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Duddon Bridge Ironworks, Cumbria

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DUDDON BRIDGE IRONWORKS: AN ARCHAEOLOGICAL FIELD SURVEY OF THE IMMEDIATE ENVIRONS COPELAND, CUMBRIA

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1. INTRODUCTION AND BACKGROUND TO THE SURVEY

The measured large scale archaeological field survey of the former ironworks at Duddon Bridge was undertaken during November and December 1997 by archaeology staff at the York office of the RCHME as part of its project on the Iron Industry and Related Woodland Industries of Furness and South-West Cumbria. The aims of the survey were twofold: firstly to contribute to the Royal Commission's architectural assessment of the site by providing an outline plan of the standing structures, profiles of the associated ground surfaces and an examination of the water supply system; secondly to show the buildings in their wider context by recording the field archaeology of the immediate environs (Fig. 1).

The most striking architectural elements which constitute the nucleus of the ironworks are the substantial ruins of the stone-built blast furnace and its attendant ore and charcoal storehouses (barns); the latter, also built of stone, are situated on top of a marked step (or steps) above the blast furnace and its ancillary structures. The earliest of the two charcoal barns is the one on the west. A pair of cottages, currently roofless and very dilapidated, are situated some 30m south of the furnace; they were subsequently amalgamated and enlarged into a single house. A byre-cum-stable and a loose box (or stable), each with a fodder loft, are also attached to them. The buildings on the site form the subject of a separate RCHME architectural report and will only be discussed in this report where they have a bearing on the understanding of the archaeological remains.

Features of archaeological significance in the immediate environs include: natural and man-made watercourses; a terrace-way which may have been the principal route to the ironworks from the south; remnants of slag dumps and a bridge; the charcoal loading platform outside the southern charcoal barn; a former stone quarry; garden features related to the cottages; the remains of an outbuilding associated with a small field-like walled enclosure; another small, ruined outbuilding; and evidence for charcoal burning in the woods above the ironworks.

The archaeological survey, in combination with cartographic and documentary sources, provided evidence for the site of a former bobbin mill which has also been included in this report. The remains of the mill are represented by a rubble spread, adjacent to a leat, on the west bank of the River Duddon some 70m north-east of the blast furnace.

2. TOPOGRAPHY AND LAND USE

The ironworks is located some 300m north-west of Duddon Bridge at SD 1965 8829. It is situated on rising ground between the 10m and 20m contours near the foot of the hillside which forms the western side of the Duddon valley. Rising ground was also chosen for the sites of the other ironworks in the region (Lord 1990, 2). This enabled full advantage to be taken of gravity for the movement of raw materials and products around the ironworks with charcoal and ore being delivered to the upper part of the site and the iron itself being produced at the bottom (Fig. 2).

The piece of land occupied by the buildings is bounded on the north and south by narrow, fast-flowing streams; the one to the south separates the pair of cottages from the ironworks. The lower course of the northern stream was clearly modified by the supply system put in place to power the water-wheel which certainly worked the later bellows of the blast furnace. The tail-race, which flows eastwards and away from the wheel-pit, follows a markedly angular course. This rather curious route was chosen, not because of topographical dictates, but in order to avoid interfering with the former bobbin mill (see below); this was apparently achieved by taking the tail-race across to the southern stream and utilising its lower course.

The ironworks has been opened up to the public and regularly mown grass now occupies the area between the principal buildings. Unmanaged woodland, largely deciduous in character with many saplings and patches of brambles, covers the rest of the site and immediate environs. An unsurfaced vehicle track, leading to the woodland (New Wood) north-west of the site, skirts the ironworks on the south and west and is now the principal access.

The site of the bobbin mill is located at SD 1973 8834 on the valley floor below the ironworks. It lies within a narrow strip of damp, alder woodland and scrub situated between the River Duddon and the road leading from Duddon Bridge to Beckfoot.

3. HISTORY AND PREVIOUS RESEARCH

In order to understand and interpret the features recorded by the RCHME archaeological survey, a brief resume of the history and previous investigation of the site is required. What follows is not intended to be comprehensive but merely an attempt at highlighting those aspects which are of direct relevance to the field archaeology. Some of the authorities referred to below contain much fuller accounts of the history of the ironworks and the technological processes involved.

Construction of the blast furnace and its associated buildings commenced in the early spring of 1736 by Edward Hall and Company (also known as the Cunsey Company) (Fell 1908, 215). The furnace had a relatively long life with production continuing until 1867 (Fell 1908, 215). Even though production had ceased, the ironworks was still regarded as an important asset for a number of years. On 11th January 1889, for example, the solicitors acting on behalf of the lessees of the site wrote to the town clerk of Barrow in Furness stating that 'our clients ..... regard the Duddon Furnace as a reserve which may prove extremely valuable at any time' (CRO, Z 2165/1) - indeed a fully costed estimate for repairs to the ironworks was even prepared (CRO, Z 2165/2).

Morton in his description of the furnace and analysis of the slags and pigs, gives three principal reasons for the choice of Duddon Bridge as the location for the blast furnace: proximity to abundant charcoal supplies from coppiced woods in the vicinity; ample water for power from the River Duddon; and the good access for coastal craft provided by the Duddon Estuary (Morton 1962, 444). The latter was particularly important for transporting the iron ore. Ore from mines on Lindal Moor and at Crossgates was brought to Ireleth, situated on the western bank of the Duddon Estuary some four miles west of Ulverston, and then shipped up the estuary to wharves below Duddon Bridge; from here the ore was taken by road transport to the site (Morton 1962, 445).

Initially the blast to the furnace was provided by leather bellows, however, during the late 18th century these were replaced by a system employing cast-iron open-topped cylinders (Fell 1908, 228; Mart 1937-8, 95). These cylinder bellows were driven by a water-wheel which was supplied from a weir upstream at Founders Hole on the River Duddon; a head-race was constructed to bring the water to the wheel. The weir, the course of the head-race and the buildings which make up the ironworks were all depicted by the Ordnance Survey on their first edition 1:2500 map of 1860 (Cumberland - Sheets LXXXVI/11 and LXXXVI/15). The head-race - which survives as a substantial earthwork - approached the blast furnace from the north and terminated at a right angle to the principal axis of the wheel-pit (Riden 1993, 110). The buildings, although by then derelict, were still included by the Ordnance Survey on the second edition of their map (Sheet LXXXVI/15), published in 1899.

During World War I the furnace complex was stripped of its machinery which, with any ore that remained, was removed to Ulverston (Mart 1937-8, 98). The designation of the ironworks as a Scheduled Ancient Monument was followed by a programme of excavation and consolidation in the 1980s undertaken by the Lake District National Park Authority (Riden 1993, 110). During the first season of excavations the robbed-out remains of the ancillary structures associated with the actual furnace - casting room, bellows room and wheel-pit - were exposed (Cherry 1982, 226-8). In the four subsequent seasons the examination of both the wheel-pit and also the head-race and tail-race associated with the water supply system was completed, the interior of the furnace stack together with the

ancillary buildings on its western side were excavated, and the charcoal barns examined with the western barn being fully excavated (Cherry 1983, 199-201; 1984, 321; 1985, 185; 1986, 354-5). The excavated features have been left uncovered as part of the presentation of the site to the public.

The bobbin mill and its attendant water supply system were also depicted by the Ordnance Survey on their first edition 1:2500 map of 1860; according to the labelling on the map the mill was concerned with brushstock and handle production. In a lease of 1886, it is described as a 'Bobbin Mill or Brush Stick Manufactory' (CRO, Z 2159). The letter of 11th January 1889 to the town clerk of Barrow in Furness (see above) stated that 'Our clients have been lessees of the Duddon Bridge Iron Furnace and Bobbin Mill for upwards of 100 years' (CRO, Z 2165/1). It appears that the bobbin mill ended its days as a saw mill because it was published on the second edition of the Ordnance Survey 1:2500 map of 1899 as 'Duddon Saw Mill (Disused)'.

4. DESCRIPTION AND ANALYSIS OF THE FIELD MONUMENTS

The descriptions of the sites included in this section are derived from RCHME's archaeological survey which took place at the end of 1997. The letters in brackets refer to the letters on the site plan (Fig. 1). The monuments recorded can be grouped under four main headings: those connected with the woodland industries; those relating directly to the ironworks; those occurring in the environs of the ironworks whose associations or functions are not always clear (a miscellaneous category); and those associated with or representing the remains of the bobbin mill.

The woodland industries

During the initial reconnaissance of the area, it was observed that the woods west and north-west of the ironworks contain ample evidence for charcoal production in the form of pitsteads (charcoal burning platforms); at least one potash kiln was also located. One of the pitsteads, (a), occurs just within the area surveyed at large scale. It is situated at SD 1960 8823, above and some 35m south-west of the charcoal barns, and consists of an oval platform measuring a maximum of 11m across. A natural rock outcrop appears to have been incorporated into its south-eastern side, probably because it provided a ready-made revetment; on this side the platform is up to 1.2m high. On the east a ruined wall, representing the corner of a small enclosed plot (see below - Miscellaneous Monuments), appears to have been built against the edge of the pitstead at a later date. The vegetation comprises grass tussocks and trees; where the ground surface is disturbed, small pieces of charcoal are visible. A footpath is present below the platform on the east.

Monuments in the environs related to the ironworks

The principal monuments associated with the ironworks include the charcoal loading platform, a stone quarry, a terraced track, the water supply system, slag dumps and a bridge, and the remains of the former gardens associated with the pair of cottages.

The charcoal loading platform

A flattish rectilinear area (b), at SD 1962 8826, is the site of the charcoal loading platform; it abuts the outer face of the long, south-west wall of the southern charcoal barn and is currently covered by brambles. Charcoal from both the adjacent woods and from further afield (Lord 1990, 2) was brought to this platform for loading into the charcoal barn via three large openings which pierce the wall on this side. The charcoal must have been lowered or emptied into the barn given the fact that the floor is about 4.0m below the top of the platform and the openings (Fig. 2). The platform appears to have utilised a slight natural stepping in the hillside which may also have been enhanced with material dug out during the construction of the charcoal barn. On the north-west its edge is defined by a dry-stone wall, now partly collapsed, 0.6m wide and up to 1.1m high. Its south-eastern edge is formed by a long, outward-facing scarp which seems to be the natural slope of the ground above the southern stream. The south-western perimeter is obscured by the vehicle track to New Wood; the track may be a creation of the 20th century because it was not shown on the Ordnance Survey maps of 1860 and 1899.

The stone quarry

The close proximity of a quarry, (c), to the ironworks suggests that the former was one of the principal sources of the stone used in the construction of the buildings on the site. It is situated at SD 1963 8823, just beyond and to the south of the southern charcoal barn. The quarry was already worked-out when the Ordnance Survey produced their first edition 1:2500 map in 1860. On this map the edge of the quarry was depicted by a line which, together with the deciduous woodland symbol, implies abandonment and a covering of trees. The quarry symbol was used on the second edition of the map and the site was labelled 'Old Quarry'.

The remains of the quarry pit still survive within woodland although its northern half has been substantially infilled with spoil derived from the archaeological excavation and consolidation of the ironworks during the 1980s (A Lowe, pers comm). The pit is approximately sub-rectangular in plan and measures 30m long, 20m wide (maximum) and up to 6.0m deep. The steep rock face which characterises the western side of the quarry is largely moss-covered although, where the rock is still bare, there is evidence that drilling took place because one drill hole and part of a second are visible. A drill hole is also visible in one of the large slabs used in the construction of the lower part of the north-east corner of the blast furnace stack.

The terraced track

The area occupied by the blast furnace has a terraced track, (d), leading towards it from the south-east. It is quite possible that this track formed part of the route between the blast furnace and the wharves below Duddon Bridge, along which the iron ore was brought to the site. The track was shown on both the first and second editions of the Ordnance Survey 1:2500 map and extends from approximately SD 1971 8826 to SD 1969 8829.

The top of the track is about 5.0m wide and its centre is slightly hollowed in places. On the eastern (down-slope) side it is edged by an outward-facing scarp, 1.1m high on average. As the track proceeds north the scarp is replaced by a revetment wall, 0.6m high; at least six courses of dry-stone walling are present and in front of the wall there is an elongated hollow, 0.5m deep. At the north-west, in front of the blast furnace, a bridge formed of large slabs carries the track across the southernmost of the two streams which flank the site. Similar slabs, clearly displaced and now lying against the side of the stream, indicate that the bridge was once wider.

At its southern end, just outside the survey area, the track now joins a metalled road which provides access to several dwellings on the hillside above the ironworks. A cottage, also depicted on the Ordnance Survey map of 1860, is situated at SD 1971 8824 on the southern side of the road opposite the junction with the track. The external appearance of this building, its small size and restricted width, together with its position at the entrance to the ironworks point towards it having been an ancillary building detached from but related to the works. By the late-19th century it may even have become one of 'the three cottages or Dwellinghouses' which were specifically mentioned in connection with the ironworks in the lease of 1886 (CRO, Z 2159); the other two cottages are probably represented by the pair of ruined cottages near the blast furnace.

The water supply

The topographical location of the ironworks ensured that it was close to a number of water sources, even so it is quite possible that water was still a problem at certain times of the year. During wet periods surface run-off and overflowing of the streams, especially the southern one, is likely to have caused localised flooding in the lower part of the site where the blast furnace is situated. Indeed, this was observed at first hand during the survey which coincided with a particularly wet winter period. At the other extreme fast-flowing mountain streams, of the kind flanking the ironworks, are notoriously unreliable in periods of drought thus creating problems where a constant supply of water is needed to power machinery. Indeed apparent modifications to the natural drainage and the systems put in place to supply the water-wheel help to confirm that all these factors had to be taken account of.

The southern stream, where it passes the blast furnace, has clearly been canalised. A low, stony bank, 0.3m high, on its southern side at SD 1968 8828 may be the result of periodic cleaning out of the stream bed to prevent the build-up of obstructions. In the area adjacent to the pair of cottages and blast furnace, both sides of the stream have been revetted with stone walling - presumably to help contain the water and reduce erosion to the sides. Near the cottages the southern revetment rises above the stream to form the northern wall of a small garden attached to them on the north-east; in front of the cottages the stream is bridged by large slabs.

Below the ironworks the natural south-west to north-east route of the stream to the River Duddon is blocked by the remains of a slag heap, (e), with the result that the stream has been turned through ninety degrees to flow south-east along a new course. The north-western part of this course was shown on the 1860 Ordnance Survey map suggesting that the slag heap was in existence by that date. The present route of the stream between the slag heap and the river developed some time after the map was prepared - the latter has the stream resuming a northerly course again immediately beyond the slag heap to flow into the tail-race which took the used water away from the water-wheel. Part of this former course survives as a short, linear hollow - now dry and about 0.3m deep - skirting the southern foot of the slag heap. The diversion of the stream by this slag heap may well be connected with the construction of the tail-race channel. The latter, in order to avoid the bobbin mill, appears to have been laid out so that it could drain into the original lower course of the stream.

The route of the northern stream was greatly affected by the provision of a reliable water supply, certainly for the water-wheel which powered the cylinder bellows. Near the blast furnace the stream has been truncated by the head-race associated with this later wheel which was of the low-breast type. The head-race consists of a substantial leat (see below), constructed across the stream and at ninety degrees to the main axis of the latter. The stream discharges into this leat and may once have augmented the supply to the later water-wheel, however, because the supply system is no longer maintained, the water now flows along the leat in the reverse direction to the ironworks. A marshy linear hollow at (f), centred SD 1968 8832, is all that survives of the original course of the stream beyond the leat.

Excavation of the extant wheel-pit in 1983 produced evidence for a smaller and earlier wheel-pit. It has been suggested that this pit was associated with an overshot wheel supplied by a launder; a revetted platform in front of the storehouses and an opening at the junction of the charging bridge were considered to be at an appropriate height to have fed this launder (Cherry 1984, 321). The RCHME survey has also produced evidence for this being the

possible route for the water. At (g), north-north-east of the western charcoal barn, a short length of wall may be related to the platform revetment; it is centred at SD 1964 8830 and is on the same alignment as the edge of the platform and the opening referred to above. The wall, in ruinous condition, is 0.9m high (north face) and 0.6m wide and is largely concealed by brambles. Its eastern extremity disappears under a dump of spoil (presumably relating to the excavation and consolidation of the 1980s) while its western end has been mutilated by a drain. Beyond the drain, a scatter of large, stone blocks continue its line to the stream. This would suggest that the stream was the water source, however, there is no obvious sign, at least in the immediate vicinity, for the stream having been damned and the water impounded to provide a sufficient body of water both to power the water-wheel and also to sustain its operation. Perhaps the water was impounded higher up the hillside, beyond the environs of the ironworks, with the stream itself being diverted and used as the head-race; it is certainly curious and possibly significant that the stream was not depicted on either the first or second editions of the Ordnance Survey 1:2500 map.

The head-race at (h) was constructed to bring water southwards from a weir on the River Duddon at SD 1955 8898 to the later water-wheel at SD 1967 8831 which powered the cylinder bellows. Authority to make the weir was given to the ironmasters in a lease of 1790 (Barlow-Massicks 1897, 449). The end of the head-race just beyond the blast furnace was excavated in 1981 and found to be lined with masonry; adjacent to the stack its floor consisted of levelled bedrock which was later supplemented by pine boarding and kerbed with boards placed in an upright position (Cherry 1982, 228).

The head-race survives as a substantial leat or wet ditch with a total length of about 690m (Fig. 3) . The northern two thirds of its course follows the river quite closely, however, at SD 1963 8852, just north of where it is crossed by the road to Beckfoot from Duddon Bridge, the leat turns towards the ironworks and away from the river. Within the area of the survey, the leat is approximately 4.0m wide and up to 1.5m deep, with a bank on its lower (eastern) side. Mature trees grow on top of the bank which is 1.2m high; the overall width of the bank and ditch is about 8.0m. Beyond the limits of the survey, at SD 1964 8839, a bypass channel leaves this leat on the east and runs down the slope to join the head-race associated with the former bobbin mill; the bypass channel was also shown on the first and second editions of the Ordnance Survey 1:2500 map.

Used water from the water-wheel was led away in an east-north-east direction by the tail-race (i), which, following excavation and consolidation of the ironworks, has been left open and forms a conspicuous feature. It consists of a channel, about 0.8m wide and 0.5m deep, lined with carefully built dry-stone side walls; it as situated in the bottom of a trough which has splayed sides. At its western end, immediately beyond the wheel-pit and at about SD 1968 8831, the first metre or so of the channel has been bridged with large slabs. After proceeding downslope for about 22m, the tail-race turns to the south-east and runs under the car parking area and access track to the site, either in a culvert or a pipe. It has been argued elsewhere in this report that this change in direction was probably governed by the presence of the bobbin mill whose site would have lain in the path of the leat had the latter maintained its east-north-east course to the River Duddon. The tail-race has been slighted immediately beyond the eastern edge of the track, however, after a gap of about 8.0m it reappears again as a broad hollow which has a maximum depth of 1.1m. In this area it is probably occupying the original lower course of the southern stream (see above). Proceeding in an easterly direction it is crossed by the road from Duddon Bridge to Beckfoot and then joins the tail-race from the former bobbin mill.

The slag heaps and bridge

A prominent tree-covered, oval mound at SD 1969 8830, (j), east of the blast furnace and ancillary structures, appears to be largely composed of earth and slag and is about 2.0m high. One of its functions was clearly to serve as an access ramp to a bridge situated at its north-western corner. The bridge crosses the tail-race and was probably built to facilitate the dumping of slag away from the casting room and rest of the blast furnace complex (Cherry 1982, 228). The strip of ground above the northern side of the tail-race, between the end of the bridge and the Duddon Bridge to Beckfoot road, is covered in slag suggesting that dumping did indeed take place. However, apart from two well defined depressions (with much slag visible in their sides) near the road and minor scarps, this area is fairly level suggesting that the dumped slag has been carted away from the site for use elsewhere. Returning to the bridge, it is a solidly built structure which measures 2.0m across and stands about 3.0m above the bottom of the tail-race channel; the top is now obscured by brambles. Its dry-stone side walls, built of slabs laid in neat courses, have ends which splay outwards.

The tree-covered slag heap, (e), located at SD 1971 8830 some 40m east of the blast furnace, has already been discussed in respect of its relationship to the southern stream. It consists of a finger-shaped mound, 1.0m high, containing much slag and large pieces of firebrick lining.

Garden features associated with the cottages

At the north-east end of the pair of cottages, apparently last occupied in 1957 (Marshall 1984, 6), is the remains of a small and very overgrown walled garden, (k). Its outline was depicted on the Ordnance Survey first edition map of 1860. It is located at about SD 1967 8828 and is approximately rectangular in plan with a stone-built privy protruding from its eastern corner towards the valley bottom; the end wall of the cottages forms one side of the garden which was entered through a narrow gateway, located where the short, south-west wall of the garden comes up to the northernmost corner of the cottages; all that survives of the gate and fixtures is a metal hook in the wall of the building. The walls of the garden are free-standing - apart from the one at the south-east which forms a revetment against the higher ground which rises above the garden on this side - and are generally 0.5m to 0.6m wide.

Within the garden, the edges of a former path are represented by two parallel rows of slates spaced about 0.6m apart. The slates have been set on edge and protrude a maximum of 0.2m above the surface. The path, except on the south-east, almost mirrors the line of the garden walls and is separated from them by a narrow bed, about 1.0m wide. Near the privy, a cross-division within the bed is also represented by a line of edge-set slates. The south-eastern corner of the garden appears to have been the location of a triangular bed which, on the north, terminated against that section of the path which gave access to the privy. A large bed, defined by the path and thus slightly rhomboidal in plan, occupies the centre of the garden; the north western half of the bed was used for fruit growing judging by the tangle of overgrown blackcurrant and gooseberry bushes which occupies this space.

It is possible that there was also a small garden plot at SD 1965 8826 on the hillside above and to the south-west of the cottages. This is represented by slates set on edge which are just visible above the surface at (l). They form three short rows two of which are parallel to each other and are reminiscent of the edging to a former path; near the southern end of this feature is a rectangular area of rubble measuring 1.5m by 1.0m, possibly the remnants of a small, collapsed structure.

Miscellaneous monuments in the environs of the ironworks

Monuments in this category include the remains of a walled enclosure and small outbuilding, situated in the woodland south of the southern charcoal barn, and the ruins of a small outbuilding and platform opposite the stone quarry and above the southern stream; this last building is near a terraced track.

The enclosure and outbuilding

Ruined walls in area SD 1962 8824 delimit three sides of a small, rectangular field-like enclosure, situated at (m) upslope from the southern charcoal barn. Two small fields were depicted on this part of the hillside by the Ordnance Survey in 1860; the southern one was probably disused well before the map was prepared because the conventions used indicate that its interior was tree-covered. The western and southern boundaries of the enclosure recorded during the RCHME survey equate with those of the northern field. The fields were not shown on the 1899 Ordnance Survey map, however, a former outbuilding and wall - which form the northern side of the RCHME enclosure - were marked. This outbuilding may also have been in existence by 1860 because a small structure is shown in this area on the first edition Ordnance Survey map. However, a cartographic error may have occurred because this map positions the building some 10m east-south-east of the extant ruins and what was shown on the 1899 map. The position of the south-eastern end of the nearby southern charcoal barn - as drawn in 1860 - similarly does not agree either with the second edition map or what currently survives. In this instance it is just possible that what was shown on the first edition map was the extent of the charcoal barn prior to its rebuilding and probable extension after a fire (Cherry 1985, 185).

The walls which define the southern and northern boundaries of the enclosure are about 0.6m wide. The southern one, at best about 0.2m high, has been largely destroyed by robbing whereas the better preserved northern wall survives to a maximum height of 0.5m. The western boundary wall has been reduced to little more than a band of rubble following the edge of a natural rock outcrop, while on the east there is no trace of a boundary at all - perhaps the one in this direction, given the location and close proximity of the stone quarry, was destroyed by the quarrying. The western part of the enclosure is crossed by a hollowed track, 2.2m wide and up to 0.6m deep, which leads up the hillside. It was depicted on the Ordnance Survey map of 1899 as the upper part of the track which still skirts the ironworks on the south.

The ruins of a small, rectangular stone outbuilding (SD 1962 8825) occur at the present north-east end of the enclosure. The north wall of this building forms part of the northern boundary of the enclosure. Internally it measures 2.4m (west-north-west to east-south-east) by about 1.5m. Where best preserved its walls stand to a height of 0.8m with up to eight courses still visible. Average wall width is 0.55m and a slight gap in the northern wall (at the northernmost corner) could be the site of an entrance; traces of mortar are visible in places between the stones.

The ruined outbuilding and platform above the southern stream

An L-shaped structure, (n), comprising the vestiges of a small, rectangular stone outbuilding with a dry-stone platform protruding from its north-western side, is located at about SD 1965 8824. It is situated on the south-east bank of the southern stream, some 25m south-west of

the pair of cottages.

The building may have become redundant during the second half of the 19th century, possibly when the ironworks fell out of use, because an outbuilding was shown here by the Ordnance Survey in 1860 but not in 1899. Some form of association with either the ironworks or the cottages is suggested by its close proximity to a terraced track, situated to its east and north-east. The track, which leads up the hillside from the cottages, has a branch leaving its western side in the direction of the southern charcoal barn. It crosses the stream by means of a slab bridge, depicted on the maps of 1860 and 1899.

The building has a damp situation because its floor has been sunk to a depth of up to 1.25m into the slope just above the stream. As a result, the walls contain much exposed bed rock although dry-stone walling occurs too. Overall the building is about 3.0m long (north-east to south-west) and 2.0m wide. The absence of an end wall at the north-east indicates that this was the location of the entrance. The platform is square in plan, about 1.5m across, and stands 0.7m above the stream against which it terminates; it may have been a small yard.

The bobbin mill

The former mill buildings have been completely erased and all that was surveyable at the time of the RCHME survey was an apron-like platform, largely composed of spread stone rubble, at (o). It lies in the gap between the end of the head-race - which supplied the water-wheel at the mill - and the start of the tail-race. It is always possible, however, that further remains are concealed in the dense snowberry thicket which covers much of the area immediately beyond the platform on the north and north-east. The Ordnance Survey first edition 1:2500 map of 1860 indicates that the mill complex (SD 1973 8834) consisted of two principal building ranges: the mill itself located at the end of the head-race and with its main axis at ninety degrees to the water supply system; a second building situated a short distance from the mill on the north-east, with its principal axis parallel to the head-race and the River Duddon.

The rubble spread is very close to the site of the mill building and may, in part at least, relate to the subsequent infilling of the wheel-pit. The second building shown in 1860 was probably the dwellinghouse mentioned in connection with the bobbin mill in the lease of 1886 (CRO, Z 2159). Its demise, judging by its depiction on the second edition of the Ordnance Survey map which only showed its north-western half, had already commenced before the end of the 19th century; perhaps this was a consequence of the bobbin mill becoming a saw mill.

The water supply system, whose full extent was also shown by the Ordnance Survey in 1860, is still substantially intact (Fig. 3). However, most of it lies outside the area surveyed by the RCHME and the description which follows is based largely on cartographic evidence supplemented by selective reconnaissance in the field. Water was taken from the River Duddon at SD 1964 8852, south-west of Breast Dub, and carried by a leat (head-race) to the water-wheel which was located at the south-west end of the mill building. For its first 123m the head-race follows a slightly curved course, generally in a south-south-east direction, however, at about SD 1966 8841, where it is joined by a bypass channel from the nearby head-race which supplied the ironworks, it turns through ninety degrees and runs east-north-east for 18m. After another almost right angled bend, it heads south-east along a straight course for 80m to the site of the former water-wheel at about SD 1972 8834. Throughout this last section there is evidence for dry-stone revetment walling lining both sides of the

head-race channel. Within the area surveyed by the RCHME, near the end of the head-race (here up to 4.5m in width), the revetment on the side adjacent to the river still stands to a height of 0.7m; five courses of carefully laid stones are visible. A bypass channel, now heavily scoured by water action, leaves the north-eastern side of the head-race at SD 1971 8836 and joins the river. The short section of leat between the bends is crossed by the road from Duddon Bridge to Beckfoot. The water supply system is very similar in form to that which served the later water-wheel at the ironworks indicating that the bobbin mill wheel was either of the low-breast type or an undershot wheel.

The tail-race, (p), is also a substantial channel which at the time of the RCHME survey contained standing water. It is 5.0m wide on average and 1.4m deep; at its south-east end it runs into the River Duddon. The north-eastern lip of the channel is followed for much of its course by a tree-covered bank, approximately 3.5m wide, which on the side facing the river is about 0.6m high. The channel is joined on the west by the tail-race from the former ironworks

5. DISCUSSION

The RCHME archaeological survey and its attendant research have shown that the ironworks and bobbin mill formed the two principal elements of a small industrial landscape on the western side of the Duddon valley not far from Duddon Bridge. Both industries relied on access to good communications and an abundance of manageable water to power their respective water-wheels. In addition, both required access to the products of coppiced woodland - charcoal for the blast furnace and wood of a suitable size and shape for turning at the bobbin mill. The environs of Duddon Bridge provided an excellent location for drawing on these resources. With regard to communications, close proximity to the Duddon Estuary and its shipping was, as discussed above in the History and Research Section, of particular importance to the ironworks. The pitstead recorded at (a), together with the ones observed during initial reconnaissance, provides an excellent illustration of the close association between the woodland industries and local iron industry. Although there is no record of where the charcoal produced at (a) was taken to, it may well be significant that this pitstead is by a track which leads directly to the charcoal loading platform outside the southern charcoal barn. The proximity of the ironworks to the stone quarry at (c) represents another interesting relationship - the latter may have been one of the principal sources for the building stone used on the site.

The association of the ironworks with the bobbin mill is also worthy of comment. In this instance the two sites are separate unlike at Low Nibthwaite, situated besides the River Crake near the southern end of Coniston Water, which has also been surveyed by the RCHME. At this last site the blast furnace, following the cessation of iron production at the site, became a bobbin mill which itself was later reused as a saw mill and joinery works (Blood and Bowden 1998, 1). The RCHME Furness Project has shown that the reuse of earlier industrial sites by other industries was a recurring phenomenon in the area. One of the contributory factors to this process must have been the desire to take advantage of the water supply systems which had been established for these earlier industries. In the case of Duddon Bridge it was the bobbin mill which was reused as a saw mill during the latter part of the 19th century.

Although the Duddon ironworks and bobbin mill were separate entities they were nevertheless clearly dependent on each other for certain things - indeed they even had the same lessees during the 19th century (see above - History and Research). Although each industry had its own system of head and tail-races, the head-races were linked by the bypass channel from the head-race which supplied the ironworks. This presumably meant two things: first that the supply to the bobbin mill could be augmented as and when required with additional water brought from the weir on the River Duddon (at Founders Hole) by the head-race belonging to the ironworks; and second that water from the head-race which serviced the ironworks could be discharged into the Duddon itself via the bypass channel leading to the river from the head-race of the bobbin mill (the discharge may have also included the water from the northern stream when the water-wheels were not being used). The tail-race from the former water-wheel at the ironworks joins the tail-race of the bobbin mill but only after it has followed a rather angular course laid out to ensure that the discharge of water did not interfere with the operation of the bobbin mill.

One final aspect which the RCHME survey has highlighted is the 'domestic' side of those people who worked at or lived near these industrial sites. According to documentary sources four dwellings were associated with the ironworks and bobbin mill. It is tempting to see

these former habitations and the cottages which still survive to the south and south-west (Duddon Bridge and High Duddon), as representing a rather dispersed hamlet whose origins were closely connected with the industrial development in this part of the Duddon valley. The survey has even provided a plan of the internal arrangements of the small walled garden attached to the pair of former cottages, situated opposite the ironworks on the banks of the southern stream. Their survival and visibility is quite remarkable given their insubstantial nature and current dense vegetation cover. At Duddon, in keeping with many industrial sites that functioned in a rural environment where subsistence often formed an important element in the personal economies of those employed, agricultural monuments are close at hand. This is demonstrated by the field-like enclosure and outbuildings which occur within the area surveyed by the RCHME. The outbuildings may have been for livestock such as pigs. At the former ironworks at Newland near Ulverston (NMR No. SD 27 NE 44), for example, a survey by the RCHME architects has recorded the remains of a pig sty to the north of the blast furnace.

6. SURVEY METHODOLOGY

The RCHME archaeological survey was undertaken at a scale of 1:500. The ironworks and its environs were enclosed by a ring traverse using a Leica TC 1610 electronic theodolite with integral electromagnetic distance measuring. Major features including building outlines, boundaries, watercourses and the road and tracks were captured with the theodolite while fine detail was surveyed using the tape and offset technique. The profiles for the RCHME architectural assessment of the ironworks were also undertaken with the TC 1610 theodolite.

7. ACKNOWLEDGMENTS

The archaeological survey was carried out by Christopher J. Dunn and Amy Lax from the RCHME's York Office. The report was researched and written by Christopher J. Dunn and edited by Amy Lax. The site plan and other figures were prepared by Allan T. Adams (also at the RCHME York Office).

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APPENDIX

Table of NMR numbers linked to the survey

SITE NAME	COUNTY	DISTRICT	PARISH
Duddon Bridge Ironworks	Cumbria	Copeland	Millom Without

NMR no	Unique Identifier	NGR	Description of site
SD 18 NE 14	37256	SD 1965 8829	Ironworks and sites in immediate environs
SD 18 NE 15	1133232	SD 1955 8898 SD 1967 8831	Leat (head-race) supplying ironworks
SD 18 NE 16	1133681	SD 1963 8823	Stone quarry
SD 18 NE 17	1134051	SD 1940 8846	Charcoal burning platforms and potash kiln
SD 18 NE 18	1134075	SD 1973 8834	Site of bobbin mill
SD 18 NE 19	1134145	SD 1964 8852 SD 1972 8834	Leat (head-race) supplying bobbin mill

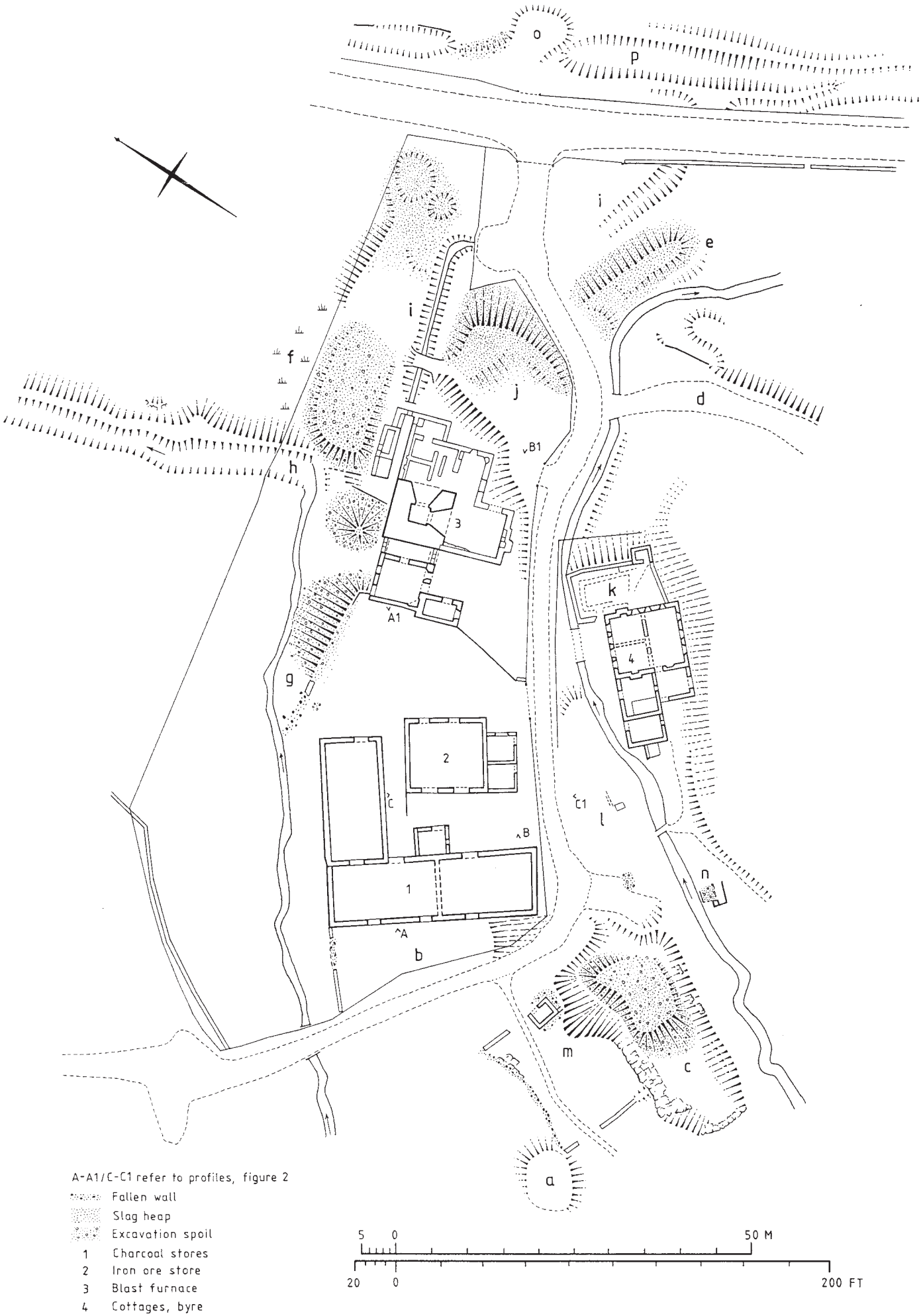

Figure 1. RCHME archaeological survey plan of Duddon Bridge Ironworks and the immediate environs (reduced copy of 1:500 scale archive drawing).

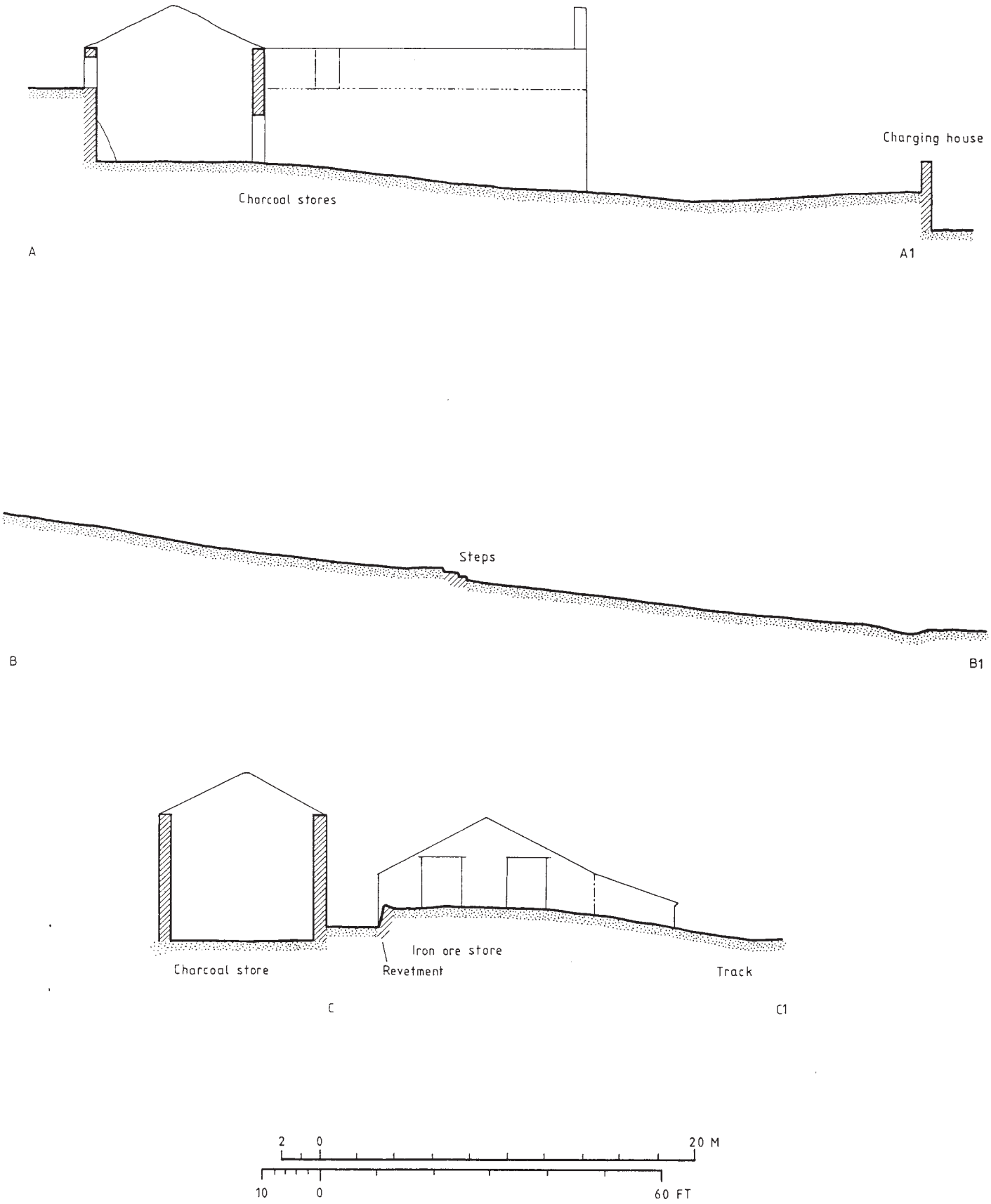

Figure 2. Profiles across the area occupied by the buildings (reduced copy of the 1:200 scale archive drawing).

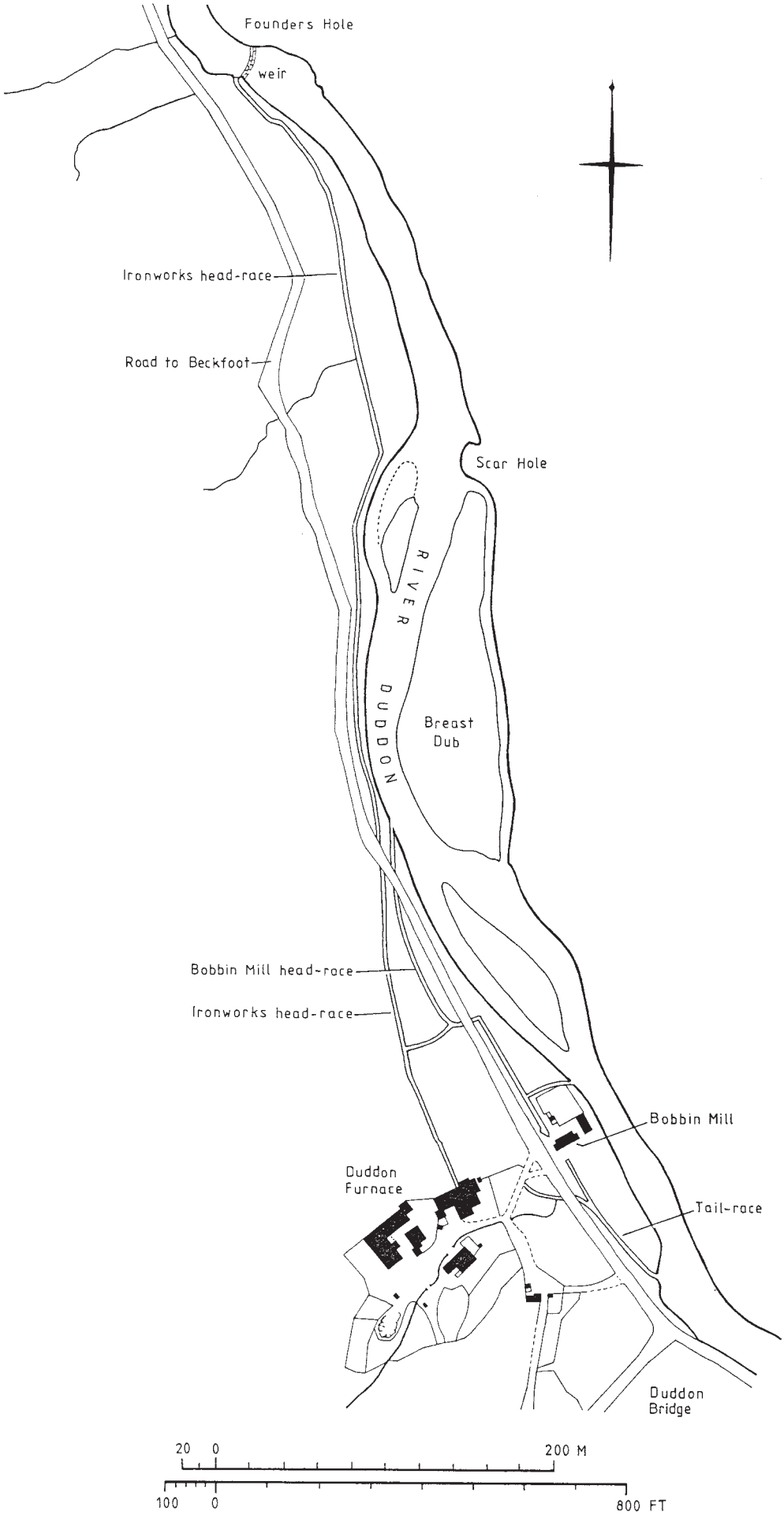

Figure 3. Diagram showing the water supply systems to the ironworks and bobbin mill (based on the Ordnance Survey first edition 1:2500 scale map of 1860).