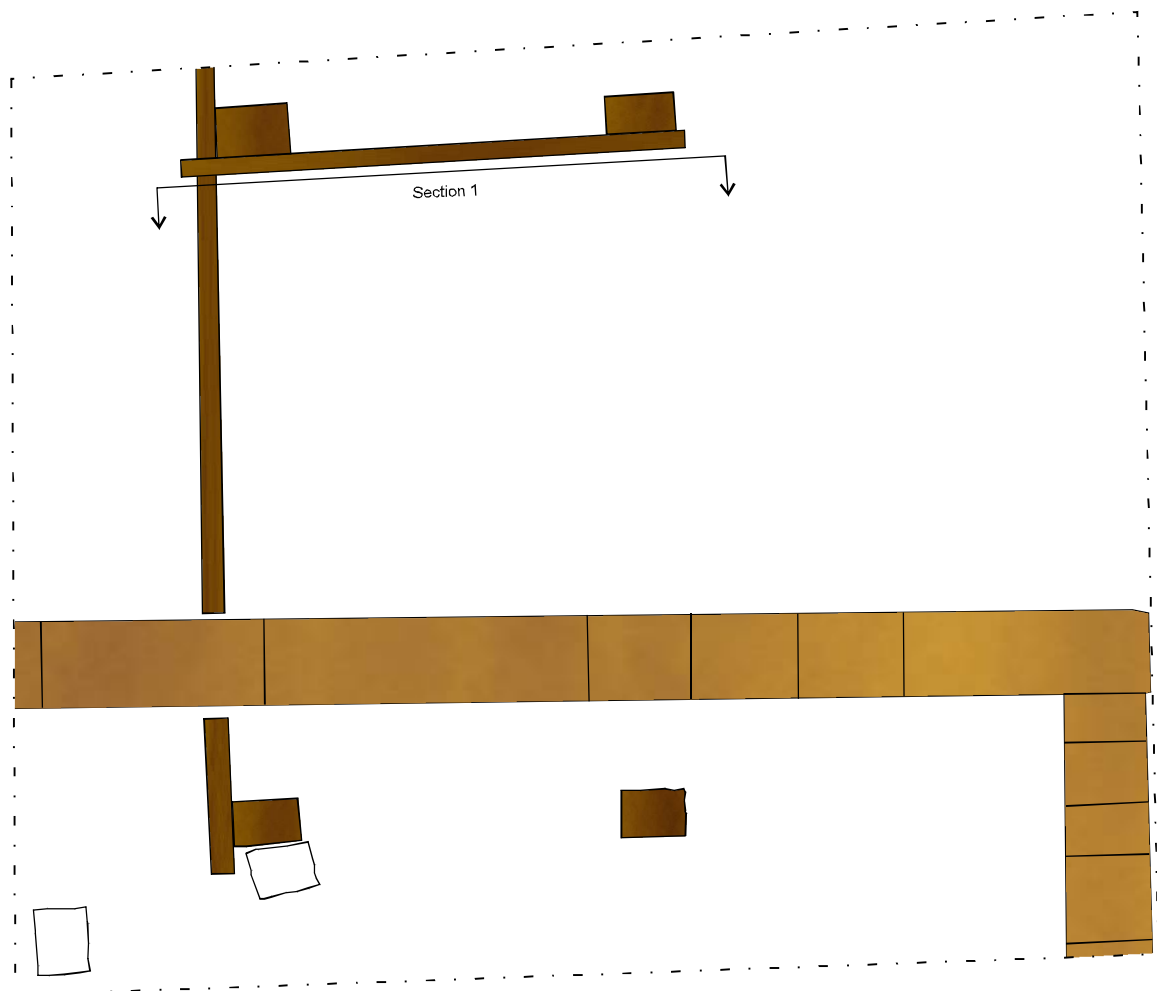
0 Scale 1:20 1m

Illus. 40a: Plan of Trench 2, The Buddle House.



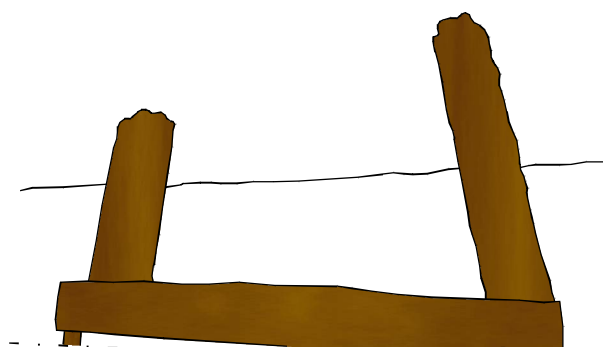
0 Scale 1:20 1m

Illus. 40b: North-east Facing Section 1 of timber structural remains in Trench 2, The Buddle House.



0 Scale 1:20 1m

Illus. 41a: Colour plan of Trench 2.



0 Scale 1:20 1m

Illus. 41b: North-east Facing Section of Trench 2.



Illus. 42: View looking north-west during excavations in Trench 2.



Illus. 43: View looking east during excavations in Trench 2.



Illus. 44: View looking west across Trench 2.



Illus. 45: Vertical view of Trench 2.



Illus. 46: View looking south-west across Trench 2.



Illus. 47: View looking north-west across Trench 2.

friable, dark grey, shale-gravel mixed with loam (02), as also recorded in Trench 1, was thought likely to be associated with made-up ground from the original construction of the building.

Cutting through these layers and projecting up to 0.45m above ground level, were the remains of four weathered timber uprights (03) arranged in a rectangular formation and joined at their bases, some 0.50m below current ground level, by timber cross braces. It was apparent from their structural formation that the uprights had once been considerably longer. As visible in the north-east facing Section 1 (see *Illus. 40b*), the southern timber upright measured 0.60m (height) x 0.17m (width) x 0.13m (depth) and was fixed at an angle of 10°. The western timber upright measured 0.90m (height) x 0.17m (width) x 0.10m (depth) and was fixed at an angle of 13°. The distance between the uprights, at base level, measured 0.88m. Sufficient in-situ lengths of these angled timber uprights survive to calculate a total projected length for the point at which they would meet - around 2.18m above the present ground level and a total post length of about 2.68m (9ft). A timber cross brace measuring 1.34m (length) x 0.16m (width) x 0.05m (depth) was joined to the base of the uprights on their north-eastern faces. A second timber cross brace measuring 2.12m (length) x 0.06m (depth) connected the southern timber upright to the eastern upright. At approximately 1.43m along its length to the north-east, this cross brace had a 0.28m section cut out, and a rectangular boxed segmented timber drain inserted through the gap. This drain was aligned south-east to north-west, bisected the trench at 90°, and returned at 45° along the north-western edge of the trench in a north-easterly direction, disappearing into the north-eastern edge of the trench. No other features or deposits of note were encountered in Trench 2.

Interpretation

It was apparent from their structural formation that the uprights recorded in Trench 2 had once been up to 9ft in height above current ground level, and are likely to have joined at their highest point to form a double A-frame support. The centre line of the structure, parallel with the north-west wall of the building, was at the same distance from the west wall as the centre of the buddle excavated in Trench 1. This suggests that the two structures were probably related. The likelihood, based on the current excavations and the Groverake model (see *Illus. 06*), that the buddle house was occupied by four individual buddles, suggests that the putative, overhead channel or launder evidenced in Trench 2 is most likely to have been connected to the same slurry supply as the buddle revealed in Trench 1. It is suggested that the slurry supply coming from the jigger house entered the building at the extreme south end of the north-west wall where a recess suggests the possible presence of a tank, perhaps used to agitate the mixture before it was fed into a launder supplying Buddle 1. It is suggested that half of the slurry mixture may have been taken off here, with the remainder travelling via the overhead launder – supported by the timbers recorded in Trench 2 – to a second buddle in the east corner of the building. The box drain found cutting through the bracing timbers for the launder support in Trench 2 may have brought waste water from a buddle in the south corner of the building, feeding it in to a drain running along the north-west wall, which may also have taken waste water from Buddle 1.

3.3 Trench 3 – SE-NW aligned arm 4.60m x 1.56m, SW-NE aligned arm 3.64m x 1.20m

Description (*Illus. 48-56*)

Trench 3 was an L-shaped trench, positioned in the eastern corner of the Buddle House. The western corner point of the SE-NW arm (labelled Point A) was located 3.16m southeast of

the eastern corner of Trench 2. The south-western edge of the trench was therefore parallel to the north-eastern edge of Trench 2.

Excavations revealed a very shallow layer of a mortar-rich deposit (01), as seen across the entirety of the Buddle House, forming a rough surface just beneath the present ground level. Beneath this layer, fragmentary deposits of collapsed roof timbers and associated roofing slates (02) were observed throughout much of the trench. Below this was a firm but friable, dark grey deposit of shale gravel (03), probably representing made ground when the area was levelled before and after the original construction of the building.

Cutting into this made-up ground were a series of archaeological features that have been interpreted as the partial remains of a buddle (04). The first group of these features comprised three stubs of timber posts (04a) forming an inner ring, situated close to the south-western edge of the trench. These post stubs measured (on average) 0.08m in diameter and were positioned about 0.70m apart, forming a visible circular alignment extending in a south-westerly direction beyond the edge of the trench. The timber posts that fitted these holes were likely to have supported a circular structure associated with the inner workings of a buddle; sufficient remains of the feature were exposed to calculate a projected maximum diameter of this inner ring to 2.27m (7.45ft).

A boxed segmented timber drain (04b) aligned roughly north-south, virtually identical to that observed in Trench 2, was uncovered at the west end of the trench. The projected alignment of this drain beyond the south-western edge of the trench, meets exactly with the centre point of the proposed inner ring (04a), and would appear therefore to have been an instrument of water supply or, much more likely, drainage associated with the buddle workings.

A second concentric ring of post stubs (04c) (with some simply being postholes), numbering six in total within the trench, was observed at 0.70m beyond (4a) to the east and north, with a wider projected diameter of 3.80m (12.50ft). Individually, these postholes were slightly more substantial than those of the inner ring, measuring on average 0.10m in diameter, and some were set closer together – varying between 0.45m – 0.68m.

A further, outer concentric ring was comprised of flat timber pads (04d), five of which were visible within the trench. The pads measured on average 0.24m x 0.23m and were located immediately behind the second concentric ring of postholes (04c). Again, it was possible to calculate a projected maximum diameter for this feature, giving a potential maximum diameter for the entire buddle of around 4.48m (14.70ft).

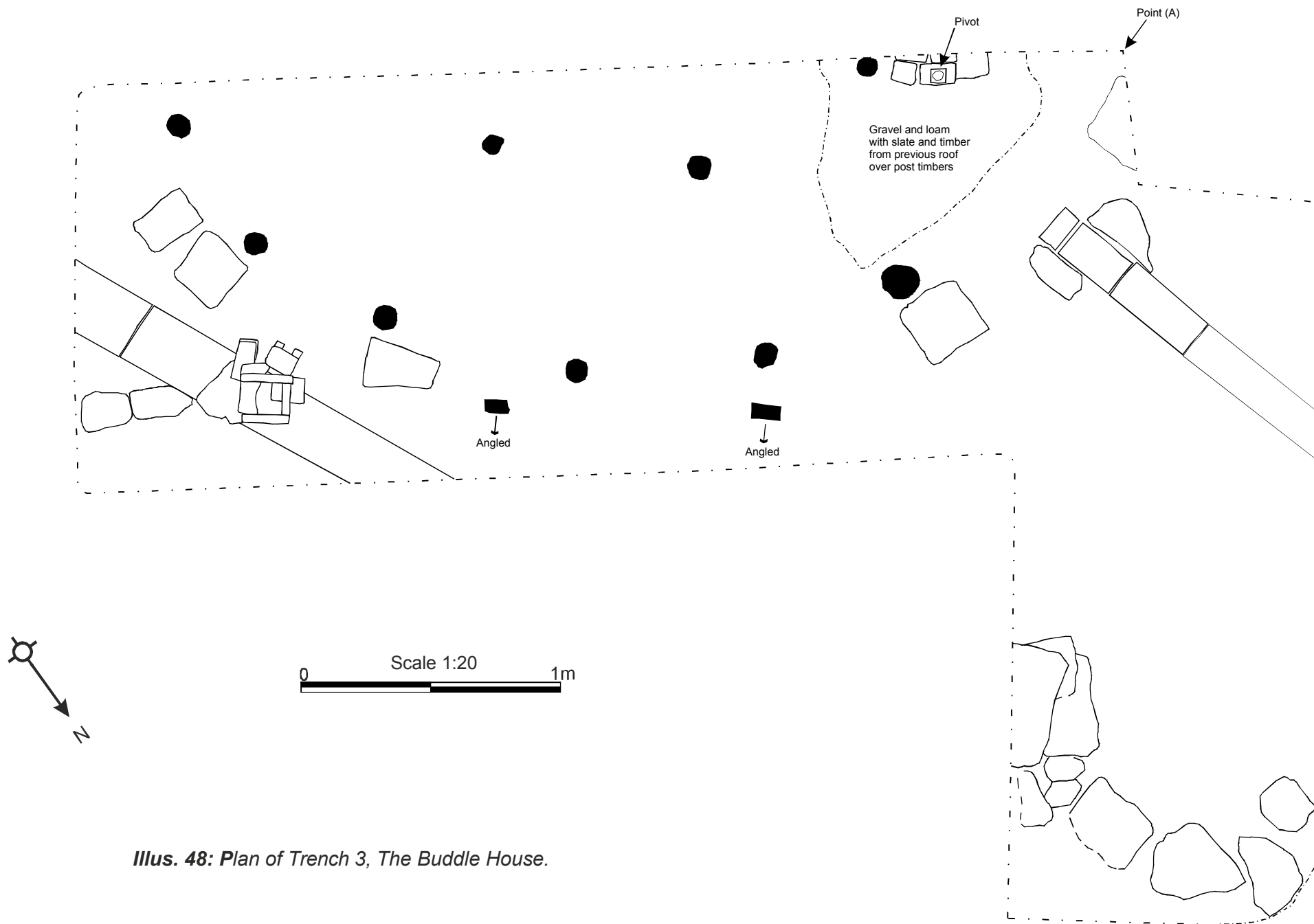
Associated with these pads and observed within the same concentric band at the centre of the north-eastern end, were two rectangular stubs of timber posts (04e). These posts measured 0.10m x 0.05m, were set 0.93m apart, and were both angled downwards in a north-easterly direction, evidently to lean on and thus provide further support for the main structural frame of the proposed buddle.

Immediately adjacent to the eastern side of the outer perimeter of the proposed buddle, a further boxed timber segmented drain (04f) was observed running (roughly) on a north-south alignment. This drain was slightly broader than the first, measuring 0.21m in width. A small collection of timber and iron workings, including a small open topped timber box and a timber baton bolted to the centre of a flat iron blade, were observed sitting upon and spilling over the drain. It is unclear whether some of these features were associated with the buddle itself

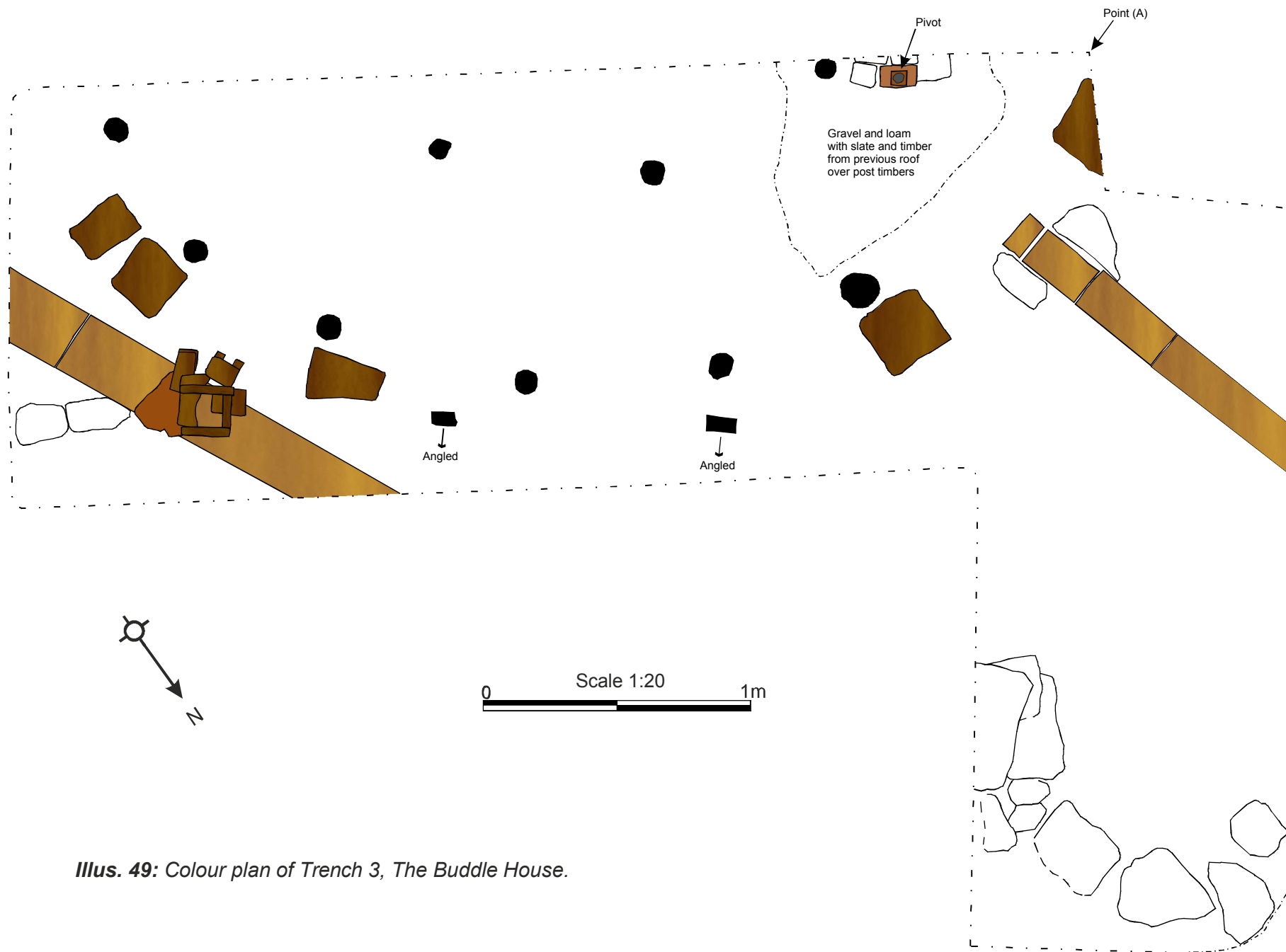
or with the collapsed roofing timbers, but the open-topped box appeared most likely to have served as an inspection or cleaning facility for the drain.

Interpretation

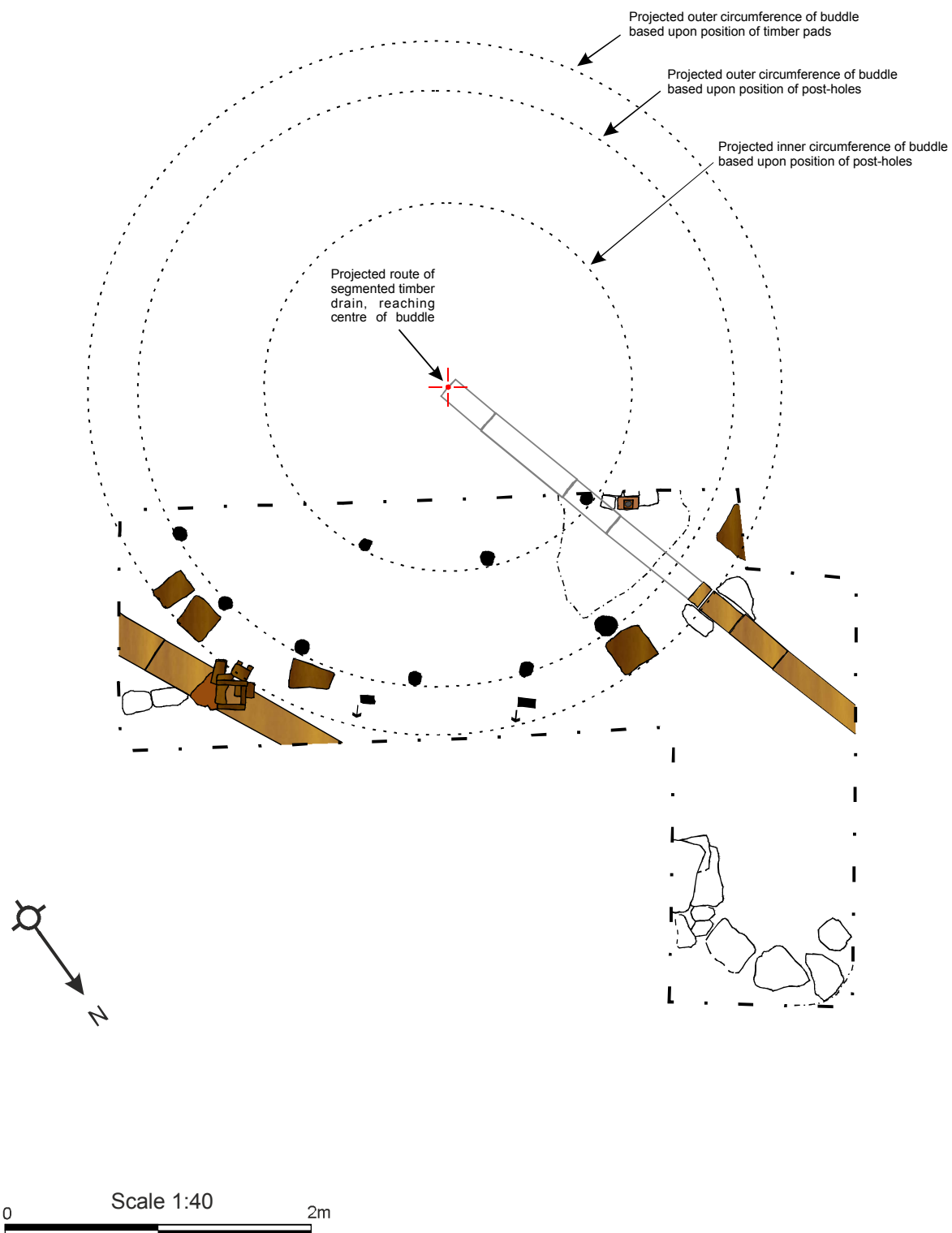
The remains excavated in Trench 3 are best interpreted as those of a convex buddle, with the two concentric rings of posts providing support for the convex, saucer-like wooden buddle. Some of the loose timbers and iron fittings found strewn within Trench 3 may relate to the super-structure of the buddle, but some could equally be part of the roof structure of adjacent waterwheel. One of the box drains found in Trench 3 is clearly positioned to drain the centre of the buddle – as would be expected for a convex buddle structure – but the other, running NW-SE in the east corner of the trench, is of unknown function.



Illus. 48: *Plan of Trench 3, The Buddle House.*



Illus. 49: Colour plan of Trench 3, The Buddle House.



Illus. 50: Colour plan of Trench 3, showing projected circumference of suspected buddle.



Illus. 51: Elevated oblique view looking south-west across Trench 3.



Illus. 52: Vertical oblique view looking south-west at wooden structural remains at the south-east end of Trench 3.



Illus. 53: Vertical oblique view looking south-west at the north-west end of Trench 3.



Illus. 54: View looking south-east during excavations in Trench 3.



Illus. 55: View looking south-east during excavations in Trench 3.



Illus. 56: View looking south-east at detail of timbers revealed in the south-east end of Trench 3.

5. CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The excavations conducted within the Buddle House in November 2012 have provided evidence for surviving structures below floor level in three locations and it is considered likely that other such remains survive elsewhere within the building.

In Trench 1 were revealed the remains of what is best interpreted as a small convex buddle, connected to an over-head launder, the supports for which were excavated in Trench 3.

In Trench 3 remains best interpreted as the substructure and drainage arrangements for a concave buddle were excavated.

The suggested presence of two different kinds of buddle, if correct, is not entirely surprising given the date of construction of the buddle house, in 1877, only a few years after the first publication of plans for a concave buddle. It is possible, therefore, that it was decided to experiment with the newer type of buddle whilst installing the older type as security. It may also have been found that the two types worked well in tandem, with one being used, effectively, as a kind of Classifier and the second refining its products. To this speculative suggestion might be added another; that the remains found in Trench 1 represent the partial remains of a convex buddle rather larger than the excavated remains suggest, which pre-dates the construction of the buddle house. The possibility that buddles existed on this particular site prior to the construction of the buddle house is suggested by the documented record, on 24th July 1877, of "*cutting out for foundations of building over circular buddles*". However, although plausible, this suggestion is made less likely by the fact that some of the excavated remains are at ground level, which would preclude subsequent use of that area.

In addition to the remains of buddles, there sections of well-preserved box drains were uncovered, one of which could clearly be associated with one of the buddles. It is likely that these and other box drains survive virtually intact within the floor of the buddle house.

The floor surface itself is made from an infill of shale waste material, perhaps derived from the early workings of the site, which has been used to provide a level platform for the working area of the buddle house, which was built upon sloping ground, probably by infilling after the construction of its lower walls.

4.2 RECOMMENDATIONS

It is recommended that the remains of the convex buddle uncovered in Trench 1 should be fully exposed by excavation in order to determine its full size and the nature of all its components, and that consideration is made to their preservation and display – perhaps mounted on a wall of the building or in another suitable location - alongside interpretive material presented on a panel or in the form of a reconstructed model.

The 'buddle' structure should be fully revealed by excavation as soon as possible to avoid differential drying of the wood components. It should then be carefully dismantled and

washed with water to remove soil and other debris. The board/central block/large timber could be kept together so as not to risk losing their current close association, but the segments of the circular component may be dismantled. The structure should then be subjected to controlled air drying, ideally on a temporary structure built on the overhead roof beams in the building, as detailed in *Appendix 1*.

It is recommended that the remains of the putative concave buddle uncovered in Trench 3 should be further exposed and recorded if significant ground disturbance is proposed in that area, or if it is considered that drainage works will change the sub-surface hydrological conditions enough to threaten the survival of sub-surface timber remains. While of considerable archaeological and interpretive value, however, the condition of these remains is not good enough to merit their permanent display, so any excavated remains should then be back-filled without an attempt to preserve them for display. The position of this buddle would, however, lend itself to a reconstructed buddle placed above it.

The remains of wooden structures and features, including those of buddle structures and box drains, now known to exist within the infilled floor deposits of the buddle house will be vulnerable to decay if the hydrology of the site is altered significantly by further development works. Therefore, any such work should be preceded by an assessment of the impact of any specific works on the local hydrology, and followed by mitigation measures which may include avoidance or further, record excavation.

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APPENDIX 1:

THE EXAMINATION AND RECOMMENDATIONS FOR A WOOD AND METAL 'BUDDLE' STRUCTURE AT KILLHOPE LEAD MINING MUSEUM

Jennifer Jones, Conservation Services, Dept of Archaeology, Durham University

'BUDDLE' STRUCTURE

The 'buddle' is *in situ* inside a presently disused building, with intact walls and windows. Around 50% of it has been revealed by recent excavation, with the remainder concealed under a supported modern wood floor plus joists, with soil cover below.

The 'buddle' comprises an outer (presumed) circle c2680mm in diameter, made up of a series of curved, half-jointed timbers c78 x 78mm in section. Occasional surviving nails/staples and localised iron staining on the top surface of the wood suggest nailing was the original means of affixing the half joins. In the presumed centre of the outer circle is a wooden board c80mm thick and at least 1530mm long, its width concealed under the unexcavated portion of the 'buddle'. Along its front edge, this board appears to rest on a small, squared off length of timber, now broken at its visible end.



Fig

On top of the board, pieces of timber (each c70mm wide max x 90mm thick) have been cut and joined to form a circular block of wood c930mm diameter. It is not clear how the pieces were fixed together. Staining around the outer rim of the block suggests there was an original encircling iron band, now lost. The corroded remains of two unidentified iron fittings survive on the surface of the block. On top of the block lies part of a large timber 250mm wide x 160mm thick. This timber has been cut off – possibly fairly recently – and only some 540mm visible length survives. Two large nail heads protrude from the top surface,

As examined, the base of the outer timber circle and part of the central board were under water. The small central block and large, truncated timber were exposed to the air, though currently still damp. The outer circle, board and central block appear to be in very good condition, with traces of tool marks still visible on the outer circle and no signs of wear to most of the components. The wood is extremely hard and almost completely resistant to puncture with a steel awl. Part of the edge of the central block has been damaged, possibly during truncation of the large timber which lies over it, and it was possible to remove a sliver of damaged wood for species identification. This was identified microscopically as pine, though the exact sub-species could not be determined; pitch pine is a possibility. The top surface of the large timber is worn and abraded, in contrast to the condition of the rest of the 'buddle' structure, and the wood can be punctured to a depth of c3mm, suggesting some degradation of the timber.

RECOMMENDATIONS

Taking into account the relatively recent date of the structure (19th century) and its (mainly) excellent condition, it is likely to survive lifting and controlled air drying without significant damage or distortion.

Very hard, non-degraded timbers do not benefit from the pre-treatment and freeze-drying process which is applied to archaeological wood, as the treatment solutions will not penetrate the still-solid wood structure. Controlled air drying is the preferred method for drying solid, historical timbers.

The 'buddle' structure should be fully revealed by excavation as soon as possible to determine its full size and the nature of all its components, and to avoid differential drying of the wood components. The structure should be carefully dismantled as far as possible and washed with plain water to remove soil and other debris. The board/central block/large timber could be kept together so as not to risk losing their current close association.

It is suggested that a temporary structure be built on the overhead roof beams in the building to support the buddle components while they dry. The support should be fashioned to allow maximum (controlled) air flow around the wood to discourage mould growth, and could simply consist of dressed timber lengths or pallets to support the drying components and to allow air to flow around them.

The 'buddle' pieces should be arranged in a single layer on the dressed wood or pallets. The timbers of the outer circle should be re-arranged in their present position, to allow for monitoring of any distortion between the pieces.

To control the drying process, to minimise timber distortion, the wood should be loosely covered (**but not wrapped**) in polythene sheeting.

The drying process will take several weeks, and the wood should be regularly inspected for mould growth and excessive distortion. When dry, the timbers and associated metalwork are likely to require further basic mechanical surface cleaning. Following controlled air drying, the large truncated timber may require an application of wood hardener to strengthen and consolidate its surface.

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