ISSN 1478-7008

ENGLISH HERITAGE

Force Crag Mine, Cumbria

Alastair Oswald and Trevor Pearson

SURVEY REPORT

Archaeological Investigation Report Series AI/1/1999

FORCE CRAG MINE
ALLERDALE
CUMBRIA

Archaeological Investigation Report Series AI/1/1999

NMR No: NY 12 SE 11
NGR: NY 1997 2163
CUMBRIA SMR No: 11693

Surveyed: May-June 1999
Surveyed by A. Oswald, T. Pearson,
S. Ainsworth, A. Ditchburn and B. Thomason
Report by A. Oswald
Drawings by A. Oswald and T. Pearson
Photographs by K. Buck and P. Horne

ISSN 1478-7008

York Office: 37 Tanner Row, York, Y01 6WP
Tel: 01904 601901 ***Fax:*** 01904 601998

National Monuments Record Centre, Great Western Village, Kemble Drive, Swindon. SN2 2GZ
Tel: 01793 414700 ***Fax:*** 01793 414707 ***World Wide Web:*** http//www.english-heritage.org.uk

CONTENTS

LIST OF ILLUSTRATIONS

1. INTRODUCTION AND BACKGROUND TO THE SURVEY

Between the middle of May and the end of June 1999, English Heritage undertook a field investigation to identify, interpret and record the above-ground remains of the Low Force Workings and ore processing areas of Force Crag Mine in Cumbria. The archaeological survey was requested and partly funded by the National Trust, which owns the property, and was intended to inform their conservation and management of the site. The mine occupies a fairly remote location 4kms south-west of the village of Braithwaite and 7kms west of the town of Keswick, in the parish of Above Derwent in the district of Allerdale. The extant mill building, the focus of the area investigated, lies at National Grid Reference NY 1997 2163.

The site was mined for lead from 1839 until 1865, and for barytes and zinc intermittently from 1867 until it was finally abandoned in 1991, with varying success by a string of different companies. The extant mill building was built in 1908-9 and redesigned in 1939-40. It retains much of the ore-refining machinery that was in use in the 1980s, and some earlier equipment. Numerous other remains were recorded around the building, including the sites of two earlier mills and features relating to the mining and transport of the ore, the powering of associated machinery and the disposal of waste products. As a whole, the complex represents one of the best-preserved metal mining complexes in the region. A number of remains unrelated to the mining were also recorded, including a cairnfield probably of Bronze Age date, and several hut sites, which are probably of post-medieval origin.

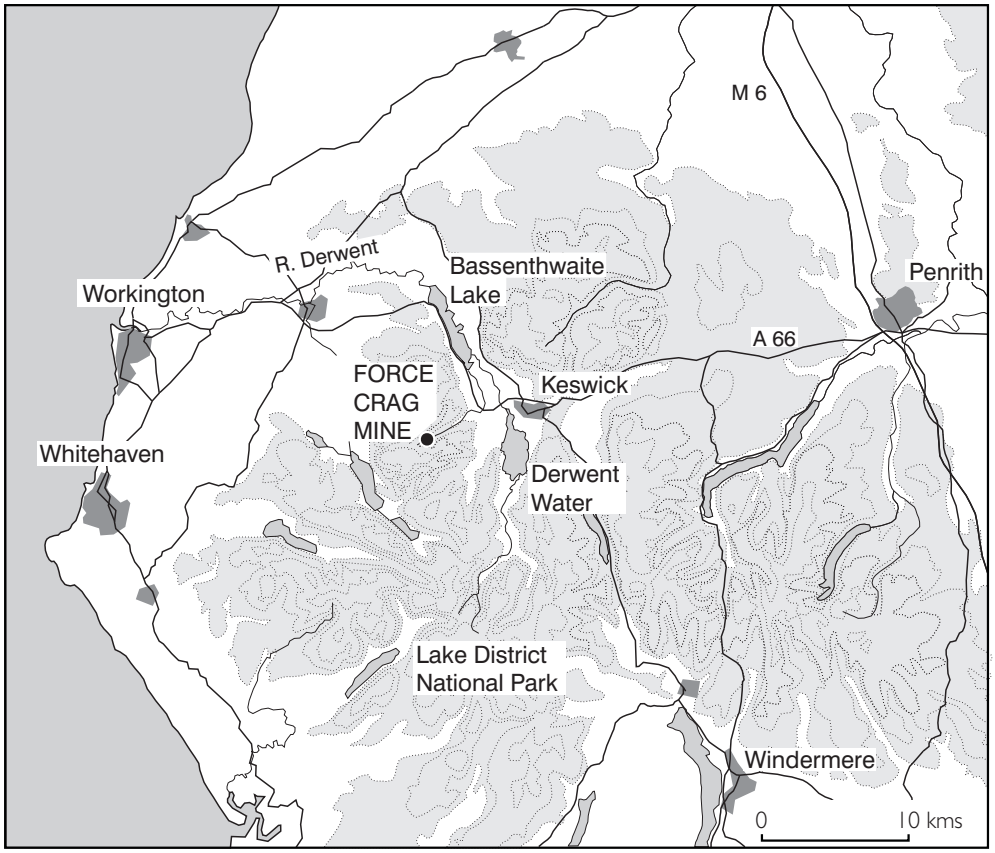


Figure 1. Location map

The fieldwork was carried out at Level 3 standard (as defined in RCHME 1999, 3-4) and was supported by less intensive documentary research (Level 2), together with a rapid field investigation of the High Force Workings and surrounding area. The surface remains of the mining complex as a whole are concentrated in an area approximately 75 hectares in extent (185 acres). The detailed survey was limited to an area of 42 hectares (104 acres) around the Low Force Workings, parts of which were under threat at the time of the survey through the slumping of natural scree and spoil tips on the northern side of the valley. Due to safety considerations, the mines below ground and some of the more unstable waste tips were not investigated.

Force Crag lies within the Lake District National Park, which is protected as a Site of Special Scientific Interest (SSSI); proposals are being considered to extend additional protection to the environs of the mine itself on the grounds of its geological importance. The extant mill building was not a Listed Building at the time of the survey, nor were the other remains protected as Scheduled Ancient Monuments. The building is recorded in the Sites and Monuments Record for Cumbria as 11693, and in the National Monuments Record as NY 12 SE 11 (this serves as a parent record for the other remains, the references for which are listed in Appendix 2).

Unauthorised entry into the extant mill building and the mines themselves is illegal and potentially dangerous.

2. GEOLOGY, TOPOGRAPHY AND LAND USE

The extant mill building stands at the head of the Coledale Valley, at an altitude of 271m above Ordnance Datum (OD), its site overlooked by the imposing cliff known as Force Crag. The High Force Workings lie some 750m to the west of the building and more than 300m higher. The valley, which is of glacial form, is narrow and steep-sided; it stretches from south-west to north-east and opens into the broader valley occupied by Bassenthwaite Lake and Derwent Water. A small fast-flowing stream, the Coledale Beck, runs along the length of the valley to join the Newlands Beck, and eventually flows into Bassenthwaite Lake. The Low and High Force Workings take their names from spectacular waterfalls ('forces') which occur where the Pudding Beck, a tributary of the Coledale Beck, descends the cliffs adjacent to the workings.

Detailed studies of the local solid geology of Force Crag have been undertaken in the past (Eastwood 1921; Young and Cooper 1988; see also Institute of Geological Science 1971). The Coledale Valley more or less follows the boundary between the Skiddaw Group Siltstones to the north and the Crummock Water metamorphic

Figure 2. Force Crag Mine as photographed 17 June 1999 (NMR 17273/18).

aureole to the south (Young and Cooper 1988, 6-7). The valley bottom is overlain by a glacial deposit of yellow boulder clay. Alongside the Coledale Beck, a layer of peat has formed over this. The Force Crag mineral vein cuts obliquely through the Skiddaw slates, running for at least 4.8kms from Gasgale Gill at the west (NGR NY 163 210) to Force Crag at the east. It generally maintains a thickness of *c*.1.5m, but reaches up to 6.1m in places (*ibid.*, 7) and divides into two thinner fractures below Level 1 of the mine. Lead, zinc, silver and a number of other minerals are present, but the barytes (barium sulphate) deposits are most exceptional in quantity and quality. Barytes was first refined in 1808, and was subsequently used in the manufacture of a variety of products including lithopone paints, munitions and plastics (Tyler 1990, 3-4).

Apart from the mining activity, the upper reaches of the Coledale Valley are open fell typical of the region and have seen no intensive land-use. The land was formerly part of the Leconfield Estate and now lies within the bounds of the Lake District National Park; light grazing by sheep has therefore continued uninterrupted. The area is open to the public, and the track along the northern side of the valley floor and footpaths along both rims are well used by walkers and cyclists. However, vehicular access along the Coledale Valley is controlled by the National Trust, and is difficult except by 4-wheel drive.

3. HISTORY OF RESEARCH

The English Heritage survey was the first detailed field investigation of the surface remains of the complex. It followed an initial assessment carried out in September 1995 by Lancaster University Archaeological Unit for English Heritage's Monuments Protection Programme, which recommended that more extensive and detailed survey should be carried out (Hedley and Cranstone 1995 unpublished).

Most previous studies of the physical remains have concentrated on the mining activity below ground. A number of fairly brief notes have been produced, which for the most part repeat similar information (Postlethwaite 1913, 103-5; Shaw 1972, 108-11; Adams 1988, 44-7; Hall nd unpublished; McFazdean and Tyler 1992). Several studies have dealt with the extant mill building in greater detail. In 1991, the refining process and working environment were recorded on film by Leeds University Television Unit (Chapman 1993 unpublished). In October 1996, the building was planned at 1:100 scale (Waring and Netts 1996 unpublished), and in November 1997 an analysis was made of the surviving equipment (National Trust 1997 unpublished). By far the most detailed and useful account of the development of the mine as a whole is presented in Ian Tyler's 1990 book, entitled *Force Crag: the History of a Lakeland Mine*. The book includes reproductions of a number of historic photographs and original documents, discusses some of the archaeological field remains dealt with below, and also deals in detail with the social history of the mining operation.

Prior to the English Heritage field investigation, there had been no specialist aerial photography of the site, in part due to the difficulty of low-altitude flying along the valley. To remedy this, a series of black and white and colour aerial photographs were taken in the course of the survey (Figure 2; see also Appendix 1). Black and white vertical aerial photographs produced by three non-specialist sorties, made in January 1947, June 1957 and August 1970, are also held in English Heritage's National Monuments Record (RAF 1947; 1957; Ordnance Survey 1970), but these images are at smaller scales and not particularly informative.

The documentary research undertaken by English Heritage was limited to a review of the secondary sources and readily available primary sources, particularly maps and plans. Another original document worth singling out is a diagrammatic 'mill flow sheet' compiled in 1985 by the owners of the mine (Sutcliffe 1985 unpublished, reproduced in Tyler 1990, 104). This report therefore draws heavily on existing studies: Section 4 comprises an overview of the development of the complex as a whole, while documentary evidence relevant to each individual feature is summarised in Section 5.

4. THE HISTORY OF THE MINE

A report written in 1578 for Sir Thomas Percy, Earl of Northumberland, records the quantity of silver per ton of lead in the 'crust ore' at Coledale. As Tyler (1990, 7) observes, this would seem to imply that some form of surface extraction had taken place, probably on a relatively small scale. A document dated 1755 indicates that further trials were made in the vicinity, and the Coledale Valley was included in a mining lease signed in 1783, though it is uncertain whether any work was done at Force Crag (*ibid*.).

In 1819, John Tebay, a speculator who had interests in many of the mines in the Derwent area, took up a lease on Force Crag, but appears not to have carried out any trials. In 1839, he sub-let to Messrs. Airey and Cowper, and several other partners (*ibid*., 9-11). Mining for lead ore began with the digging of Level 2 and Level 3 of the Low Force Workings, which lie close to the point where the mineral vein is exposed on the surface. A water wheel and basic processing area were constructed on the valley floor, and a dam was built in the saddle south of the Force Crag massif. Documents record the first sale of ore in September 1841. At about the same date, the Keswick Mining Company was involved in exploring for cobalt at Scar Crags, some 1.2kms to the south-east at NGR NY 206 207 (Tyler 1990, 12). They objected to the use of the land to the south of the Coledale Beck by the Force Crag operation, but appear to have proposed the construction of a smelter, by way of conciliation. According to Tyler, this was to be sited next to the stream and its use was to be shared by the two companies. In the event, the cobalt mine was a total failure (Adams 1988, 48) and the smelter was not built. The Tithe Map for the parish, surveyed in 1841, does not provide any information on either mine, since the upper reaches of the valley had not been enclosed (Cumbria CRO a).

James Postlethwaite (1913, 105) recalled that in 1846 some of the original partners lost interest, and mining ceased in order that those who were still committed could take out a fresh lease. However, it seems unlikely that his recollection of the date is accurate (McFazdean and Tyler 1992, 166). Certainly, on 21 June 1848, the lease was taken up by Messrs. Cowper, Cowper, Walton and Dowthwaite, and in the following year work commenced on Level 1 (Tyler 1990, 12-5). Considerable effort and expense was concentrated on the new mine, and in order to process the expected winnings a new water wheel and mill were built in 1854. However, despite being driven for a considerable length, the adit yielded only 350 tons (344.5 metric tonnes) of lead ore and so was abandoned in 1863 or shortly thereafter. Declining prices and overall yields of ore forced the company to go out of business in 1865. In 1861, the area was surveyed by the Ordnance Survey for the First Edition of the County Series 25-inch map, referred to throughout this report as simply the First Edition map (Figure 3; Ordnance Survey 1862). This large-scale survey offers an informative plan of the operation at this stage, although the field investigation suggests that some of the less regularly used components of the site were not recorded. Furthermore, the map indicates that iron was being mined, an assertion for which there is no other documentary support. However, siderite iron ore is present in significant quantities, staining some of the waste products and unprocessed blocks of ore-bearing rock a distinctive orange/brown colour (Young and Cooper 1988, 9). It is possible that the

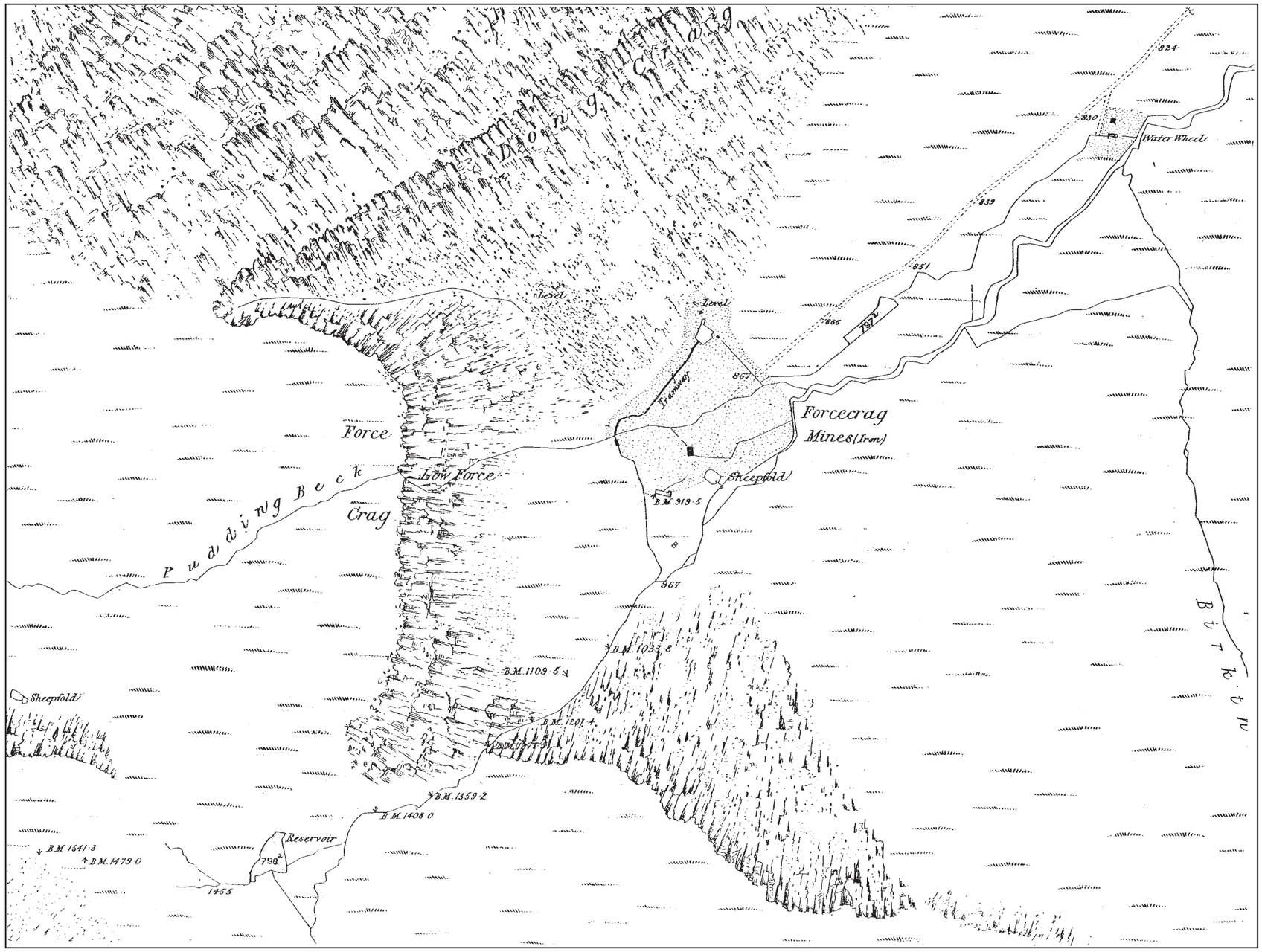


Figure 3. Force Crag Mine as mapped in 1861.

identification was an uncharacteristic error, based on an inference from the observations of the map-makers, rather than any information from the miners.

In 1867, the lease was taken up by Messrs. Hall and Straughton, initially with the intention of exploiting the barytes deposits alone, although in the event lead ore was still extracted as a by-product and some zinc ore was produced in 1872 (Tyler 1990, 17ff). Work began immediately on two new adits, Level 4 and Level 5 of the High Force Workings, and mining continued in Level 1. The deposits of barytes in the new levels proved good and in August 1871, the operation was floated as a public company under the name of The New Force Crag Mining Company Limited. In 1873 work began on Level 6 of the High Force Workings and the construction of a horse-drawn tramway from Braithwaite. In the following year, work was begun on Level 7 of the High Force Workings. Production was intensive over the next few years, reaching a peak in 1877. However, prices went into a sharp decline from 1878 onwards and the harsh winter of that year prevented any mining being done. In January 1881 the company was wound up, by which date about 5400 tons (5314.7 metric tonnes) of barytes ore had been extracted. By 1885, the mines and buildings were in a state of disrepair (*ibid.*, 30). The 6-inch revision of the First Edition map was carried out in 1898; though at a smaller scale it offers useful insights into how the complex had developed up to 1881 (Ordnance Survey 1900).

In December 1906, Cumberland Mines Limited, under the directorship of Joseph Lobb and Thomas Dennison, took up the lease on the site and began to repair and mine Levels 1, 2 and 3 (*ibid.*, 32ff). Zinc ore was now the main target, but barytes and lead were again extracted as by-products. The small mill they initially installed soon proved inadequate for processing zinc ore, and so a large new processing building - much of which still survives - was constructed in 1908-9. Possibly due to the cost of this investment, the company went bankrupt in 1911. The lease was taken up in the following year by The Coledale Syndicate. This company also invested considerable capital in repairing Levels 1 and 2 of the Low Force Workings and installing an up-to-date Elmore Flotation Plant capable of separating the minerals efficiently (*ibid.*, 36). A pelton wheel, which was turned by a pressurised jet of water being forced against cups around its perimeter, supplied power to the new equipment (*ibid.*, 35). The earliest dated plan of the underground workings was made in 1913 (Cumbria CRO d). In 1914, with demand for minerals rising as the First World War loomed, mining was begun on Level 0, but the high cost of this largely unsuccessful trial put the company out of business. In 1915, Braithwaite Mines Limited took over the lease and installed new machinery to process zinc ore being mined from Levels 1, 2 and 3; Level 0 was driven forward but remained unproductive (*ibid.*, 37ff). The sudden drop in the demand for zinc at the end of the First World War proved problematic: barytes was targeted as an alternative, but production had virtually ceased by 1921 and the company went out of business a year later.

In March 1928, The Derwent Fells Mining Company Limited took on the lease and carried out trials in Levels 4, 5 and 6 of the High Force Workings, before commencing work on two new adits, the High Force Level and the Newbould Crosscut, at slightly higher altitudes than Level 4 (*ibid.*, 49ff). The barytes deposits

proved prolific, and by 1933 about 5000 tons (4921.0 metric tonnes) had been extracted. However, for some reason the company then abruptly ceased production.

By 1939, when Tampimex Oil Products Limited took up the lease, most of the adits and buildings were again in a state of disrepair (*ibid.*, 51ff). Tyler (*ibid.*, 52) suggests that given the huge capital investment required to put the complex into working order, the company may have had financial backing from the Ministry of Munitions, since the onset of the Second World War had once again increased the demand for barytes for use in the explosives industry. The extant mill building was constructed, incorporating parts of the 1908-9 building. New machinery for processing the ore was installed, and a plan thought to be of *c.*1940 shows how this was arranged within the building (Cumbria CRO g; reproduced in Figure 22). Mining began on an unprecedented scale in the High Force Workings and a track was constructed to transport the ore down to the mill. By 1940 it was clear that this alone was inadequate and an aerial ropeway was constructed at a cost of around £10,000. This necessitated some changes to the building, which are reflected in a plan of 19 May 1944 (Cumbria CRO f). During the course of the war about 35,000 tons (34447.0 metric tonnes) of ore was extracted. However, the harsh winter of 1947 put the mine out of action for six weeks and caused severe flooding. This, together with the drop in demand for barytes that accompanied the end of the war, forced the mines to be abandoned.

In 1949, the La Porte Chemical Company began an ambitious programme to cut a long underground incline from Level 3 to the High Force Workings, in order to transport barytes and zinc ore down more efficiently and to test the mineral vein at various depths in the process (*ibid.*, 54ff). However, in 1952 the expensive incline was abandoned only a little short of completion and the whole operation ceased, without any ore having been extracted.

In October 1960, McKechnie Brothers Limited took up the lease on the site, intending to complete the projects begun by La Porte (*ibid.*, 67ff). This proved more difficult than anticipated and so in the interim mining was resumed in Levels 0 and 1. A number of documents from this period, including plans and section drawings, were collected by WT Shaw, the site manager and engineer (Cumbria CRO b; c; h). After 1964, production in the High Force Levels began to pick up but never reached the expected quantities. In March 1967, the operation was closed and the mill machinery was auctioned off; a copy of the catalogue listing all the items for sale still survives (Cumbria CRO b).

Within months, WT Shaw formed a new company with Canadian financial support, called Force Crag Mines (Toronto) Limited, and work began once more in Levels 0 and 1 (*ibid.*, 88ff). Some exploratory work was done, but little ore was produced, and the mine closed in 1972. In 1977, a subsidiary company, Force Crag Mines (UK) Limited, re-opened the mine (*ibid.*, 91ff). Having carried out some repair work, a shaft was begun in the base of Level 0 to test the vein some 30m lower, but the ore reserves were not as great as hoped and the parent company ended its financial support in 1978. Robert Gunn, a director of the subsidiary company, formed The Braithwaite Mining Company in the same year. Considerable capital

was spent on refitting the mill, but only a limited quantity of ore was extracted from Level 1. A harsh winter in 1982 and a severe collapse in the entrance to Level 1 shortly afterwards led to the closure of the mine. The equipment was auctioned off in July 1982 (*ibid.*, 100-1). In May 1984, the New Coledale Mining Company was formed, with a workforce of about eight people (*ibid.*, 102ff). Work began on the extraction of zinc in Levels 0 and 1, and once the chemical separation process had been perfected in 1987, a modest quantity of ore was extracted and refined. However, the lease on the property was due to run out in 1991 in any case, and an underground collapse in the spring of that year finally ended attempts to prolong the mining operation.

5. DESCRIPTION AND INTERPRETATION OF THE REMAINS

5.0 SUMMARY

For an overview of the remains described in Section 5, see the schematic plan of the site (Figure 4). The surviving remains can be broken down into five categories which broadly correspond to activities that occurred in the sequence from the extraction of the minerals to their processing: extraction, transporting the ore, water management, processing the ore, and waste disposal.

Section 5.1 describes features relating to extraction. Although no survey was undertaken below ground by English Heritage, the entrances of the five levels, or adits, that comprise the Low Force Workings were recorded, along with the entrance of Level 4, which is the lowest of the High Force Workings. The levels were not in fact perfectly horizontal, but sloped slightly upwards to allow any water encountered underground to drain out through the entrance. Small sumps survive outside the entrances to most of the levels, which allowed the outflow either to be drained away or redirected for use in the processing of the ore. Tramways, originally hauled by hand or pony and later by diesel or electric engines, were used to bring ore and spoil out from the mines; traces of these survive in the immediate vicinity of most of the entrances. Spoil was sometimes tipped outside the entrances, to form linear mounds often known as finger dumps.

Explosives, of various types, were essential to the extraction process and were stored in a separate building; the later of two such stores still stands. Mining was not the only extractive industry at Force Crag. In about 1961, large quantities of scree were quarried away for use as roadstone.

Section 5.2 describes the means of access to and from the site, and the various features for transporting the ore around the site. The abrupt natural topography of Force Crag Mine created continual difficulties in transporting the ore from the various adits on the valley sides - especially the High Force Workings - to the crushing mills on the valley floor. The problem was solved by different means at different dates according to the route and the technology available. There are surviving traces of tracks for carts and later lorries, hand-pushed tramways, a channel for 'slushing' the ore (ie moving it by the force of water) and an aerial ropeway. The underground La Porte Incline, which served a similar function, was not surveyed.

Section 5.3 describes features relating to water management. Water was the primary source of power until the middle of the 20th Century, and remained important in processing the ore throughout the use of the mine. Consequently, a number of cisterns and dams were built at various dates, all of which survive to some degree. Sixteen leats, or artificial water channels, were also recorded. However, there would undoubtedly once have been many more, formed by wooden channels resting lightly on the surface, that have left no identifiable trace.

Section 5.4 describes features relating to the processing of the ore. In the late 19th Century, the coarse blocks of ore were broken by hand on dressing floors before

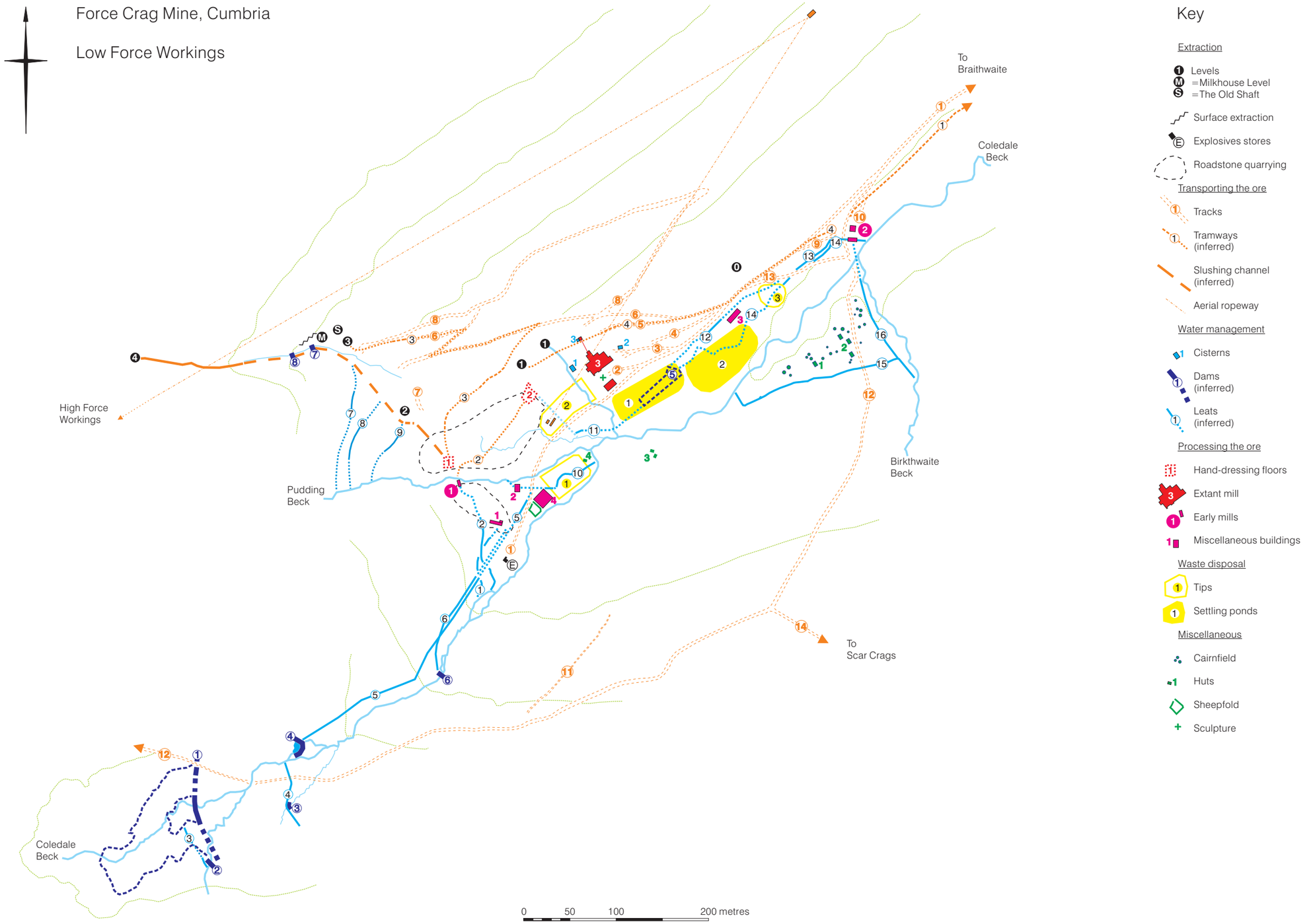


Figure 4. Schematic plan of the complex.

being taken to the crushing mills. One of the two hand-dressing floors identified on the basis of cartographic evidence has been quarried away, while the other has been buried, but their sites can be established with some confidence. The mills where the ore was crushed left more substantial remains. In addition to the extant building, the sites of two earlier mills can be identified. A somewhat different sequence of development for these is proposed from that suggested by Tyler (1990, 11), which is discussed at greater length in Section 6. At both sites, evidence for water wheel pits, washing areas and settling tanks survives. The extant mill building, built in 1908-9 and remodelled in 1939-40, retains evidence for the various phases of modification it has undergone, and documentary sources contribute considerably to the understanding of how the processing of the ore was carried out at various dates. The remains of the extant office and several other related buildings were also recorded.

Section 5.5 describes features relating to waste disposal. Most important among these are the 'slimes pits', or settling ponds, the first built *c.*1907 and a later one built at an unknown date and rebuilt *c.*1972. In addition there are several large tips of material.

Section 5.6 describes the miscellaneous remains recorded during the survey which do not relate directly to the mining activity. These include an area of field clearance cairns which are conventionally held to be of Bronze Age date, a sheepfold, three groups of crudely built huts, and a sculpture thought to be by the artist Andy Goldsworthy. Numerous minor features built by campers, mostly fire places, were not recorded. Some of the huts may in fact relate to early mining activity, but there is nothing in their form to conclusively support such an interpretation; it is quite possible that were temporary shelters built by shepherds.

In the following sections, features are described according to the categories outlined above, regardless of the date at which they were constructed. Most of the textual descriptions are accompanied by an extract from the original field survey (reduced where necessary) and in some cases by interpretative illustrations and photographs. Where appropriate, the documentary evidence for the history of the feature under consideration is summarised.

The entire photographic record is listed in Appendix 1. Note that only the principal components of the complex have been allocated individual National Monuments Record numbers; these are listed in Appendix 2.

5.1 EXTRACTION

The workings underground

Section 5.1 describes only the above ground remains that were recorded by English Heritage in the immediate vicinity of the entrance of Levels 0 to 4. A small-scale plan of the mines below ground has been published elsewhere (Adams 1988, figure on page 44), as well as cross-sections through the workings in 1869, 1939, 1948 and 1989 (Tyler 1990, figures on pages 18, 50, 55 and 110 respectively). A collection of unpublished plans and sections at various scales, dating from 1913 onwards, is held in the WT Shaw archive (Cumbria CRO d; e-k). The numbers and names that have conventionally been applied to the adits are retained throughout this report.

Level 0 (Zero Level or Low Level)

History

Work on Level 0 was begun in 1914 under the ownership of The Coledale Syndicate, with the aim of finding an ore vein containing 6% zinc that had been encountered in Level 1 (Tyler 1990, 37ff). The vein was not found, but work continued intermittently under successive companies until 1922. The level was then abandoned, and by 1939 the entrance had become blocked. It was eventually refurbished in 1965; the level was then worked until 1967 by McKechnie Brothers Limited, and until 1972 by Force Crag Mines (Toronto) Ltd, again with little success (*ibid.*, 73ff). The rebuilt portal is shown on a photograph taken in 1968 by Mr R Hilland (*ibid.*, 95). Level 0 went through its final phase of use under The New Coledale Mining Company between 1984 and 1990, when some ore was successfully extracted (*ibid.*, 102ff).

Description (Figure 5 a-c)

Level 0 is the lowest and most easterly of the adits of the Low Force Workings. The entrance lies adjacent to Track 1 at NGR NY 2012 2173, at an altitude of 257m above OD. It has been maintained and remains accessible. The portal, which is built of timber and corrugated iron, is in fairly good condition, although there have been some minor collapses into it. A sign overhead is now almost illegible, but reads 'DANGER - KEEP OUT'. The entrance lies towards the rear of a steep-sided cutting dug for a distance of 38m into the loose glacial overburden of the valley side, up to a maximum depth of 16m. Immediately upslope from the cutting, three deep sub-circular depressions mark the line of an underground collapse along the line of the adit, probably that which occurred in 1991. These are all unstable and have been fenced off for safety reasons.

A small but steady flow of water issues from the level and is drained under the road through a cast-iron pipe. The present course of the outflow stream partly follows the line of the tramway that formerly served the adit. The tracks and sleepers have been removed since 1991, leaving only slight traces, but the track evidently forked midway across Track 1. One branch continued for 20m south-eastwards onto a finger dump which retains the imprints of the wooden sleepers. A plan in the WT

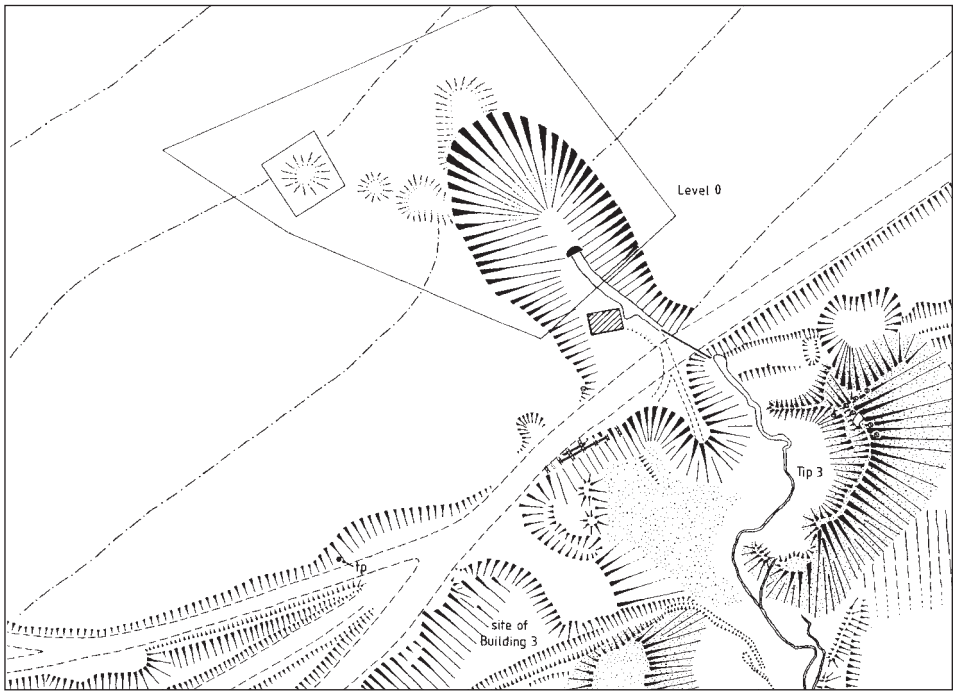


Figure 5a. Extract from survey reduced to 1:1000 scale showing Level 0.

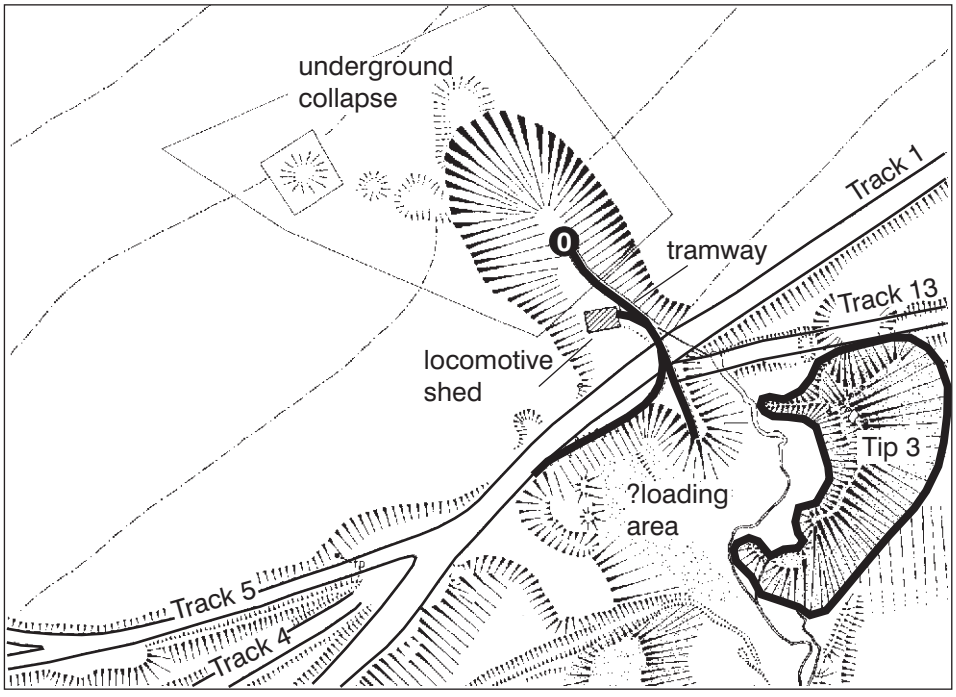


Figure 5b. Annotated extract from survey reduced to 1:1000 scale showing Level 0.

Shaw archive indicates that in 1960 the tip extended for a further 30m to the south-west (Cumbria CRO c); its terminal at that date is preserved in the bulbous end of the embankment around Settling Pond 2. A second map, dated 1972, shows that it was planned to extend the tip to form the remainder of the embankment (Cumbria CRO k). The material on what now survives of this tip comprises slate waste. The other branch of the tramway, which is not shown on either of the two plans, evidently turned south-westwards and ran for *c.*25m along the southern edge of Track 1. Seven of the timber trestles and parts of the beams that carried the rails still

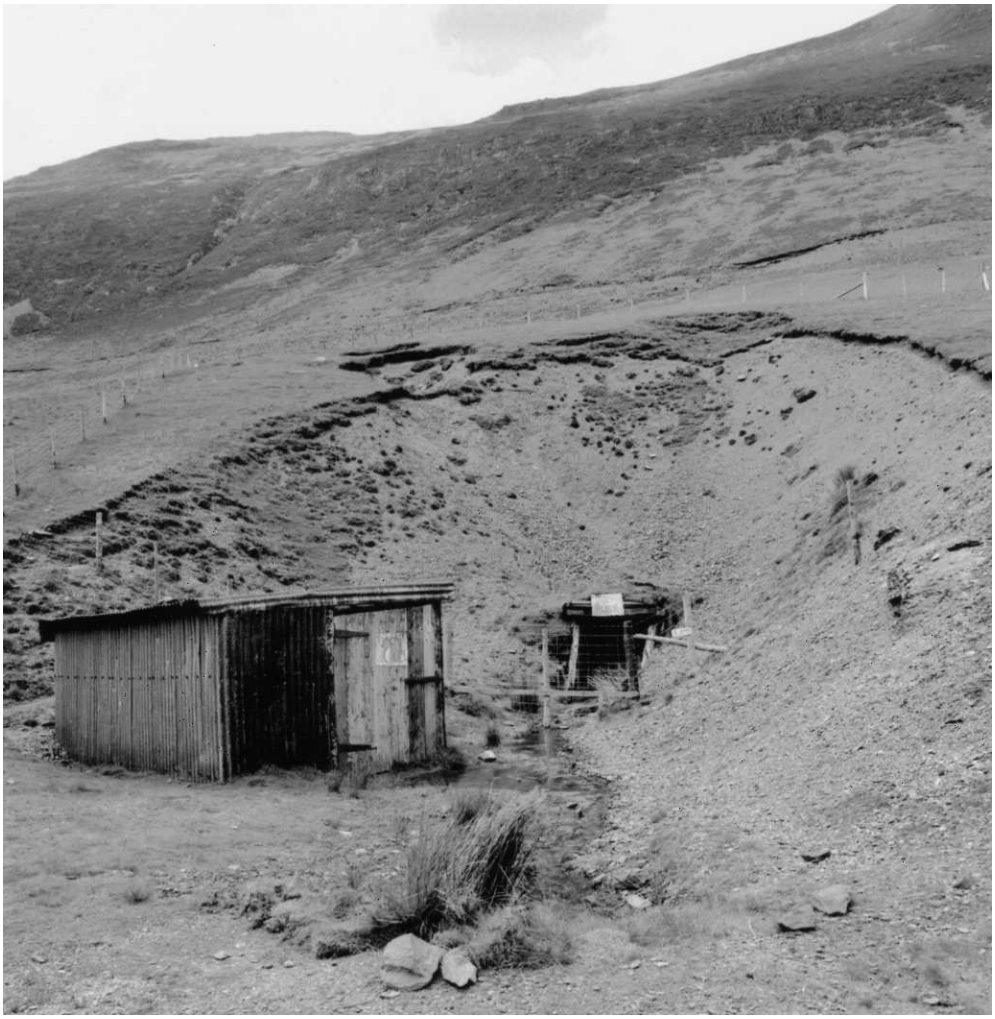


Figure 5c. Level 0 viewed from the south-east (NMR AA99/04047).

survive *in situ*, and the imprints of two more trestles are visible. There are barytes ore chippings along the length of this branch, suggesting that ore was probably tipped sideways from the trolleys for collection from the level area below.

A shed in the entrance to the cutting for the adit is built of timber and corrugated steel sheeting, and is in good condition. It, or a building of identical size, has stood there since at least 1960 (Cumbria CRO c). It is 5.0m long by 4.0m wide, with a broad doorway at its eastern end and a single window on its northern side. The tramway track seems to have run into the shed, indicating that the building housed the locomotive when it was not in use, presumably along with other equipment.

Level 1 (The Great Level)

History

Level 1 was the most intensively used of the Low Force Workings, both in terms of mining and access to the other Levels. Begun in 1849, by 1855 it was 300 yards long (274m) and cut the first major vein of ore, which was immediately 'stoped' to extract the lead (Tyler 1990, 12-22). The entrance to the adit is marked on the First Edition map surveyed in 1861 (Ordnance Survey 1862). By 1863, the level was 580 yards long (530m), but the vein had diminished in size. This, together with the falling demand for lead, caused mining to be abandoned shortly thereafter, and the company to cease trading in 1865. The level was refurbished in the following year and after 1867 work continued apace under the auspices of new owners, with the primary aim of extracting barytes. The adit was advanced 100 yards (91m) and *c*.1872, a 'rise' was driven upwards to connect with Level 2. However, due to various factors, the company went bankrupt in 1879 and by 1882, prospective lessees found the entrance to have collapsed. By 1885, the level had suffered severe collapse, and a long period of disuse followed (*ibid*., 30-1).

In 1907, under the ownership of Cumberland Mines Limited, Level 1 was put back into working order and was driven forward somewhat before the company went out of business in 1911 (*ibid*., 33-5). In 1912, the new owners, The Coledale Syndicate, were again forced to retimber the entrance (*ibid*., 36ff). By the following year, they were able to exploit a large deposit containing 6% zinc, encountered in a cross-cut. As the demand for zinc declined sharply at the end of the First World War, production slowed and in 1921 effort was concentrated on driving a 'sump' downwards from the floor of the adit. Despite the discovery of a large vein of barytes in 1922, the company directors failed to win the necessary financial backing and the mine closed (*ibid*., 47-8). Level 1 fell once more into disrepair and by 1939 the entrance was impassable (*ibid*., 51). It was eventually re-opened in 1963 under McKechnie Brothers Limited (*ibid*., 72). The ore reserves were evaluated and the extension of the level was considered, but no major mining had been undertaken by the time the company pulled out of the operation in 1967. In the same year, under the ownership of Force Crag Mines (Toronto) Limited, a new entrance was cut because the old one was in disrepair and constantly prone to collapse (*ibid*., 88-91). The sump begun in 1921 in the floor of the level was extended downwards to connect with Level 0, but little ore had been extracted by the time the company went out of business in 1972. The portal of the new entrance fell into disrepair, and was replaced by the existing structure in 1977, under the ownership of Force Crag Mines (UK) Limited (*ibid*., 92-3). Apart from an interlude of two years after a severe collapse in 1982, Level 1 remained in use thereafter until 1990 (*ibid*., 101ff).

Description (Figure 6 a-b)

The original entrance to Level 1 lies slightly higher than Mill 3 (the extant processing building) at NGR NY 1989 2163, at an altitude of 287m above OD. Access was originally gained from Track 5 and later from Track 6. The old entrance was dug into the loose material of the hillside, resulting in repeated slippage of scree and spoil

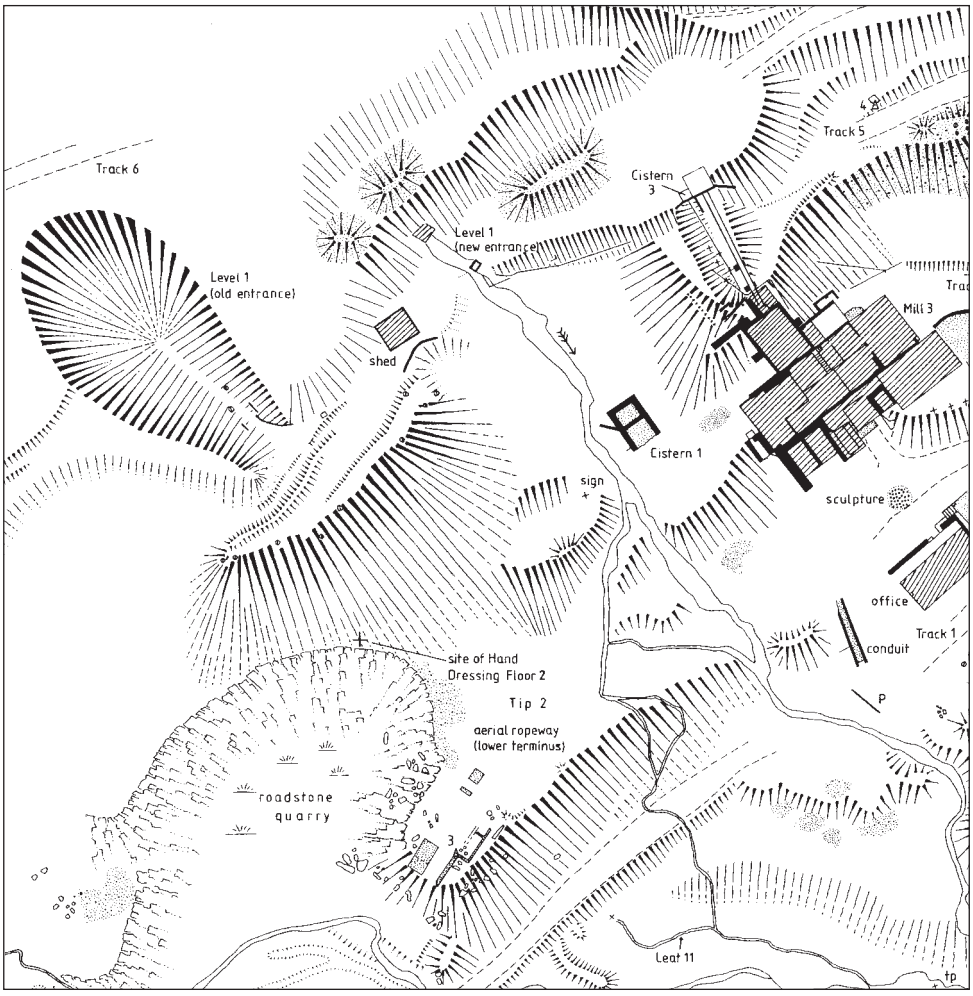


Figure 6a. Extract from survey reduced to 1:1000 scale showing Level 1.

from above, which caused it to be abandoned in 1967; it has subsequently become entirely blocked. Its position is now marked by a cutting *c*.2m wide at the base, which extends for nearly 20m into the hillside. The tops of two poorly preserved timber props protrude from the collapsed material. On either side of the entrance to the cutting, short lengths of crudely built dry stone walls, surviving to a maximum height of 0.5m, evidently served as revetments directly in front of the portal. A photograph of *c*.1916, taken by Mr J Hindmarch (reproduced in Tyler 1990, figure on page 40), indicates that these walls originally stood around 2m high. Another photograph, taken by Mr J Hodgkins shortly before 1967 (reproduced in Tyler 1990, figure on page 76), shows that the walls were in poor condition at that date and had been reinforced by timber hoarding (presumably when the entrance was cleared out in 1963).

Both photographs show tramways entering the adit, differing slightly from each other in form. The only trace of the earlier one that now survives in the immediate vicinity of the mine is a sleeper buried 1.2m below the top of the embankment that carried the tramway serving the later entrance. This has been exposed where the outflow from the new entrance has severely eroded the embankment. However, some 100m to the east of the old entrance lies a finger dump 2.5m high comprising coarse slate waste, with four poorly preserved vertical timber posts in a square

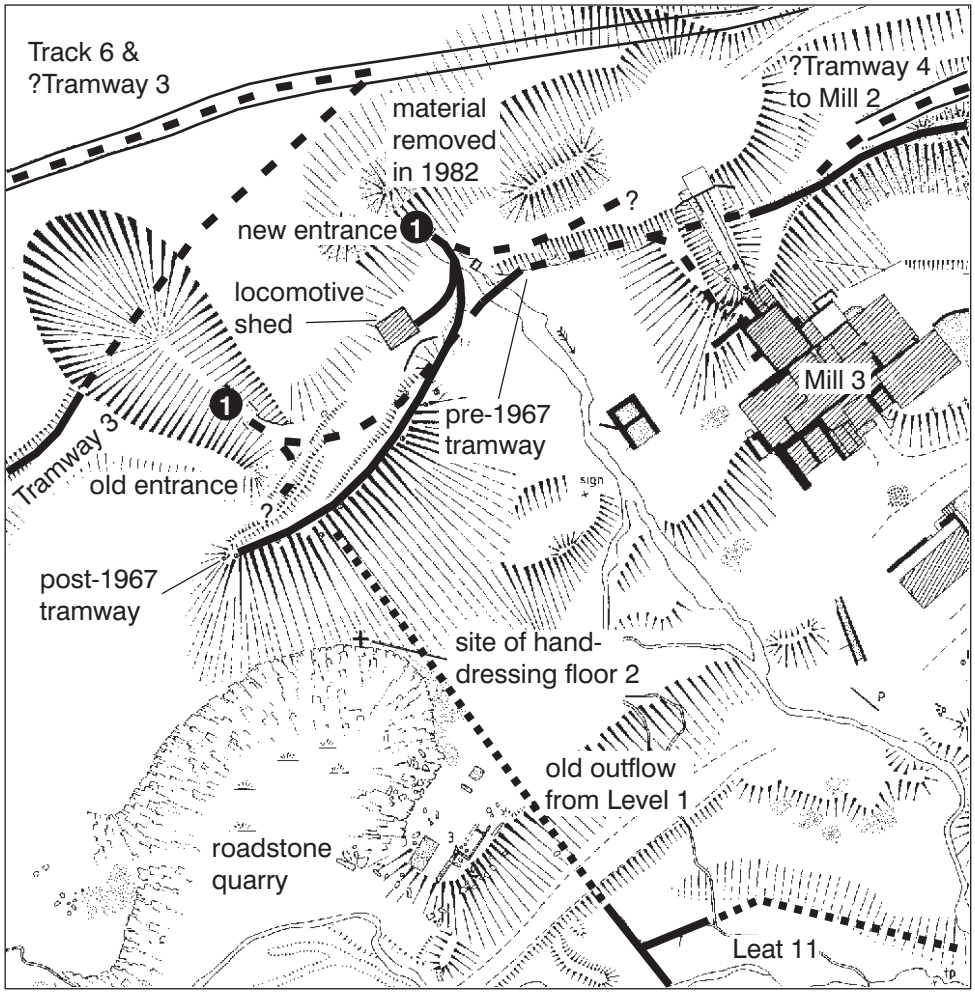


Figure 6b. Annotated extract from survey reduced to 1:1000 scale showing Level 1.

arrangement projecting to a maximum height of 0.2m near its end. This probably represents the waste tip at the terminal of one branch of an early tramway. It seems probable that at some point before *c*.1881 another branch would have connected with Tramway 4 to carry ore directly from Level 1 down to Mill 2.

The First Edition map surveyed in 1861 (Ordnance Survey 1862) shows that the water flowing out of the old entrance was drained straight down the hillside to join the Pudding Beck. A short stretch of this channel still survives, close to its junction with Leat 11, and water still wells up from underground at its head. Immediately outside the entrance, a damaged brick-lined sump 0.4m square is also partially exposed. The type of brick is similar to that used in Phase 3 of Mill 3, suggesting that the sump was built *c*.1939. From this a ceramic pipe leading to the east would probably have carried the outflow from the level to Cistern 1, from where it was piped to Mill 3; only fragments of the pipe survive.

The new entrance to Level 1, cut in 1967, lies 33m to the north-east of the original entrance at NGR NY 1992 2165 and connects with the old level underground approximately 75m to the north. It is cut into similar unstable glacial scree, but remains entirely clear due to the removal in 1982 of a considerable quantity of this material from the slope above (Tyler 1990, 101). The portal, rebuilt in 1977 with

breeze block walls roofed over with railway sleepers, still survives in good condition. The tramway which served the new entrance branched east and west immediately outside the portal. Much of the western branch can still be traced on the ground as an embankment 0.3m high and 3.0m wide, extending for some 35m. Several upright timber revetment posts still survive *in situ*, and the imprints of several of the sleepers can be identified. The eastern arm of the tramway, of which little trace survives, presumably extended as far as the ore crusher. A considerable stream of water issues from the level, and flows southwards down the hillside to join the Pudding Beck. This outflow was collected in a sump some 8m outside the portal and fed via a grey plastic pipe to Mill 3, where it was used for washing the ore. The sump, which is more or less intact, is 0.3m deep and formed by a single course of breeze blocks, which suggests that it was constructed at the same time as the portal in 1977. The plastic pipe and stanchions survive, but the pipe has become detached and now lies adjacent on the ground.

Some 10m to the west of the new entrance stands a shed, built of timber and corrugated steel sheeting, which is 5.0m long by 4.0m wide, with a broad doorway at its eastern end and a single window on its southern side. It is in good condition, and probably housed the locomotive when it was not in use, along with other equipment.

Level 2

History

Level 2 was begun *c*.1839, and by 1850 had been driven 120 yards (110m). It produced a steady supply of lead ore, as well as providing the main haulage access from Level 3 above via a vertical rise completed in the early 1840s (Tyler 1990, 11-2). The entrance to the adit is marked on the First Edition map surveyed in 1861 (Ordnance Survey 1862). Following the closure of the mine in 1865, the entrance to Level 2 collapsed. It would appear that it was subsequently repaired, but after *c*.1872 when the rise from Level 1 broke through and that adit became the main haulage route to the mill, it is unclear whether the entrance to Level 2 was maintained, although work continued underground. Certainly by 1882, the entrance had entirely collapsed (Tyler 1990, 30). Work below ground continued with some success until *c*.1921 (*ibid.*, 33ff). Around 1950, the construction of the La Porte incline, which linked Level 3 to the High Force Workings, effectively rendered Level 2 completely redundant, particularly since much of the spoil produced by the construction of the incline was dumped in the exhausted adit.

Description (Figure 7 a-b)

The entrance to Level 2 lies at NGR NY 1976 2158, at an altitude of 331m above OD, with access gained via Tracks 6 and 7. Ore from Level 2 may have been transported down to Mill 1 along the Slushing Channel or Tramway 3. The entrance, which is cut into the loose material of the valley side, has been entirely blocked by the slippage of scree and spoil from above. The upper part of the portal, which is formed by a crudely built dry stone wall, protrudes from the slipped material and stands to a maximum height of 1.7m. On either side of the cutting

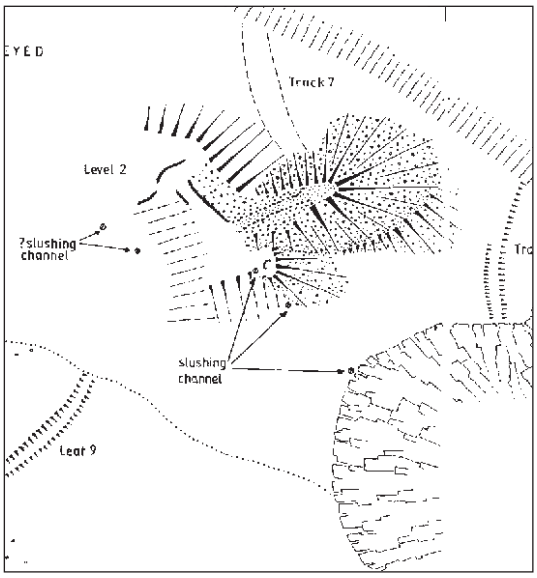


Figure 7a. Extract from survey reduced to 1:1000 scale showing Level 2.

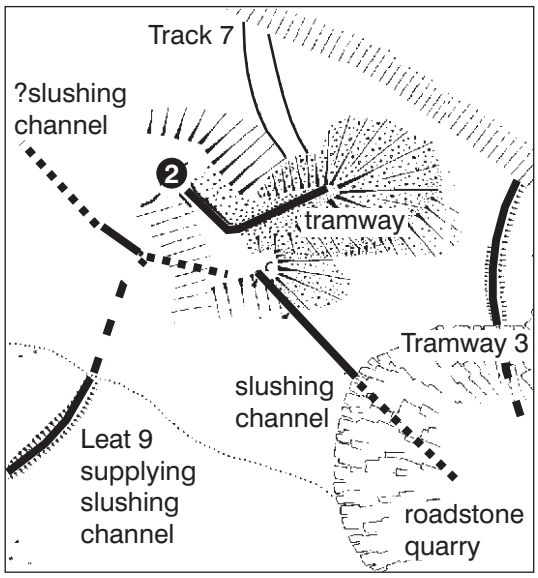


Figure 7b. Annotated extract from survey reduced to 1:1000 scale showing Level 2.

leading to the portal, inward curving lengths of dry stone walls built to a similar standard survive to a maximum height of 0.7m, retaining dumps of coarse rubble. Immediately outside the entrance, three finger dumps represent different episodes of activity. The uppermost dump preserves a central passage for a tramway along which the trolleys of spoil would have been pushed. The rubble in all three dumps is coarse and appears to contain considerable quantities of zinc and barytes ore. It seems unlikely that these ores would have been thrown away after *c*.1870, when the extraction of barytes and zinc became intensive. At approximately the same date, 'The Old Shaft' (see below) that had been driven upwards from Level 2 reached the surface, which would have meant that it was no longer necessary to maintain the entrance of Level 2 for ventilation. This suggests that the entrance has remained virtually untouched since the 1860s.

Cut into the upper surface of the underlying dump is a small horseshoe-shaped pit 0.8m deep, reveted on its uphill side with dry stone walling. The function of this is uncertain, but it may have been a sump similar to those constructed in modern materials outside the entrances to the other adits.

Level 3

History

On the grounds that Level 3 is nearest to the surface exposure of the mineral vein, Tyler (1990, 9) infers very reasonably that it was probably the earliest adit to be started, *c*.1839. The vein was reached after a distance of 100 yards (91m). The completion of a rise from Level 2 in the early 1840s and The Old Shaft from Level 1 in about 1872 effectively rendered the entrance to Level 3 redundant as a haulage route, though it continued to provide good ventilation and an escape route. Curiously, however, the entrance to the adit is not marked on the First Edition map

surveyed in 1861 (Ordnance Survey 1862). The fact that the depiction of the stream flowing down from the gulley above Level 3 is also demonstrably inaccurate may indicate that no measured survey was carried out in that area, presumably due to the difficult nature of the terrain. Following the abandonment of the mining complex in 1881, the entrance fell into disrepair and by 1885 was entirely blocked (Tyler 1990, 31). It was repaired *c.*1907 and some exploratory work was done, but the level remained virtually idle until 1949. Then, under the ownership of the La Porte Chemical Company Limited, the adit was driven forwards slightly prior to beginning the construction of the long underground incline up to the High Force Workings (*ibid.*, 64ff). With the completion of this project *c.*1961 under the ownership of McKechnie Brothers Limited, ore from the productive levels above could be hauled out through Level 3 and loaded into lorries for the descent to the mill. More work to create additional connections between the levels was carried out in 1962-3, though little ore was extracted from Level 3 itself. However, ore reserves in the High Force Levels were decreasing, and no further work was done after McKechnies gave up the lease in 1967.

Description (Figure 8 a-c)

The entrance to Level 3 lies at NGR NY 1970 2165, at an altitude of 358m above OD. Vehicular access would originally have been possible via Track 6, and later from Track 8. Some spoil and scree is heaped on either side of the entrance, but it may originally have been cut straight into solid rock at the point where the mineral vein was exposed on the surface, for there is only evidence for very low dry-stone

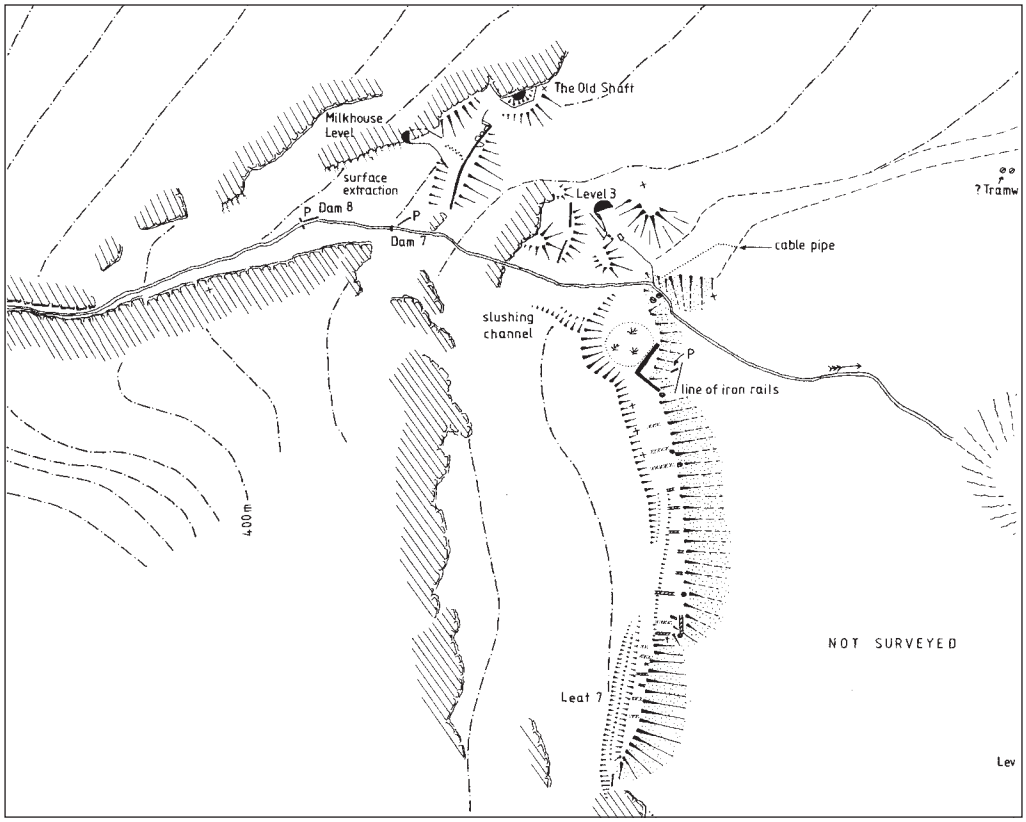


Figure 8a. Extract from survey reduced to 1:1000 scale showing Level 3, The Old Shaft and The Milkhouse Level.

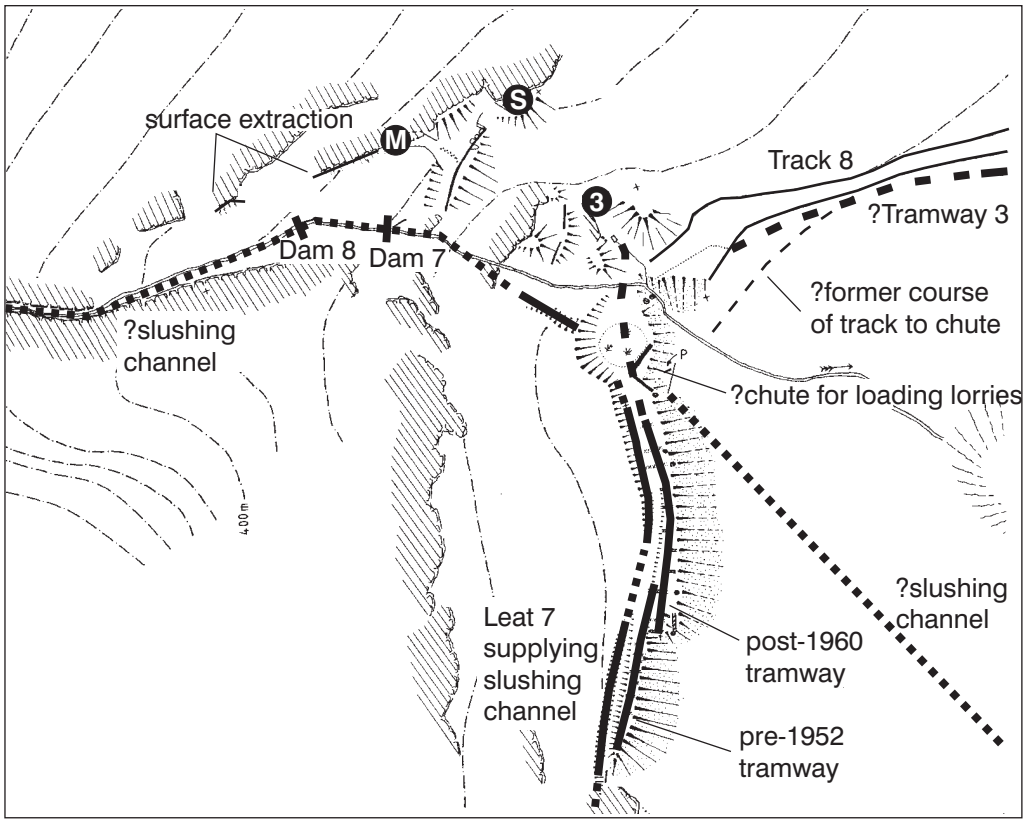


Figure 8b. Annotated extract from survey reduced to 1:1000 scale showing Level 3, The Old Shaft and The Milkhouse Level.

walls flanking the approach. The portal is constructed of timber uprights and roofed with corrugated iron supported by rails from the dismantled tramway. This probably represents repair work carried out in 1949. Although it has not recently been maintained, the entrance is partially open and still useable. The present opening is 1.5m wide and 1.0m high, but was evidently originally *c*.1.5m high. Immediately outside the entrance a small wooden box sunk into the ground acts as a sump for a trickle of water which drains out of the adit through a plastic pipe. The noise of rushing water indicates that there is a much stronger flow underground, but this presumably continues down to Level 2 and from there to Level 1.

Before *c*.1872, ore from Level 3 may have been transported down to Mill 1 along the Slushing Channel and Tramway 3. The tramway which transported material out of the adit can only be traced to the south of the entrance where it runs along a terrace cut into the side of the steep natural slope. Two phases can be identified in the associated waste tip. An earlier tramway, probably in use until 1952, extended for 55m along a low embankment which partly buried the channel of Leat 6. A later one, probably in use between 1960 and 1967, extended for 18m further, the tip mostly comprising glacial overburden. Many of the timber sleepers of this later tramway survive, and towards the end of the spoil tip several of the more substantial trestles also survive.

Outside the entrance are the poorly preserved and partly buried remains of a rectangular or three-sided concrete structure interpreted as an ore chute or hopper. All that now survives is two walls describing an L-shape 3.9m wide by 4.6m long; the upper surfaces of the walls are flush with the ground and they descend for at least

Figure 8c. Level 3, The Old Shaft and The Milkhouse Level viewed from the south-east (NMR AA99/05404).

1m. The concrete around their interior sides retains the imprint of a lining of corrugated iron sheeting. If the structure were a chute, this would imply that there was originally a track *c*.1.5m below the level of the present track. This has left no obvious trace on the surface or in section at the point where the stream has eroded through the slope. However, a slight change of gradient some 50m to the east and a line of tramway rails forming a revetment *c*.2m downslope would seem to support the possibility. This arrangement would have allowed lorries to position themselves at the base of the chute to collect ore being tipped sideways from the tramway. Part of a single course of brickwork, of the same type of pink mortar brick used in the construction of the extant Office in 1960, stands on the concrete walls. This seems to be a later addition or repair, since the lower part of the structure uses red bricks and orange/brown bricks similar to those used in Phases 1-3 of Mill 3. On balance, it seems most likely that the hopper would have been built in 1949, when material from the La Porte incline first began to be taken down the hillside by lorry.

'The Old Shaft' (see Figure 8a-c)

In about 1872, a 'rise' being driven upwards from Level 1 via Level 2 into Level 3 broke through to the surface; this later became known as The Old Shaft (Tyler 1990, 22). The opening lies at the base of a rock outcrop at NGR NY 1969 2167, at an altitude of 381m above OD. It is mostly blocked by natural slumping, but an opening 1.4m in diameter remains and the shaft has therefore been fenced off for safety reasons. Spoil from the shaft forms a collar around the opening and spreads downslope for several metres.

The Milkhouse Level (see Figure 8a-c)

According to Tyler (1990, 51 & 113), the Milkhouse Level was driven *c*.1907 to test a surface exposure, but was evidently soon abandoned. The entrance, at NGR NY 1968 2166 and an altitude of 384m above OD, is cut into the base of a rock outcrop blasted to form a vertical face. It is arched in profile, and increases in size beyond the entrance to a maximum height of 3.1m and width of 3.4m, and extends for 7.3m into the hillside. The mineral vein is clearly evident in the ceiling and rear wall of the adit as a white band varying between 10cms and 50cms in width. Immediately outside the entrance, a narrow platform is formed by a low revetment of large blocks of slate laid to form a rough wall 13m in length.

Immediately downslope from the Milkhouse Level, another outcrop has been blasted to form a similar vertical face 2.0m high, presumably in preparation for a trial. Here too, blocks of slate have been laid to form a low intermittent revetment wall 8m in overall length, creating an even surface adjacent to the face. A block of concrete of similar composition to that used in Phase 1 of Mill 3 has been incorporated into this wall, which suggests that the trial was begun *c*.1909, or broadly at the same date as the Milkhouse Level.

Surface extraction (see Figure 8a-c)

An outcropping rock immediately downslope from the Milkhouse Level appears to have been split using a metal wedge, leaving three characteristic scalloped indentations along the split edge. This technique would seem to indicate a relatively early origin, though a 19th-Century date cannot be ruled out entirely. Further evidence for surface extraction, on a smaller scale, can also be found uphill from the Milkhouse Level at NGR NY 1967 2166 at an altitude of 389m above OD. A rock outcrop on the line of the mineral vein has a freshly broken appearance over a distance of several metres, although no actual tool marks can be identified.

Level 4 (Postlethwaite's Level)

History

Work began on Level 4, the lowermost of the High Force Workings, in April 1867, with the intention of following the vein from a point where it is exposed on the

surface (Tyler 1990, 17). The new adit was named after James Postlethwaite, one of the three directors of the company at that time. By the end of the first month of operation, the mine was already producing considerable quantities of barytes ore. However, by 1870 the vein had diminished in size and work ceased. An inspection of the mines in 1882 recorded that the entrance was virtually blocked (*ibid.*, 30).

Description

Level 4 lies at NGR NY 1947 2164, at the head of the natural gulley which runs steeply upwards from Level 3, at an altitude of 501m above OD. The entrance is cut into a solid rock face, and it seems that only a short cutting was dug to reach this surface. The entrance has mostly been blocked by scree that has slipped down from the slope above, but there is still an opening 1.0m wide and 0.4m high at the top of the original arch-shaped portal. Since the entrance was recorded as being blocked from 1882 onwards, it is possible that this opening has been created in recent years. There is no evidence for any drain outside the entrance, possibly because the outflow would have been directed straight into the Slushing Channel which ran down the length of the gulley (see below).

To the east of the entrance, a narrow ledge varying from 0.9m to 1.8m in width has been blasted into the steep natural outcrop. Several sparse patches of white barytes ore lie towards the end of this ledge, and are scattered down the hillside below, but there is little suggestion that there was any prolonged dumping either of ore or waste material. The surface of the ledge is now somewhat uneven, but its width suggests that it may have carried a short tramway.

Meikle Sikes

Trial adits may have been contemplated at Meikle Sikes, approximately 1.2kms down the Coledale Valley from Mill 3, at NGR NY 2080 2246. These lie outside the area surveyed in detail, and have not previously been identified as mines. The area has been fenced off at some point, but the fences are now in disrepair. Two near-vertical cuts have been dug into the loose glacial material *c.*20m from each other, at the points where natural springs (Meikle Sikes meaning 'large springs') issue from the hillside. The altitude is roughly 340m above OD, similar to that of Level 3 and the mid-way station of the Aerial Ropeway. The small quantity of spoil in the vicinity suggests that neither trial was driven far, possibly due to the loose nature of the hillside at this point, or possibly because of the amount of water issuing from the springs. Both are now obscured by material which has slumped from above, although a short length of drystone walling stands immediately downhill from the lower of the two faces. Some 40m downhill from the adits, a small cistern appears to have collected the outflow and distributed it elsewhere along two ceramic pipes. Adjacent to Track 1 and directly below the possible trials, at NGR NY 2089 2232, a much larger covered cistern has been marked on Ordnance Survey maps (Ordnance Survey 1978). It seems to have had a vaulted brick roof, which has suffered minor collapses in certain places. From the cistern, a cast iron pipe allowed water to return to the natural stream course. The type of red brick used in a partially exposed pier adjacent to the cistern is similar to that used to reconstruct the

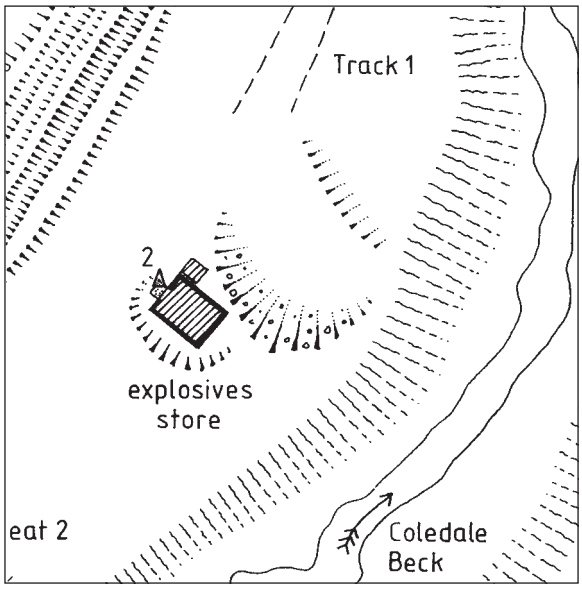


Figure 9a. Extract from survey showing the explosive stores.

processing building. This suggests that the cistern, and therefore the possible trial adits, originated *c*.1939. However, its precise purpose remains unclear.

Explosives Stores (Figure 9 a-b)

The First Edition map and the Second Edition 6-inch revision (Ordnance Survey 1862; 1900) both show a rectangular building that can confidently be interpreted as a gunpowder store, located at NGR NY 1987 2142. The site of the building, at the westernmost end of Track 1, is typically remote from the main areas of activity. The building

Figure 9b. The explosives stores viewed from the north-west (NMR AA99/04038).

as a whole was evidently approximately 5m long by 3m wide, but half of this area seems to be depicted as a lean-to. No trace of the structure itself now survives on the ground, but the level platform where it stood appears to have been reused for the construction of the extant building. The building must have been built before 1861 and demolished at some point between 1898 and *c*.1908.

The extant building, which can be interpreted with certainty as an explosives store, stands on the same site as the earlier building. It comprises a single room 4.0m long by 3.1m wide, with its long axis aligned from north-west to south-east. It has no windows and a single door at its north-west end. The walls, which are 0.45m thick, are built of roughly dressed blocks of slate (possibly re-used from the earlier building) with a rough external render and limited use of brick around the doorway. The type of orange/brown brick is the same as that used in Phases 1 and 2 of Mill 3, suggesting that the new store was built at some point between 1908 and *c*.1912. A scatter of thin roof slates in the vicinity almost certainly represents the original roofing material. The relatively thick walls and flimsy roof would have ensured that the blast from any accidental explosion was directed upwards so as to cause as little damage as possible. The original roof was missing by June 1957 (RAF 1957) but was subsequently replaced with a layer of concrete poured over corrugated steel sheeting. This may have been done *c*.1960 when the small store described below was built, since the same technique is used there. The strong steel frame around the doorway survives *in situ*, but at the time of the survey the reinforced steel door itself was in use as a makeshift bridge across the Coledale Beck some 40m to the east. The door surround was plastered, and the plaster evidently butted up against a timber frame that may have supported a lightweight internal door. The wooden floorboards are in relatively good condition, although some have apparently been replaced. The raised timber floor would have had two functions. Firstly, it would have kept the explosives dry by creating good under-floor ventilation, the air entering through two ornate cast-iron vents on the downslope side of the building. Secondly, the timber surface would have prevented sparks being struck accidentally by the boots of those working in the building. An imprint on the external render to the left of the door indicates that there was a sign, which presumably warned about the hazardous contents of the building.

Adjacent to the north-east side of the building stands a smaller store, which presumably held some other form of explosive, possibly gelignite. The store is 1.3m square and 1.5m high with a broad doorway on the south-eastern side. The walls are constructed in pink mortar brick, of the same type used to construct the extant Office, suggesting that it was built c.1960. Four galvanised-steel vents in the side walls are also identical to those used in the Office. The roof is formed by a layer of concrete poured over corrugated steel sheeting.

A level platform some 10m long by 6m wide lies immediately downhill from the stores. This was presumably an area for loading and turning vehicles.

Roadstone quarrying (see Figure 4)

Two letters in the WT Shaw archive - the first an enquiry from JMR Boyle of McKechnie Brothers head office to WT Shaw dated 11th August 1961 and the second a reply from Shaw dated 15th August - refer to the quarrying of roadstone at Force

Crag (Cumbria CRO b). The correspondence indicates that Leconfield Estates had agreed to allow natural scree to be quarried for the construction of the Portinscale by-pass near Keswick. This was regarded by Shaw, then engineer at Force Crag, as a potential threat to the stability of the hillside in the vicinity of the mines. The by-pass was completed in 1963 (information from Cumbria County Council, Department of Economy and Environment), which would suggest that the quarrying may have been carried out late in 1961 or in 1962.

Two areas were affected by the quarrying. The first, specified in Shaw's letter, is an area measuring 130m by 50m to the north of the Pudding Beck, centred at NGR NY 1984 2154. It is difficult to estimate the volume of material that has been removed. The quarry was served by a return loop at the end of Track 1. Although a wide margin was left around the lower terminal of the Aerial Ropeway, parts of both Hand-Dressing Floors, Tramway 2 and Tramway 3 were destroyed.

The second quarry, not referred to specifically in the correspondence, is an area approximately 50m square at the tip of the spur between the Coledale Beck and the Pudding Beck, centred at NGR NY 1986 2148; again the volume is difficult to estimate. The scree content is lower here, the stone being intermixed with subsoil. Parts of Leat 2 and Mill 1 were destroyed by the quarrying.

5.2 TRANSPORTING THE ORE

Tracks (see Figure 4)

Track 1, the main access route from Braithwaite, was completed around 1842 (Tyler 1990, 11) and is shown on the First Edition map (Ordnance Survey 1862). From Braithwaite, the track gently climbs for 3.5kms along the valley, its course meandering to follow the natural contours of the steep northern side of the valley. In several places, rock outcrops have been blasted away to allow the track to pass, but for the most part it is simply terraced into the loose glacial overburden and partly built up on the downhill side. Material for this was apparently initially quarried from scoops up to 5m wide dug at intervals adjacent to the uphill edge of the track. More recently, probably from 1939 onwards, much larger scoops up to 30m wide have been dug; in some cases, this has created level spaces large enough for vehicles to pass. Tailings from the mill have been used in numerous places to repair eroded patches. To the south of the lower terminus of the Aerial Ropeway, a small stream that has subsequently changed course has been bridged using four large slate gatepost slabs; this is also likely to be a later repair. Elsewhere, cast iron pipes carry streams under the track. The bore of these (23cms or 9 inches) is the same as that of the pipes that until at least 1922 ran along Leat 5 to supply a pelton wheel, suggesting that they were re-used and probably put in place *c*.1939.

At its western end, the track terminated eventually at the Explosives Stores. Via a series of side tracks added at later dates, it also gave access to the different floors of the extant processing building (Mill 3), to the sites of two earlier mills (Mills 1 and 2), to each of the Low Force Workings and to the High Force Workings. All these tracks

tend to run obliquely across the contours so as to maintain a fairly constant gentle gradient of between 1 in 5 and 1 in 8.

Track 2 runs a short distance up to the present forecourt of Mill 3 and returns from there to Track 1 immediately west of the extant Office. The track seems to have been put in *c.*1939 to give access to the dressing house, and had probably been extended by May 1944 after the dressing house was removed (Cumbria CRO g; f). The track would then have allowed lorries to collect the processed ore without the need for difficult manoeuvres.

Track 3, in its present form, incorporates the western end of Track 4 and gives access principally to the vehicle shed adjoining Mill 3. At some point, it would probably have continued to the rear wing of the building, but the final section has been entirely obscured by later modifications. Given its relationship to the building, it was probably constructed *c.*1909.

Track 4 apparently provided the principal access to the first phase of Mill 3, and was therefore probably constructed *c.*1909. It presumably became redundant when Track 2 was constructed at some point between *c.*1939 and 1944 and is now overgrown and in places has been quarried away. Its original course is preserved in the short stretch of Track 3 that leads to the vehicle shed.

Track 5, in its present form, gives access to the rear of Mill 3 and the machinery of the extant ore crusher and conveyor belts. Originally, it seems to have been the principal means of vehicular access to Level 1, and may also have carried Tramway 4 (see below). Given its possible relationship to Tramway 4, it may have been constructed as early as *c.*1854.

Track 6, in its present form, gives access to the top of the extant ore crusher at the rear of Mill 3 and, via Track 8, to Level 3. Originally, it carried straight on beyond the junction with Track 8 and reached Level 3 via two short switch-backs. It may also have carried part of Tramway 3. These upper sections are now grassed over, and long stretches have been eroded away or buried beneath spoil slipping down from above. Track 6 would also have provided access, via Track 7, to Level 2. It must therefore have been constructed prior to *c.*1872. Although it is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), its possible relationship to Tramway 3 suggests that it may have been constructed as early as *c.*1839. The use of tramway rails to construct revetments upslope suggests that it continued in use until it was superseded by Track 8 *c.*1949.

Track 7 would have provided access from Track 6 down to Level 2. It is now grassed over and survives for a distance of only 20m, the western end being partially buried beneath spoil from the level, and the eastern end having been severely eroded by the stream and consequent slippage. Although it is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), its relationship to Level 2 suggests that it may have been constructed as early as *c.*1839. It had presumably gone out of use by *c.*1872.

Track 8 provides access from the upper end of Track 5 to Level 3, with a single switch-back roughly a third of the way up its course. The track is intact for most of its length, but was deliberately blocked at its lower end by a dump of rubble, possibly in 1967 or when the complex finally went out of use in 1991. It seems probable that the track was constructed *c.*1949, when material being brought out of Level 3 was regularly being brought down the hillside by lorry. Initially, it would seem to have incorporated the uppermost section of Track 6, possibly because this was a fairly convenient route to the base of the hopper outside Level 3. At a later date, a new section was constructed, raising the surface of the track and removing the kink. The lower stretches of the track are particularly massively constructed, terraced up to 2.5m deep into the hillside with an embankment of similar size downhill.

Track 9 provided access from the mines via Track 1 to a level platform immediately overlooking Mill 2, where Tramway 4 also terminates. The alignment of the track from west to east runs precisely parallel to Tramway 4, suggesting that the two routes are broadly contemporary with each other. The eastern end of the track overlies Leat 13, which was constructed to supply the water wheel probably erected in 1854, indicating that both the track and the tramway are somewhat later additions. From the level platform, ore would probably have been fed down a chute into the crusher. The western end of the track is overlain by the rebuilt embankment of Track 1. It is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), but must have been built before *c.*1881, given its relationship to Mill 2. It may have been completed at roughly the same time as Tramway 1 in 1873-4.

Track 10 provided access from Mill 2 back up to Track 1, and would presumably have been the route along which the processed ore would have been transported off the site, prior to the construction of Track 12 and later Tramway 1. To the west of the tramway, where the track ascended the steep natural scarp adjacent to the stream, a section some 20m long can be traced as a grassy earthwork. It probably dates to about 1854, when Mill 2 was built. The track is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862) and its eastern end is overlain by the earthworks of Tramway 1, so it must have been completely redundant by 1873.

Track 11 is a minor path, still marked as a footpath on current maps (Ordnance Survey 1978). From an indeterminate point close to the valley floor, it ascends the hillside in a somewhat erratic line, heading for the pass at the southern end of the Force Crag massif. Tyler (1990, 17) suggests very plausibly that this path would have allowed ponies to reach the High Force workings between 1867, when work began on Level 4, and 1928 when the upper stretch of Track 12 was constructed.

Track 12 diverges from Track 1 at almost the same point as the earlier Track 10 and is joined by Track 13 on the valley floor just before it fords the Coledale Beck. From there, it ascends the southern side of the valley in a gentle arc to the pass south of the Force Crag massif, and onwards from there to the High Force Workings. Much of it is still roughly metalled, but some sections are grassed over, while others have been severely eroded or partially buried beneath scree washed down from above. On the southern side of the valley, there is evidence that the ascent from the beck was originally straighter than the present route. According to Tyler (1990, 49-51), the

track was first constructed in 1928, in order to allow carts to reach the High Force Workings. However, the stretch between Track 1 and Mill 2 had certainly been constructed by 1861 (Ordnance Survey 1862). Furthermore, it evidently connected at some stage with Track 14, which may also have been constructed somewhat before 1928. This probably indicates that the lower part of Track 12 re-used pre-existing routes and that only the stretch uphill from the junction of the two routes was constructed in 1928. In 1939, the entire length of the track was repaired and some rock outcrops near the summit were blasted through to allow lorries to make the journey to the High Force Workings (Tyler 1990, 52). It was probably at this date that more than fifteen cast iron pipes, all but two of the same type, were put in place to improve drainage. The bore of these (23cms or 9 inches) is the same as the pipes that until at least 1922 ran along Leat 5 to supply the pelton wheel, suggesting that they were re-used. Only three are still functioning as drains and at least two have been completely removed (one lies at the base of the waterfall in the Coledale Beck). This has contributed to the present poor condition of the track. However, soon after 1939 it became clear that this was impractical as a means of regular transport and the Aerial Ropeway was built. The track was improved by more blasting and repairs carried out *c*.1960 (*ibid*., 68).

A drainage channel which continues the line of the track to the edge of the Birkthwaite Beck has been erroneously identified as a disused section of Track 12 (Ordnance Survey 1978). Although the feature, which is up to 2.0m wide and 0.6m deep, bears some resemblance to an eroded track, it is actually a continuation of a drain dug alongside the track to prevent erosion. The run-off from the channel has eroded away a section of Leat 14. The channel was presumably built at roughly the same time as several other lengths of drainage channel along the length of Track 12, possibly in 1939.

Track 13 diverges from Track 1 at a point that effectively continues the line of Tracks 5 and 6 straight down to join Track 12 at the ford across the Coledale Beck. This would have allowed material to be transported more directly from the High Force Workings to the ore crusher at the rear of Mill 3, suggesting that the track was constructed *c*.1939 when this route began to be used regularly. The track, which is eroded to a depth of up to 0.6m, cuts through Leats 13 and 14. It probably went out of regular use in the early 1960s when the La Porte underground incline was completed, and was later partially buried beneath Tip 3.

Track 14 climbs the southern hillside towards Scar Crags in a series of switch-backs. Only a short length of its route was recorded in detail. A change of angle and gradient at the junction with Track 12 probably indicates that the track built in 1928 re-used a pre-existing route up to this point. Track 14 has clearly been carefully constructed with a stone curb and revetment along the downhill edge and well-built stone-lined channels and bridges wherever it encounters streams. This quality of workmanship and the condition of the track would seem to suggest that it originated somewhat earlier than 1939, as discussed further in Section 6. However, the track is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862) and must have originated after that date.

Tramways (see Figure 4)

In addition to the short lengths of tramway that were built to carry ore and spoil out of the adits, a number of longer routes were identified.

Tramway 1, the horse-drawn tramway from Braithwaite, was built between 1873 and 1874 under the ownership of The New Force Crag Mining Company Limited (Tyler 1990, 23). This allowed the miners to be carried to the site and ore to be transported away more efficiently. From Braithwaite, the tramway gently ascends the valley for a distance of 3.5kms, its course running roughly parallel to Track 1, meandering similarly to follow the natural contours, but at an altitude between 2m and 15m lower. The tramway track is 0.9m wide on average, formed variously by terracing, shallow cuttings and low embankments according to the terrain. At the eastern terminus in Braithwaite, the track apparently ended on a wooden trestle above a hopper (*ibid.*, 23). The western terminus was very probably at NGR NY 2025 2179, overlooking Mill 2 (see Figure 18), although there is a remote possibility that it may have linked up with Tramway 4 at this point. None of the timber sleepers survive within the area surveyed, although Tyler records that in 1990 some were visible further down the valley (*ibid.*, 23). The rails were apparently salvaged in the 1940s and are now scattered widely around the rest of the mining complex, performing various different functions.

Tramway 2 is marked on the First Edition map surveyed in 1861 (Ordnance Survey 1862 and Figure 3). It apparently carried ore from Hand-Dressing Floor 2 to Mill 1, and was therefore probably built *c.*1849. It was presumably used less regularly once Tramway 4 was constructed to take ore to Mill 2, and must have been redundant by *c.*1881. Most of its course, which was centred at NGR NY 1986 2157) was destroyed by quarrying for roadstone in 1961. Only a 25m long stretch can now be traced as a terrace 2.5m wide on average, inclining gently from east to west; no trace of sleepers or rails survives. It seems likely that Tramway 2 was the only route in use in 1861 when the Ordnance Survey recorded the area.

Tramway 3 may have been used to transport ore from Levels 2 and 3 down to Hand-Dressing Floor 1. Tyler (1990, 14) states that *c.*1854, ore was being brought out of Level 2 and taken down an 'inclined track' to a plateau *c.*6m lower than Level 2, where it was tipped into a hopper and broken up by hand, before being transferred to Mill 1. It is unclear whether this conclusion is based on documentary research or field observation, but it tallies to a large extent with the field evidence. However, it is possible that the tramway may have served a similar purpose prior to *c.*1854.

There are three separate surviving elements to the tramway. Some 45m to the east of the entrance to Level 3, at NGR NY 1975 2166, erosion of Track 8 has exposed the ends of two timber sleepers at a level some 2m below the present surface of the track. This suggests that the tramway must have started at Level 3, and continued along the switch-backs in Track 6. Below this, two sections of what appears to be a continuation of the same tramway are well preserved as earthworks. The uppermost section, centred at NGR NY 1985 2162, survives for 40m between the cutting

around the old entrance to Level 1 and the gulley eroded by the stream that descends from Level 3. It is a level terrace 0.9m wide, slightly embanked on the downslope side, inclining gently downhill from north-east to south-west. Its alignment and gradient, if projected further to the east, would carry it to an intersection with the lowermost stretch of Track 6 in the area immediately above Level 1. However, this area was quarried away in 1982 to relieve pressure on the entrance, and nothing now survives of either the tramway or the track at this point. Another section of an earthwork of similar form, centred at NGR NY 1981 2157, survives for 20m between the gulley eroded by the stream that descends from Level 3 and the limit of the roadstone quarrying carried out in 1961. This follows the same incline from north-east to south-west, but bends southwards past the lowest of the three finger dumps of material outside Level 2. The course of the tramway has evidently been kept clear of rubble deliberately, and it seems likely that ore was loaded into the trucks at this point. The bend at the end of the tramway, if projected further to the south, suggests that it would have terminated at a point directly overlooking Mill 1, thought to be the site of Hand-Dressing Floor 1. There may have been a wooden chute to carry the ore down the final part of the hillside. The relationship of the tramway to Mill 1 suggests that it may have been built *c*.1839. However, it is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), which must indicate that it was not in use at that date.

Tramway 4 survives well as an earthwork for a distance of 25m, apparently terminating at a level platform above Mill 2 at NGR NY 2023 2178. Although the eastern terminal of Tramway 4 lay within a few metres of the western terminal of Tramway 1, there is no strong evidence that the two would have been linked; Tramway 4 would have ended at a slightly higher level and followed a steeper gradient. Its alignment from west to east runs precisely parallel to Track 9, suggesting that these two routes are broadly contemporary with each other. Track 9 overlies Leat 13, which was constructed to supply the waterwheel probably erected in 1854, indicating that both the track and Tramway 4 were probably added somewhat after that date. It is not shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), but must have been constructed by *c*.1881. It may well be contemporary with the completion of Tramway 1 in 1873-4. At its western end, the course of the tramway is overlain by the rebuilt embankment of Track 1, but must originally have followed the same route. As mentioned above, a tip 100m to the east of the old entrance to Level 1 suggests that a tramway extended from the entrance at least as far as that point. It seems very probable that a branch of the same tramway would have descended along the course of Track 5, continued along Track 1 and joined the section that is well preserved as an earthwork. This would have allowed ore to be transported directly from Level 1 to Mill 2.

Slushing Channel (see Figure 4)

'Slushing' involved sweeping the ore down a steep gradient along wooden channels or 'flumes', using a flow of water to push the ore along and lubricate its movement. A wooden flume, which may be comparable in form, lies adjacent to Track 12, but its excellent state of preservation suggests that it is unlikely to be part of the

19th-Century channel. According to Tyler, a slushing channel was installed in 1872 under the ownership of the New Force Crag Mining Company Limited. What appears to be a similar system had apparently existed since 1867, to transport ore down from Level 4 (Tyler 1990, 22-3 & 17-9).

The channel seems to have comprised three linked sections, extending from the entrance of Level 4 at NGR NY 1948 2164 to a point near Mill 2 at NGR NY 1982 2151. The uppermost section can be traced clearly for a distance of 17m below Level 4 as a sheer-sided cutting blasted through the natural rock. The cutting is up to 3.2m deep and 1.8m wide, and was presumably made to ensure a more-or-less continuous gradient. Below this, the channel survives for a further 35m as a regular earthwork on average 1.5m wide and 0.3m deep. For some distance below this, the course of the artificial channel becomes impossible to distinguish from the natural gulley. However, a short section can be traced as a shallow channel 1.8m wide at the point where it approached the flat platform immediately to the south of Level 3. This section is aligned on the site of Mill 1, which lies at the base of the slope. The water supply for the part of the slushing channel between Levels 4 and 3 would almost certainly have been the outflow from Level 4, since the uppermost stretch of the channel appears to be aligned on the entrance to the adit.

Tyler (1990, 23) notes the presence of pins driven into the rock faces in the gulley, which he suggests may have supported the wooden flumes. Only two iron pins were recorded during the English Heritage investigation, and one of them seems too far from the course of the slushing channel to have formed a related function; they may simply have supported ropes for improving the ascent up the gulley.

The middle section seems to have carried the ore from the platform near the entrance of Level 3 down to the platform in front of the entrance to Level 2 (*ibid.*, 23). Two poorly preserved wooden posts project from the scree, but following a different alignment from the upper and lower sections of the channel. These may have supported the middle section of the channel, if its course swung around to the south-west of the entrance of Level 2, but it is possible that they are wholly unconnected. Leats 7 and 8 probably provided an additional water supply for this section (*ibid.*, 19).

The lowermost section would have carried the ore from Level 2 down to the Mill 1, which lies directly downslope (*ibid.*, 19). All that now survives is a series of three wooden posts, running down the slope from the entrance of Level 2. These are precisely aligned on the site of Mill 1, and follow the same alignment as the final part of the upper section, but are slightly offset from the two posts of the middle section, suggesting that there may have been some form of intermediate 'staging post'. Water for this lowermost section of the descent may have been supplied from Leat 9, which arrives at Level 2 at a slightly higher altitude than the entrance.

Aerial Ropeway (see Figures 4, 10a-c and 11a-b)

In 1940, under the ownership of Tampimex Oil Products Limited, it became clear that the descent by lorry from the High Force Workings along the newly-constructed

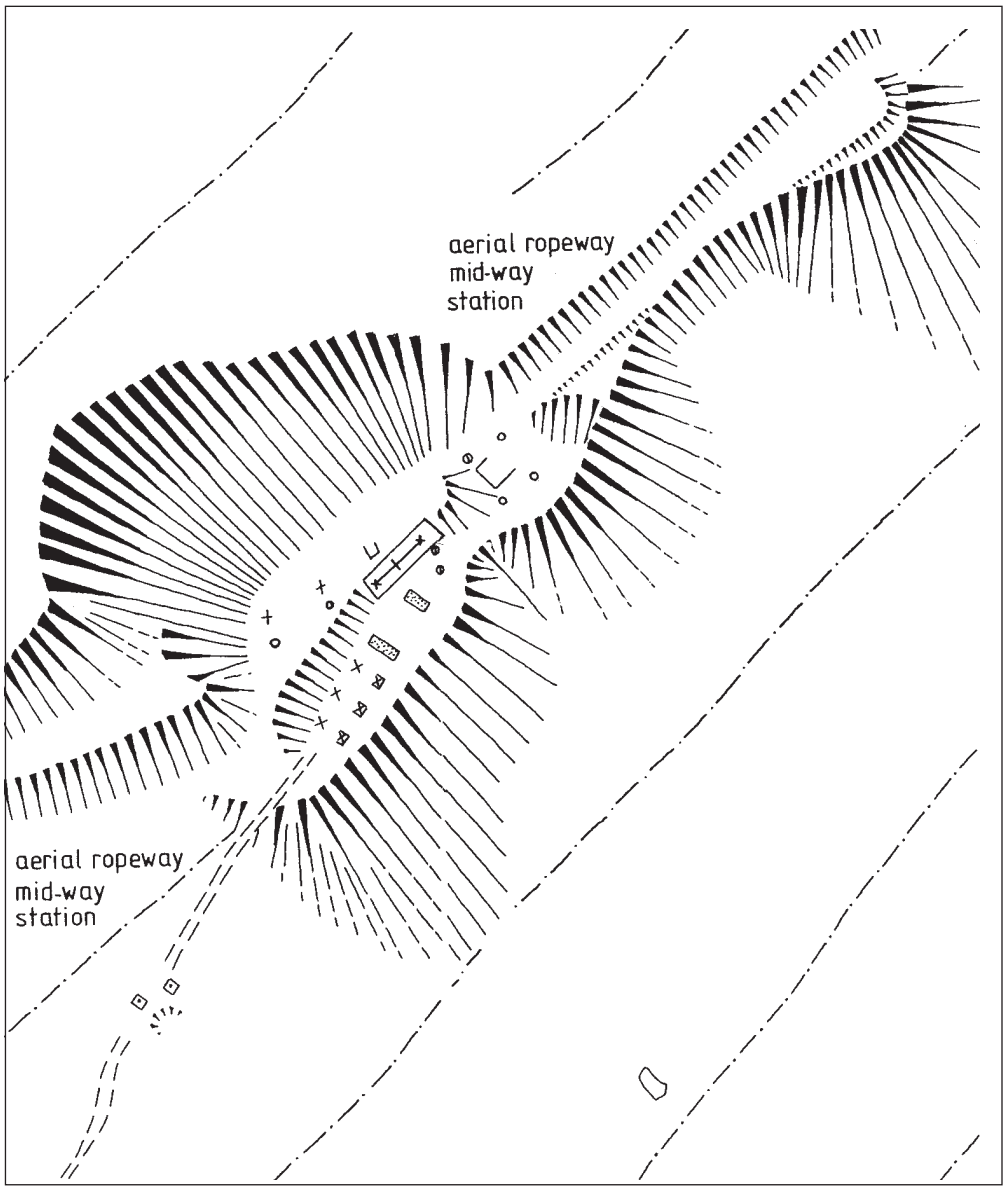


Figure 10a. Extract from survey showing the mid-way station of the Aerial Ropeway.

Track 12 was too time-consuming to ensure a regular supply of ore to Mill 3 (Tyler 1990, 53-4). As a result, an aerial ropeway was constructed to transport material more efficiently, at an estimated cost of £10,000. According to Tyler's research, the company involved was the British Aerial Ropeway Company Limited, but all the fragments of the cast-iron wheel units noted during fieldwork are stamped 'Roe's Ropeways Ltd.'; the reason for this discrepancy is unclear. A date formed by slivers of slate pressed into the wet concrete of one of the pylon foundations probably records the completion date:

APRIL
10 / 41

A plan dated 19 May 1944 shows the lowermost stretch of the ropeway, and its relationship to Mill 3 (Cumbria CRO f). In the event, the cable proved liable to freeze

up in winter and the lorries continued to be used in reserve. In 1947, when severe winter conditions forced the mine to close, the ropeway was abandoned. A plan of 1972 shows the pylons still standing at that date (Cumbria CRO k), but they were sawn down and sold for scrap soon after.

The upper terminus at the High Force Workings, which lies outside the area of the English Heritage survey, is shown on photographs taken in the late 1960s or early 1970s (Tyler 1990, figures on page 60, 62 & 96). From there, the ropeway ran to the head of the gulley above Level 3, passing over three pylons (*ibid.*, figure on page 57) before steepening in gradient and descending to a mid-way station. There, it turned an acute angle and descended through the upper wing of Mill 3, where the buckets were emptied automatically, and on to a lower terminus. The total length of the ropeway was around 1500m.

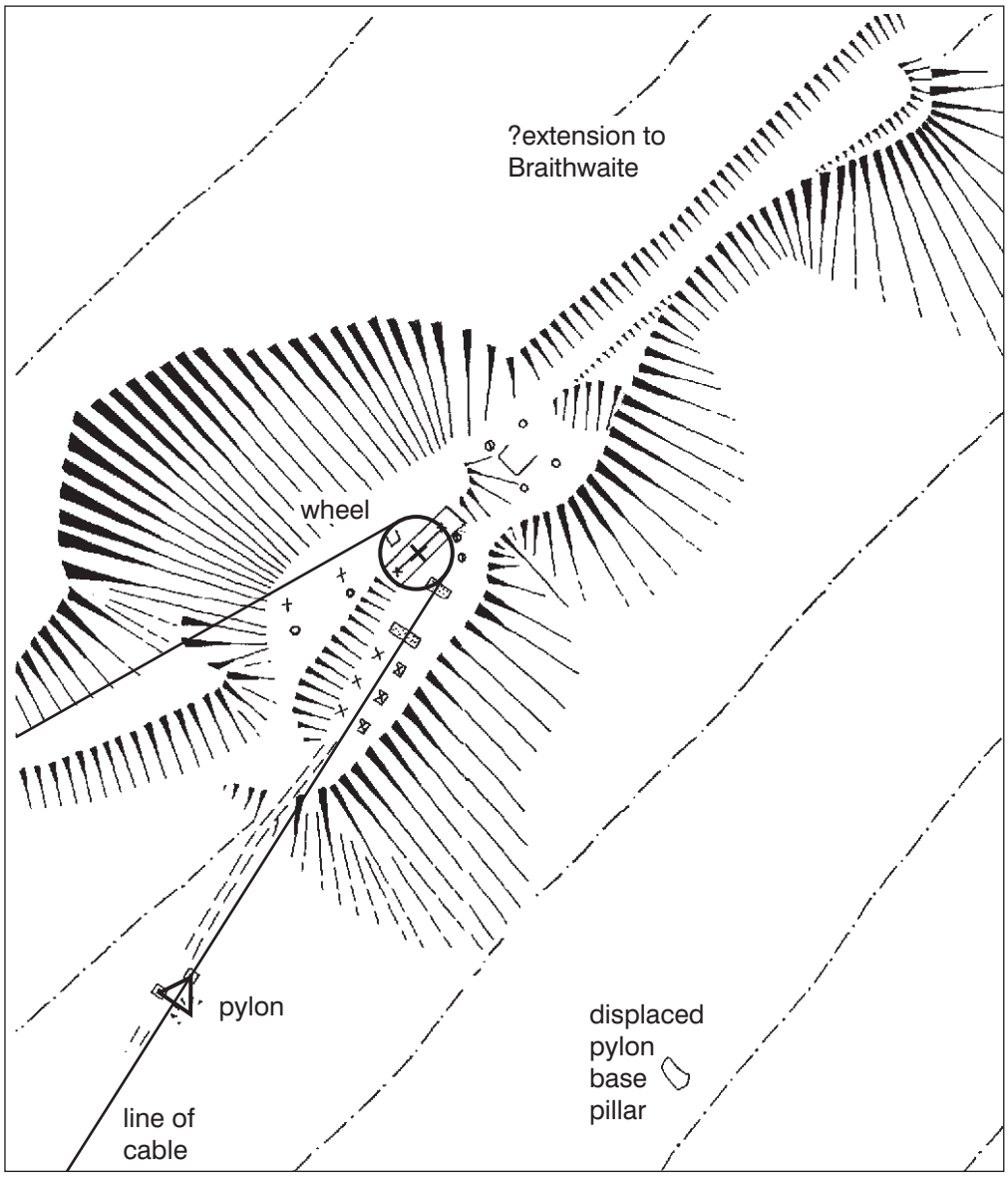


Figure 10b. Annotated extract from survey showing the mid-way station of the Aerial Ropeway.

Figure 10c. The mid-way station of the Aerial Ropeway viewed from the east (NMR AA99/04034).

The highest of the pylon bases surveyed by English Heritage lies towards the upper end of the gulley above Level 3, at NGR NY 1959 2165, at an altitude of 448m above OD. The base comprises three concrete blocks supporting an equilateral triangle of steel girders, each side 4.2m long, suggesting that the height of the pylon would have been approximately 12m. A tension brace on each side would have given extra stability to the structure. The next pylon, of similar size and form, stood 370m to the north-west. Beyond this, two smaller pylons spaced at intervals of approximately 120m would have carried the ropeway to the mid-way station; the sides of their bases are 3.0m and 2.6m long. The lower of these two bears the date mentioned above. Along this stretch, a footpath that follows more or less a straight line along the same course as the ropeway would presumably have been used for maintenance. A considerable length of steel cable lies on the ground alongside the path.

The mid-way station is built on a level platform terraced into the loose glacial overburden of the hillside, at NGR NY 2020 2201 and an altitude of 341m above OD (see Figure 10). It has been erroneously marked on recent mapping as a disused mine (Ordnance Survey 1978). The key element of the mid-way station would have been a wheel *c*.4.8m in diameter, mounted horizontally at a height of *c*.2m above a concrete plinth, around which the ropeway cable would have turned through an angle of 328 degrees. The wheel itself no longer survives, but its position and size

can be calculated from the surviving supports. These comprise a series of three concrete plinths above the wheel and five below it, each holding two steel uprights, which have been sawn off. Part of the superstructure from below the wheel survives, although it is not *in situ*. Some 10m to the north-east of the wheel, a concrete block set into the ground at an angle seems to have held a brace providing tension to the supporting superstructure. Two timber posts and two post-holes indicate that this was covered by a lightly built shelter 4.0m long by 3.0m wide, which may have been used for storage.

To the north-east of the platform on which the wheel is located, another terrace extends for a further 30m along the hillside, terminating in a broader platform. There is no evidence that this could have related to the aerial ropeway as it was eventually built, but it may relate to the original plans to extend the route all the way down the valley to Braithwaite railway station (Tyler 1990, 53).

Below the mid-way station, the bases of three small pylons survive, spaced at intervals of 110m. Only one of the three original supports of the lowermost pylon is exposed, the other two having been buried beneath the surface of Track 8. The plan of May 1944 shows the position of another pylon further downslope towards Mill 3, but this has also presumably been buried (Cumbria CRO f). The openings where the ropeway passed through the rear upper wing of Mill 3 can be identified as brick patches the side walls (see Figure 20). The footpath used to maintain the ropeway extends as far as the angle of Track 8, where it is truncated. Prior to the construction of the track, the footpath would presumably have extended all the way down the hillside.

The lower terminus lay some 75m south-west of Mill 3, at NGR NY 1992 2157, at an altitude of 274m above OD (see Figure 11). The surface of Tip 2 was probably levelled to some degree in order to create a platform for the building. It is marked by two concrete plinths, one bearing the remnants of two steel supports. Some 10m to the south-west, a third block which is set into the ground at an angle in a similar way to that at the mid-way station presumably held a brace providing tension to the superstructure. Adjacent to these blocks, on their southern side, stood a building that can interpreted with some confidence as a generator house, but which for some reason is not shown on the plan of 1944 (Cumbria CRO f). The building was evidently single-storeyed and constructed of slate blocks with red brick quoins and concrete lintels. Only the foundations now survive intact; the fragments of the walls and roof are scattered around the immediate vicinity. The foundations indicate that there were probably two small rooms forming a rectangular range 1.8m wide and at least 5m long, oriented south-west to north-east on the same alignment as the ropeway. The type of red brick is the same as that used in Phase 3 of Mill 3, confirming that the building was constructed soon after 1939. It seems likely that the building may have been deliberately destroyed in order to remove the generator and winding gear, in 1947 or at some later date. Aerial photographs taken in 1970 (Ordnance Survey 1970) indicate that parts of the side walls still stood at that date.

Artifacts relating to the aerial ropeway are scattered widely around the mining complex, but not surprisingly there is a marked concentration in the area below its route. These include the wrought iron cradles and arms that carried the buckets, and fragments of the cast iron wheel units that carried the cable, which are stamped with

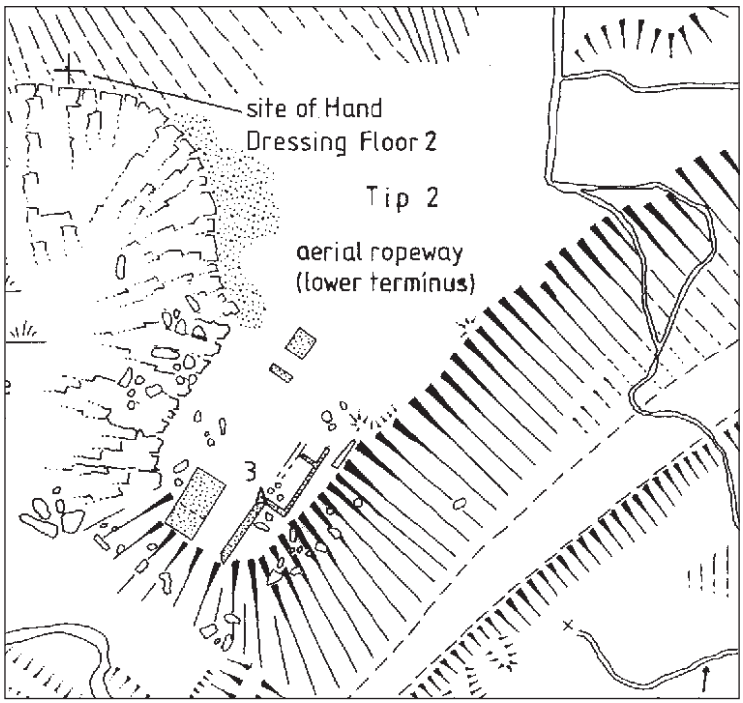


Figure 11a. Extract from survey showing the lower terminus of the Aerial Ropeway.

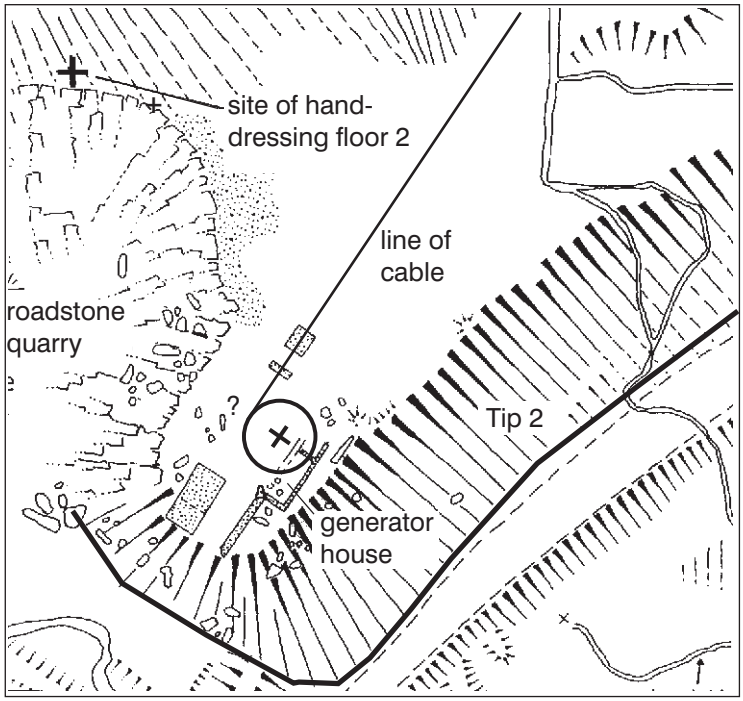


Figure 11b. Annotated extract from survey showing the lower terminus of the Aerial Ropeway.

the name of 'Roe's Ropeways Ltd.'. A complete arm, cradle and side-tipping ore bucket are on display at Threlkeld Mining Museum. The ore bucket, which has a capacity of 825lb (374 kilos) is the last known surviving example of more than thirty that once existed (Tyler 1990, 53).

5.3 WATER MANAGEMENT

Cisterns (see Figure 4)

Cistern 1 lies at NGR NY 1994 2163, 20m west of Mill 3 and slightly uphill from it (see Figure 12). The southern side of the structure has collapsed, but the remainder is well-preserved. It is built of undressed blocks of slate, with brick quoins and internal render. In its original form, the cistern was 3.0m square and 1.95m deep, giving it a capacity of 17.55m^3. The type of brick used indicates that it was built in the Phase 1-2 of Mill 3, and this is confirmed by photograph of *c*.1908 (Tyler 1990, figure on page 39). It is shown more clearly on a view of *c*.1919 (*ibid.*, figure on page 39), which indicates that at that date it was supplied with water via a wooden channel (of which no trace survives), probably using the outflow from the entrance to Level 1. There was a ceramic overflow pipe at the south-western corner of the cistern, which fed down into the outflow pipe from the base of the cistern; the reason for this is unclear.

At a later date, the sides of the cistern were raised by 0.9m and it was extended for 2.7m uphill, enlarging its cubic capacity to 32.94m^3. The earlier overflow pipe was

Figure 12. Cistern 1 viewed from the south-east (NMR AA99/04046).

blocked with mortar to prevent water escaping at that level. Water, again probably collected from the outflow of Level 1, was supplied via a ceramic pipe from a brick-lined sump directly upslope. The imprint of the pipe survives at the north-east corner of the lip of the cistern. The bricks used at the corners of the rebuilt cistern are the same as those used in Phase 3 of Mill 3, indicating that the change was made *c*.1939. It is uncertain to where the water from the cistern was fed at this date.

Cistern 2 lies at NGR NY 1999 2165, slightly uphill from the vehicle store. It is 3.3m long by 2.4m wide, with walls 0.7m high formed by three courses of breeze blocks rendered internally, giving it an approximate capacity of 5.54m^3. Breeze blocks were used to rebuild the portal of Level 1 in 1977, and the cistern is likely to be of similar date. Via a steel pipe, the cistern provided water to a tap in the vehicle store, which was presumably used for washing and maintaining equipment. A metal fitting and braces on the base of the cistern may have supported a pump, though its purpose is unclear. The cistern was evidently in use until the mine was finally abandoned in 1991.

Cistern 3 lies at NGR NY 1995 2166, immediately adjacent to the ore crusher. It is a partly buried steel tank whose dimensions and capacity are uncertain. Water was supplied from the sump outside the new entrance of Level 1via a grey plastic pipe, and fed to the rear of the processing building through pipes of the same type. After use in the refining process, the water from the cistern was piped away from the building along a single pipe, which no longer survives but is marked by a line of eighteen steel stanchions. The cistern and pipes may have been installed *c*.1977 or later, and were evidently in use until the abandonment of the mine in 1991.

Dams

Dam 1 spans the upper reaches of the Coledale Beck at NGR NY 1954 2115 (Figure 13a-c). It was built *c*.1839 to create a reservoir to supply the waterwheel of Mill 1 during summer droughts (Tyler 1990, 11). The reservoir is shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), from which it can be inferred that the dam was intact and probably in operation at that date. The dam was repaired in 1912 in order to supply the header pond formed by Dam 4, which in turn supplied the pelton waterwheel which provided power to the newly built Mill 3 (Tyler 1990, 35). There is no evidence that it would have been used after *c*.1922.

The dam is sited at the point where the natural rises on either side to the south and north are highest, rather than 30m further east where a much shorter barrier would have been required. The reservoir was not only fed by the Coledale Beck, but also by water from a tributary stream which was diverted along Leat 3. The dam now stands to a maximum height of 1.1m, but must have been considerably higher in the past. It appears to have been constructed in at least two phases, which may correspond to the work done in 1839 and 1912. The earlier phase matches the extent of the reservoir shown on the First Edition Map (Ordnance Survey 1862). It was built of turf and stone with battered revetment walls of roughly coursed slate blocks both front and back. It was approximately 25m long, 2m wide and must once have

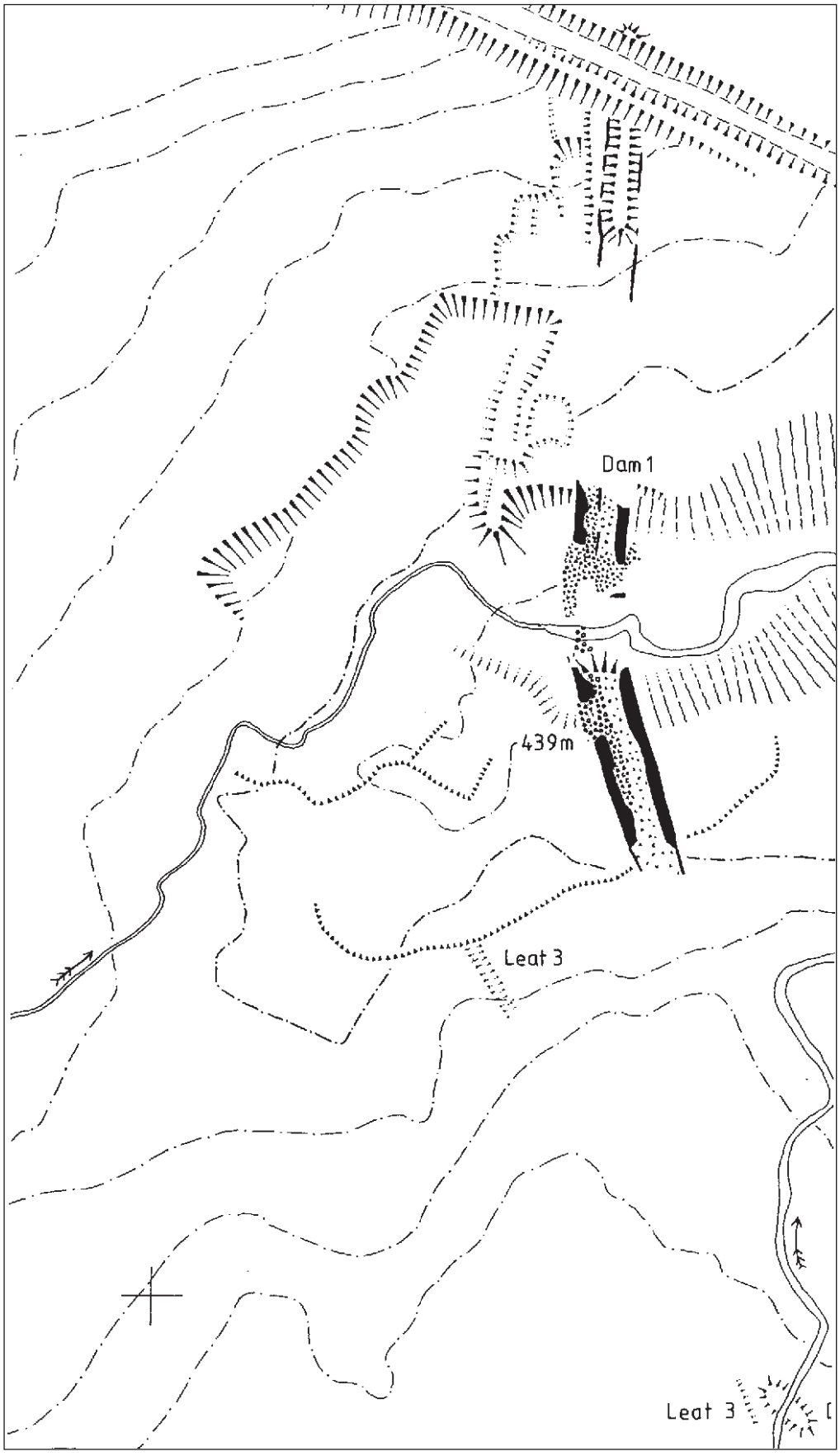


Figure 13a. Extract from survey showing Dam 1.

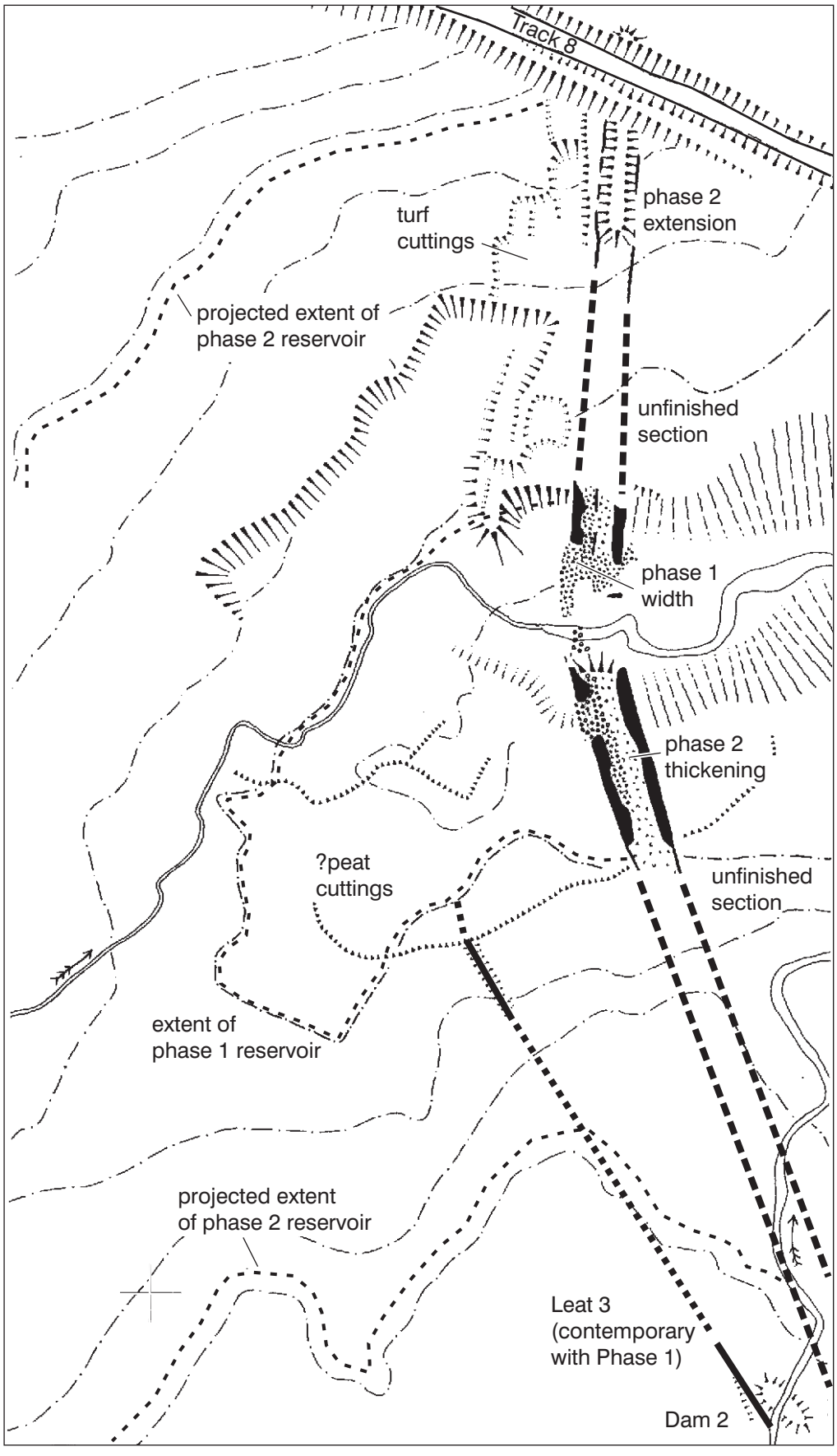


Figure 13b. Annotated extract from survey showing Dam 1.

Figure 13c. Dam 1 viewed from the south-east (NMR AA99/04026).

been *c*.2m high, aligned roughly from north to south, with a slight change of angle mid-way along its length. Close interval contour survey demonstrates that the area flooded by this early dam would have been approximately 780m^2 in extent, covering precisely the area shown on the First Edition Map (Ordnance Survey 1862), which may have provided about two weeks supply of water.

Subsequently, the thickness of the dam was almost doubled by the addition of more material on the downstream side and the construction of a new stone revetment wall. This modification may well be contemporary with an extension of the dam to the north, which would appear to have been left in an unfinished state. To the north of the dam, but separated from it by a gap of 15m, an earthen bank 18m long and up to 3.0m wide and 0.3m high, revetted both front and back by a single course of stone blocks, lies on the same alignment as the central section. Close to its northern end, the bank is cut by the course of Track 12. At its southern end, the earthen bank itself terminates abruptly adjacent to the end of a shallow cutting on the upstream side, which was presumably the source of the turves used to construct the core (see below). However, the lines of stones forming the external revetments continue for a further 5m. This would imply that the external revetments were constructed first,

and that the space between them was then packed with turf, stone and soil. The most convincing explanation for the appearance of the southern end of the bank is that construction was begun at the northernmost end of the dam, but was abandoned before the work was complete. Close interval contour survey indicates that had the central section of the dam been raised to a corresponding height, it would have had to be *c*.4m high, while the southern end would have needed to be extended by *c*.40m; this would have formed a reservoir 7265m^2 in extent. The extension of the dam to the south would have captured the flow from the tributary stream, making Dam 2 and Leat 3 superfluous. It is uncertain whether the dam was left unfinished because it became clear that the project was over-ambitious or because such a large body of water was not required.

Material to build the dam was evidently dug out in the immediate vicinity. Two different types of digging are evident. Firstly, there are shallow, precisely rectilinear cuttings no more than 0.2m deep which appear to have been dug to obtain turf, as noted above. Secondly, there are sheer-sided cuttings up to 0.8m deep, less regularly laid out, which seem to have been dug to obtain peat. Indeed, it is not entirely certain that these cuttings are contemporary with the construction of the dam, for while one on the northern side of the beck would appear to relate spatially to the shallow turf cuttings, one on the south seems to predate the dam. Equally, it is not impossible that several phases of activity are represented, or that peat was being dug at the same time, but for use as fuel rather than construction material.

Dam 2 spans a tributary of the Coledale Beck at NGR NY 1955 2109, and would have diverted water along Leat 3 into the reservoir formed by Dam 1. Leat 3 is shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862), so the dam must also have been constructed by that date. However, it does not necessarily follow that it was constructed at precisely the same date as Dam 1; it is quite possible that it was built later as a solution to a short-term water shortage. The dam is formed by an earthen bank 0.3m high and approximately 6m long, which has been severely eroded.

Dam 3, located at NGR NY1963 2115, spans a very minor tributary of the Coledale Beck and would have redirected water from it along Leat 4 to the header pond formed by Dam 4. The date of its disuse is equally uncertain. The dam is formed by a narrow bank of earth and stone 0.4m high and approximately 3m long, which has been severely eroded.

Dam 4 spans the Coledale Beck at NGR 1965 2122 (Figure 14a-c). It was built in 1912 to form a header pond to supply the newly-installed pelton wheel via Leat 5 and may have been rebuilt in 1917 when the pipe ruptured (Tyler 1990, 35-7). It was disused by *c*.1922. The pond would normally have been supplied from the Coledale Beck, or from Dams 1 and 3 in times of drought.

The dam was evidently built in two phases, the earlier of which may correspond to either of the episodes of work mentioned above. The final modification seems to have been carried out at a later date. In the first phase, the dam comprised a wall 0.9m thick and 0.6m high, built of slate blocks mortared together and rendered over externally. The resulting pond would have covered a small area, approximately 11m long by 7m wide. This would have had the advantage of limiting the damage done by erosion,

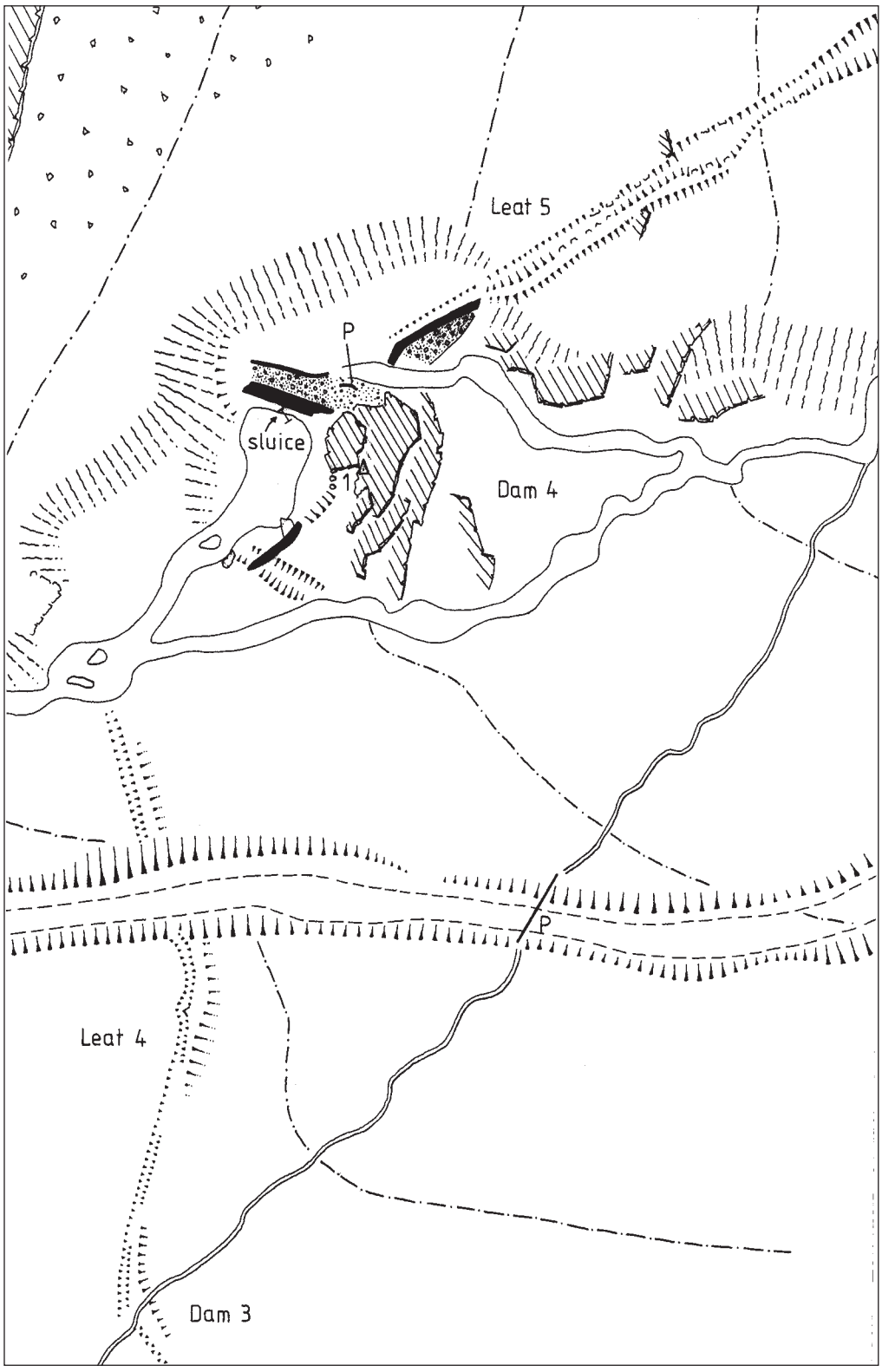


Figure 14a. Extract from survey showing Dam 4.

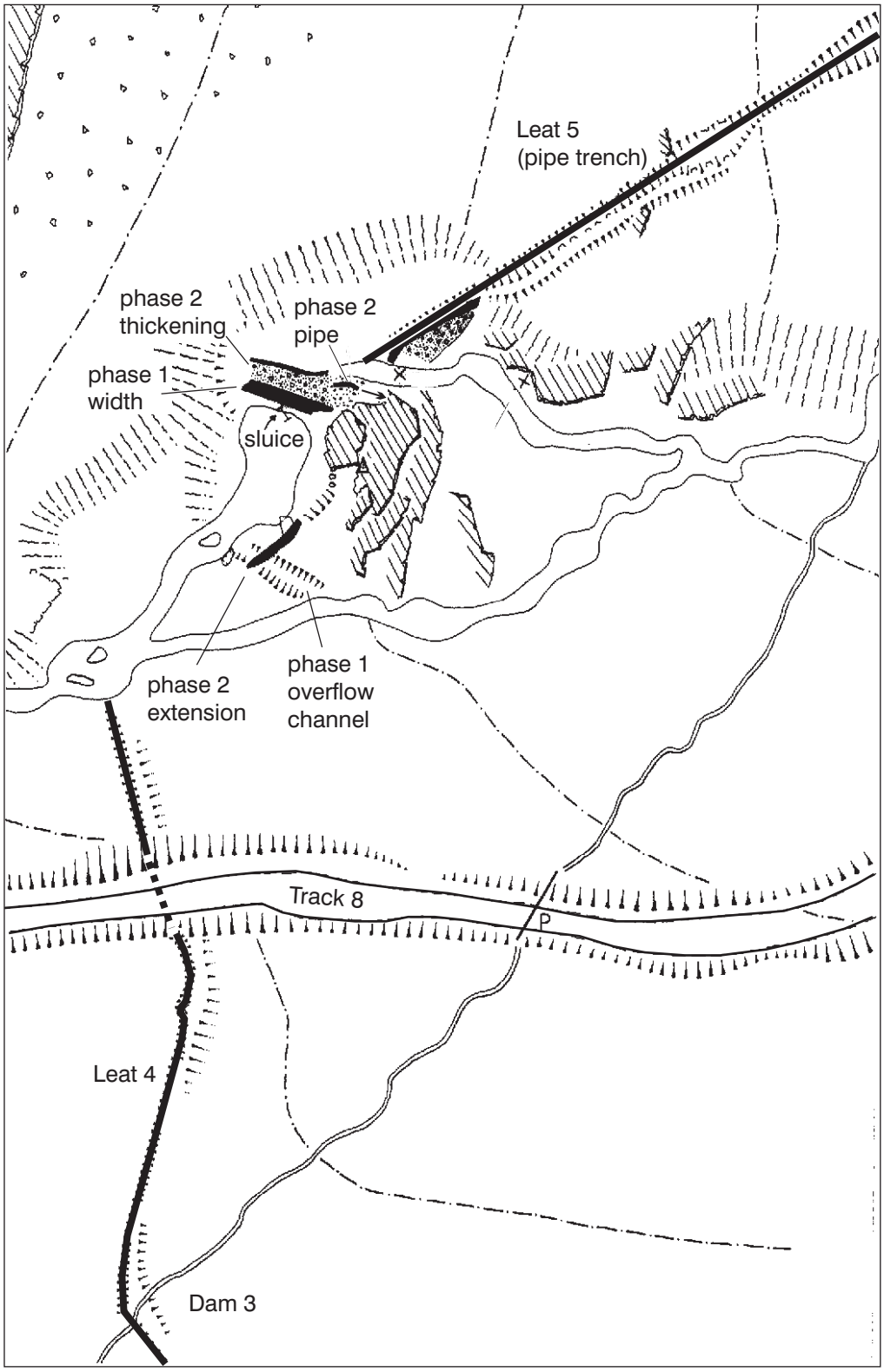


Figure 14b. Annotated extract from survey showing Dam 4.

Figure 14c. Dam 4 viewed from the south-west (NMR AA99/04036).

since water would normally have passed straight down the Beck, and only flowed through the pond when it was required to power the water wheel. Even when water was directed into the header pond, the excess would have returned to the beck through an overflow channel extending for a distance of 7m from the south-western end of the pond.

In the second phase, the dam was raised using similar materials to a height of 1.2m and the downstream side of the highest section was reinforced with a lower drystone wall on average 2m thick. The dam was also extended for a few metres to the south, blocking the former overflow channel. The extant sluice, which is preserved in fairly good condition, is probably contemporary with this modification. A cast iron pipe from the sluice gate emerges from near the base of the section of dry-stone wall that reinforces the dam. Significantly, the bore of the pipe (28cms or 11 inches) is

considerably larger than the pipes in Leat 5 that supplied the pelton water wheel. Furthermore, the final 30cms of the pipe turns an angle that directs it away from Leat 5 and towards the natural course of the beck. This suggests that in the final phase of its use, the dam served to create a small reservoir for Dam 6, which may have been constructed *c.*1939.

Dam 5 formed the reservoir that supplied the water wheel at Mill 2 via Leat 13 and later Leat 14, and was fed primarily from the outflow from Level 1, which was diverted into it along Leat 11. The pond, centred at NGR NY 2005 2161, is shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862). It presumably went out of use *c.*1881, and in about 1907 was evidently sub-divided and incorporated into the layout of Settling Ponds 1 (see Figure 25).

The more-or-less rectangular plan of the original reservoir can still be distinguished; it was aligned roughly south-west to north-east and measured approximately 50m long by 21m wide. The pond was dammed on all four sides by low banks, which clearly underlie the larger banks of the settling ponds. The banks are between 2.0m and 3.5m wide and up to 0.4m high, and increase slightly in size towards the north-east (ie downslope). The point at which the sluice for Leat 14 (and perhaps the earlier Leat 13) was located can be identified as a diminution of the bank at the north-eastern end of the pond, but no trace of the actual leat survives.

Dam 6 spans the Coledale Beck at NGR NY 1980 2129 (Figure 15a-c). It seems to have been built to create a head of water for a pipe, in a similar way to Dam 4, suggesting that it may have provided water to a pelton wheel. The date of its construction is uncertain, but the relationship of Leat 6 to Leat 5 and the roadstone quarry indicates that it was built after *c.*1922 and before 1961. The form and condition of the concrete, filter grill and pipes would suggest that the structure was built in the middle of the 20th Century, and the period between 1939 and 1947 is perhaps the most likely context for its construction.

The concrete dam is 3.0m long, with a narrow gap for a sluice at its centre. The closure of this sluice would have raised the water level by 0.3m, redirecting it through a steel filter grill into a small concrete sump incorporated into the foundations of the dam on its north-west side. From there it would have been fed into a strong cast iron pipe with a diameter of 10cms (4 inches), which would have continued along Leat 6. A second, much weaker pipe of smaller bore issues from the north-east face of the dam, and may once have extended for at least 4m, as far as a stone-built support built on an island in the stream. The purpose of this second pipe is uncertain, but it may have allowed the sump to be drained for maintenance.

Dam 7 blocked the channel of the minor stream that flows down the gulley above Level 3, some 30m upslope from the entrance to that adit, at NGR NY 1967 2165 (see Figure 8). It was a wall no more than 1.2m long and 0.4m high, built of the same pink mortar bricks used to construct the extant Office, which indicates that it was built *c.*1960. Only fragments of the wall now survive. The dam fed water into a steel pipe 4cms in diameter, which lies in approximately its original position. Its purpose is uncertain.

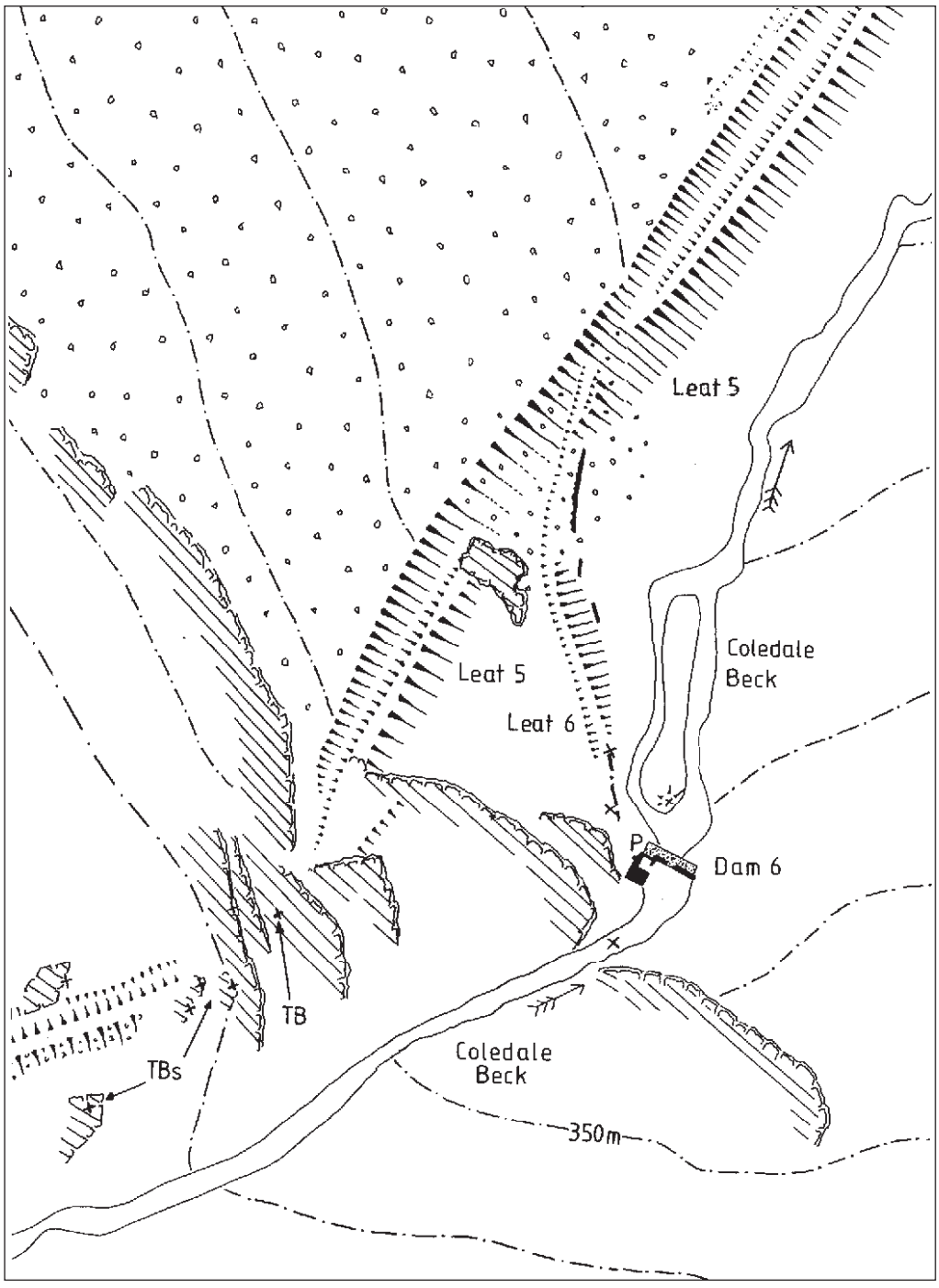


Figure 15a. Extract from survey showing Dam 6.

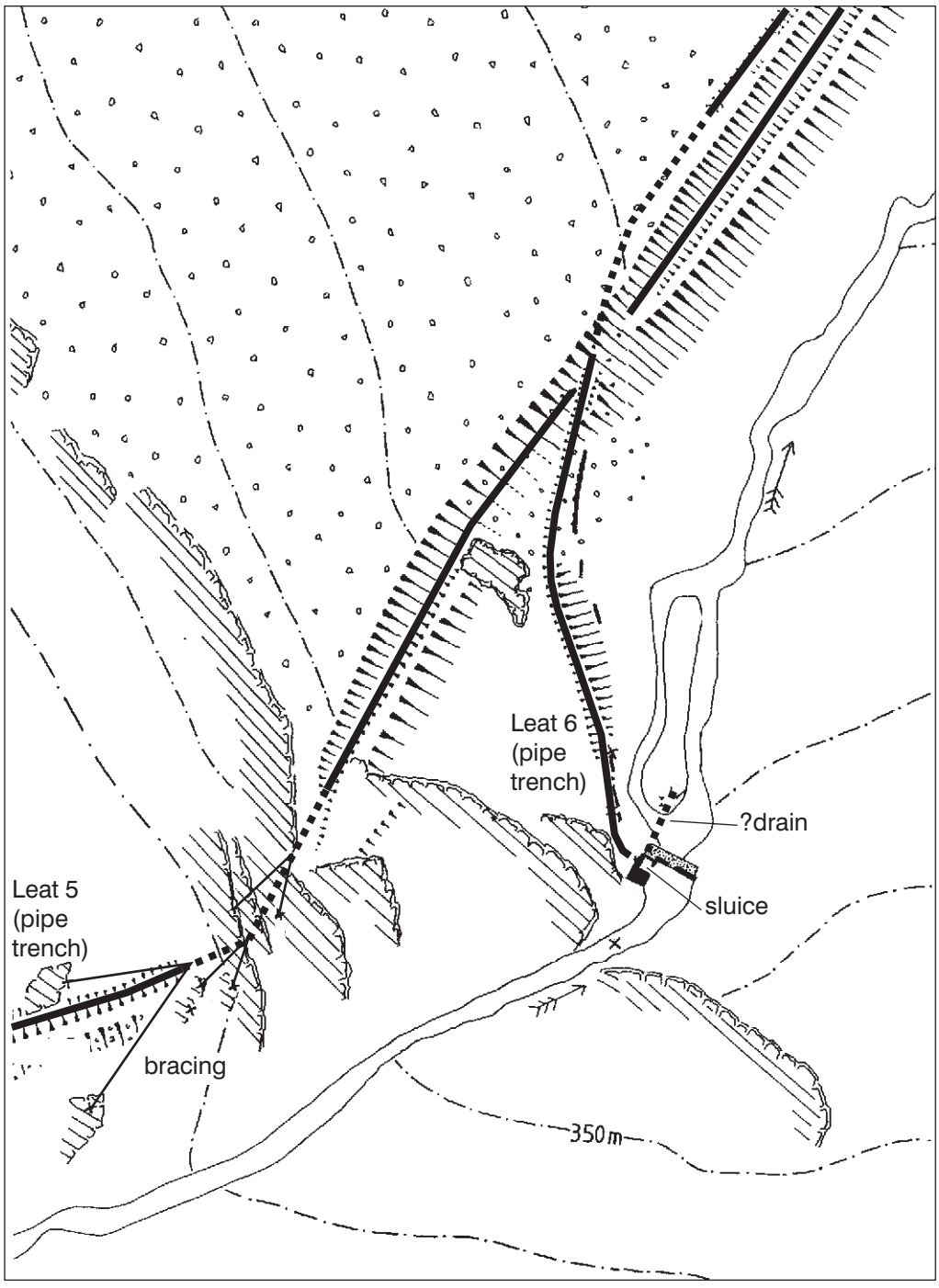


Figure 15b. Annotated extract from survey showing Dam 6.

Figure 15c. Dam 6 viewed from the north (NMR AA99/ 04029).

Dam 8 lies some 12m upstream from Dam 7 at NGR NY 1966 2165 (see Figure 8). It is of very similar size and form and also directed water into a steel pipe 4cms in diameter. The wall is less delapidated than that of Dam 7, but it is uncertain whether this is because it was built at a somewhat later date to replace the first dam, or simply because it is better preserved.

Leats (see Figure 4)

Leat 1 appears to predate Leat 2, which is known to have served Mill 1, making it is possibly the earliest artificial water course at Force Crag (see Figure 16a-b). However, the interpretation of the earthwork as a leat is open to some doubt. At NGR NY 1984 2142, a 15m stretch aligned from south to north is relatively well-preserved as a 0.5m wide channel of minimal depth, inclining unusually steeply across the contours. Further to the south, its course is overlain by Leat 5 and Leat 6, but there are slight indications that the underlying earthwork would have originated at the Coledale Beck. To the north, its course is cut by Leat 2, but it appears originally to have flowed into a slight rectangular depression cut into the hillside. This depression measures approximately 10m long by 3m wide, and is embanked on the downslope side to a height of 0.2m. In plan, the earthwork is suggestive of a wheel-pit, but the difference in height between the leat and the depression is not great, nor is the form of the

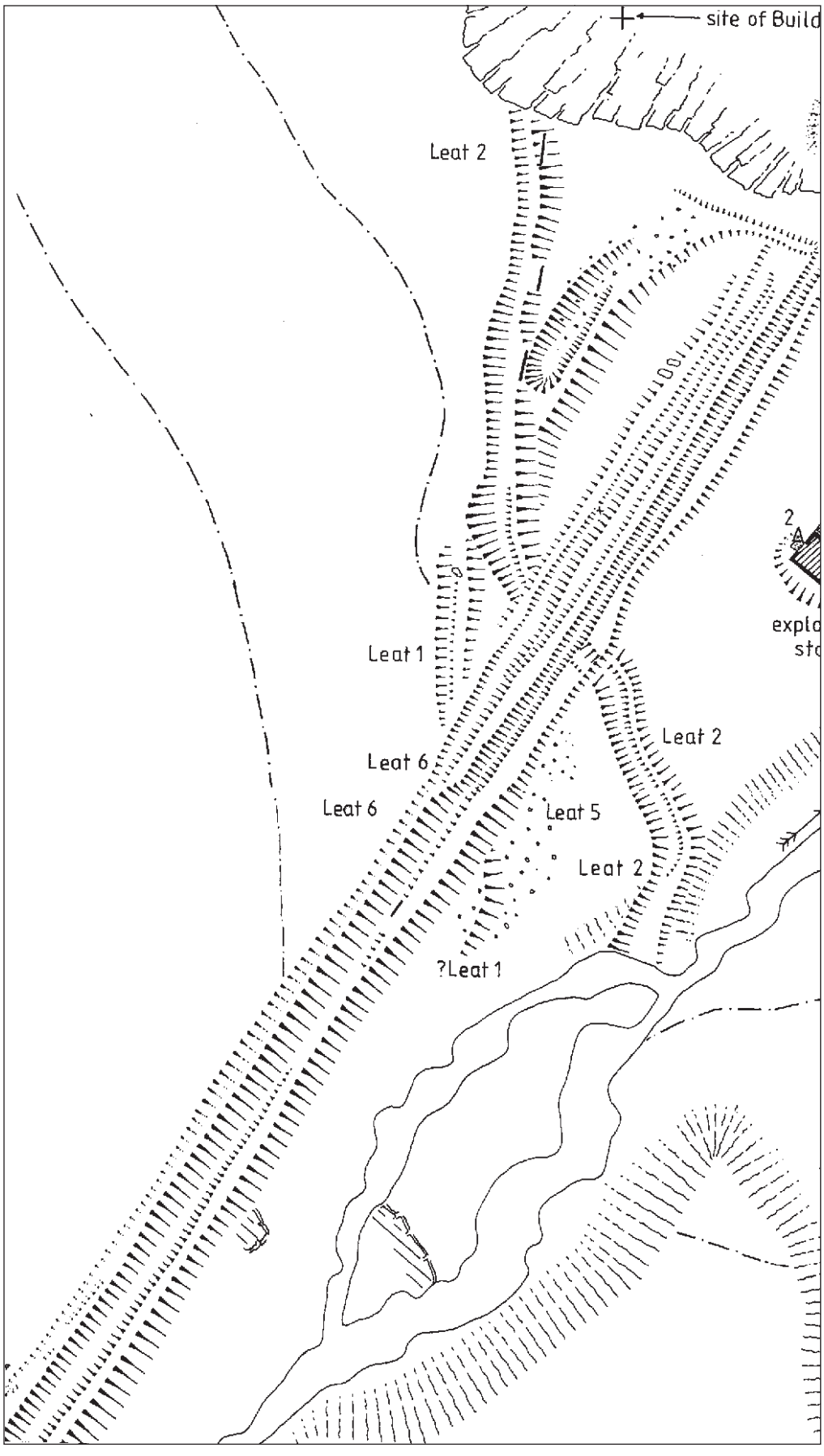


Figure 16a. Extract from survey showing Leats 1, 2, 5 and 6.

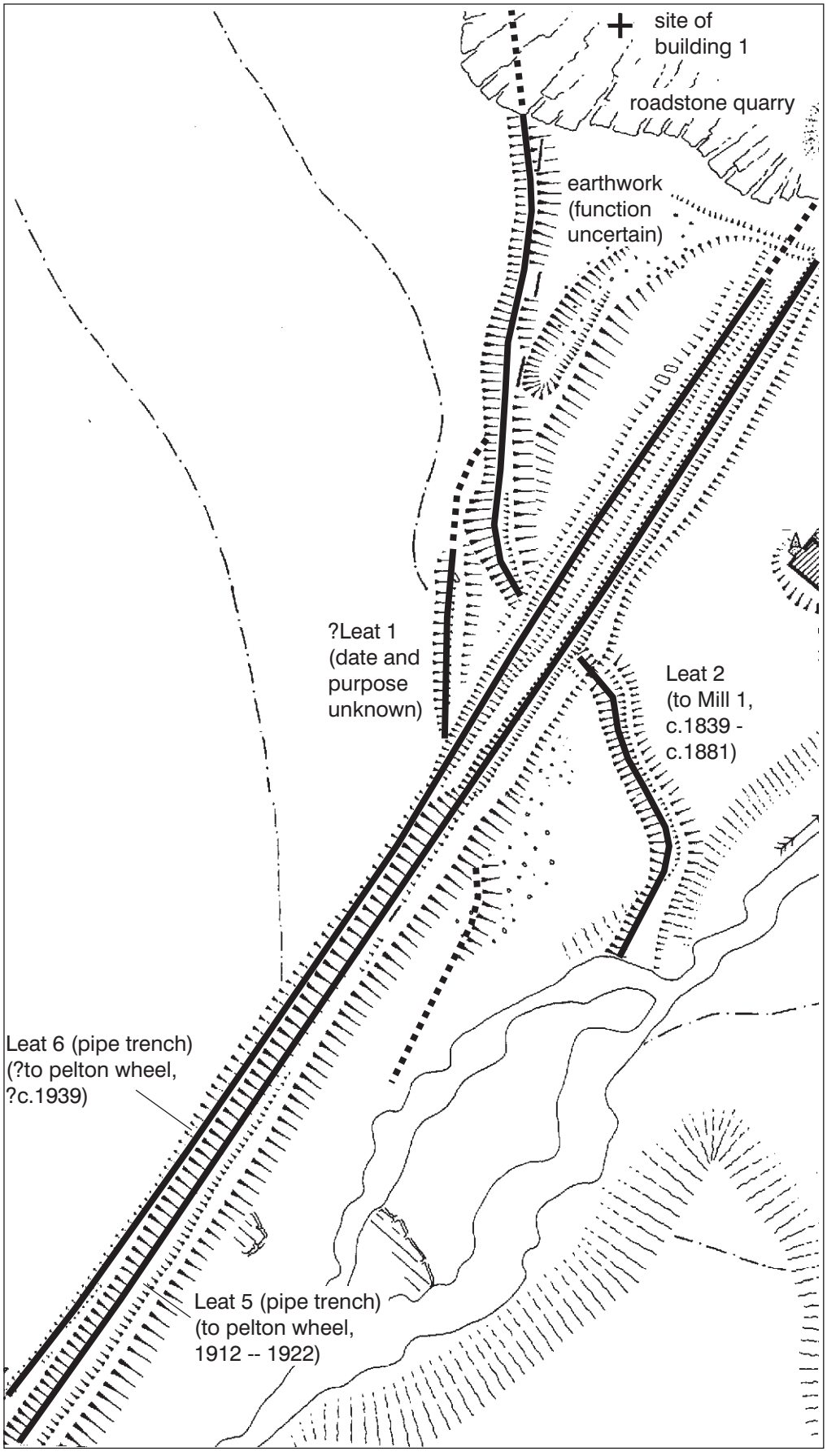


Figure 16b. Annotated extract from survey showing Leats 1, 2, 5 and 6.

supposed ‘pit’ at all convincing. On balance it seems more likely that the feature was associated with the washing of ore or some other part of the refining process.

Leat 2 supplied the water wheel of Mill 1 and is shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862). For a distance of 70m centred at NGR NY 1984 2143, the leat survives well as a shallow channel or level terrace, embanked on the downhill side to an average height of 0.4m, inclining gently downhill from south to north (see Figure 16). In places, the earthen embankment is supplemented with roughly-built stone walling. Its course cuts through Leat 1, but is in turn cut through by Leats 5 and 6. Its relationship to Mill 1 indicates that it was built *c*.1839, and the Ordnance Survey depiction indicates that it still survived, and perhaps still functioned in 1861.

Leat 3, at NGR NY 1953 2112, carried water diverted by the construction of Dam 2 to join the Coledale Beck at a point just upstream from Dam 1. It is shown on the First Edition map surveyed in 1861 (Ordnance Survey 1862). Minimal traces of the channel can be identified at two points: the first stretch where it passes behind Dam 2, and the second where it approaches the site of the reservoir formed by Dam 1. This suggests that the entire leat was formed by a wooden channel resting on the surface. The leat would have been made redundant by the unfinished extension of Dam 1, which probably indicates that it was redundant by 1881.

Leat 4, at NGR NY 1964 2118, carried water diverted by the construction of Dam 3 to join the Coledale Beck at a point just upstream from Dam 4. It does not follow that it was built at precisely the same date as Dam 4, but was presumably in use at some point between 1912 and c.1922. The leat runs for a total of 50m, bending slightly mid-way along its length to follow the contours, and inclining gently downhill from south to north. For much of its length, it survives well as a steep-sided channel up to 0.4m deep, embanked on the downhill side to an average height of 0.2m. In places, the earthen embankment is supplemented with roughly a low revetment built of stone. To the south of Dam 3, a channel 0.2m wide was evidently dug to drain a boggy area, thereby increasing the water flow into Leat 4.

Leat 5 cannot strictly be described as a ‘leat’, since it was probably constructed as a trench to carry a pipe, but the term is used here for convenience. Documentary evidence indicates that the pipe was laid in 1912 to supply water to a pelton wheel on the valley floor (Tyler 1990, 35). In 1917, the pipe ruptured and was repaired with some difficulty (ibid., 17ff). Indeed, shattered fragments of a cast-iron pipe 14mm thick and originally 23cms (9 inches) in bore were noted along the entire length of the trench, although most are concentrated towards its lower end. Tyler does not record whether the pipe ruptured in winter, but the digging of a substantial trench may have been intended to protect the pipe from freezing up. It runs almost in a straight line for 135m from Dam 4 at NGR NY 1965 2122 roughly east-north-east to the edge of the Force Crag massif at NGR NY 1977 2129, and then changes direction and runs for a further 230m north-eastwards straight down the hillside to terminate at NGR NY 1989 2148.

The upper section of the trench is aligned precisely on the sluice in Dam 4, but, as described above, the extant pipe that runs from the sluice is of larger bore and likely to

be connected with the later re-use of the dam. The first 10m of the pipe evidently lay on the surface and was carried on top of a well-built dry-stone revetment wall at least 3m wide, which is now somewhat delapidated stone. From there to the edge of the cliff face, it was carried in a trench blasted through solid rock for much of its length, up to a maximum depth of 1.3m, thus ensuring a fairly constant gentle slope. Although it maintains a fairly constant basal width of 0.4m, the overall width varies according to the depth of the trench and the material it is cut through, reaching a maximum of 4.5m. A low upcast bank runs intermittently along the southern side. A severely eroded section mid-way along this stretch may represent damage caused when the pipe ruptured.

Some 5m above the edge of the cliff, the trench runs out. Beyond this, eight iron braces soldered with lead into holes drilled into rock outcrops were probably originally arranged in four or five pairs, and must have held cables supporting the pipe. Their positions indicate that it changed course abruptly immediately before the edge of the cliff.

At the base of the cliff, the trench begins again and thereafter follows a much steeper but again fairly constant gradient straight to the valley floor. Where best preserved, it is 0.6m wide and 0.2m deep on average with a more substantial upcast bank running along the whole length of the southern side. It cuts through Leat 2, but is overlain by Leat 6. Towards its lower end, a section at least 26m long has been destroyed by the roadstone quarrying carried out in 1961, but beyond this the trench can be traced for a further 15m as a much slighter depression. The pelton wheel must have been sited a short distance beyond the end of this section, although its precise position is uncertain. The outflow would presumably have been fed back into the Pudding Beck, possibly at the point where there is a sub-rectangular depression on nearly the same alignment as the leat.

Leat 6, like Leat 5, cannot strictly be described as a 'leat', since it was probably constructed to carry a cast-iron pipe, but the term is used here for convenience. A pipe 10cms (4 inches) in diameter projects from the side of the sluice adjacent to Dam 6. This is the only part of the pipe that survives, but the earthwork remains suggest that from there it would have run in a gentle curve across Leat 5 to NGR NY 1980 2133, and then continued parallel to that channel straight down to an unknown point on the valley floor. For the first 8m north of Dam 6, the pipe was evidently carried on top of a well-built stone wall secured by angle irons hammered vertically into the ground. Beyond this for a further 20m, its course survives as a level terrace 0.3m wide, reveted intermittently on the downhill side by a more crudely built stone wall. The terrace is barely perceptible where it passes through the scree overlying Leat 5, but thereafter can be traced as a slight step in the natural slope on the north-west side of the earlier channel. On the final stretch approaching the valley floor, it survives as a slight trench up to 0.2m deep and 1.5m wide. It cannot be traced beyond the roadstone quarry dug in 1961, but presumably extended to approximately the same point on the valley floor. The form and condition of Dam 6 suggest that it was built *c*.1939, and it seems probable that Leat 6 was constructed to supply water from it to a pelton wheel, probably smaller and of a more efficient design than the one in use between 1912 and *c*.1922.

Leat 7 probably supplied water to the Slushing Channel, joining it at the same altitude as Level 3. It seems to have originated at the base of the Low Force of the Pudding Beck, but the first 75m must have been formed solely by a wooden channel, for there is no trace of its course on the ground. However, at NGR NY 1970 2158 a section 25m long narrowly escaped being buried beneath the second phase of the spoil tip outside Level 3, and is consequently relatively well preserved as an earthwork. The channel is up to 0.2m deep and 1.2m wide at the top; it curves gently to follow the contour and inclines very slightly downhill from south to north. Immediately beyond the southern end of the spoil tip, a short section of crudely built stone revetment survives; this presumably would have carried the last stretch of the wooden channel leading from the Pudding Peck. The northernmost end is largely overlain by the first phase of the spoil tip outside Level 1, but can be traced intermittently as a slight depression for a further 16m. Its relationship to the slushing channel suggests it to have been constructed *c*.1867 and it must have been disused by *c*.1881.

Leat 8 probably supplied water to the Slushing Channel, joining it approximately mid-way between Level 3 and Level 2. It probably originated at a point where the Pudding Beck briefly levels out, but the first 30m must have been formed solely by a wooden channel, for there is no trace of its course on the ground. However, at NGR NY 1971 2155 a section 35m long is fairly well-preserved as an earthwork, surviving as a terrace 0.8m wide that curves gently to follow the contour and inclines very slightly downhill from south to north. The northernmost end is entirely buried beneath the second phase of the spoil tip outside Level 1; a sheep track follows roughly the same course across the spoil, but this is not strictly connected with the earlier channel. The relationship of the leat to the slushing channel suggests it to have been constructed *c*.1867 and it must have been disused by *c*.1881.

Leat 9 probably supplied water to the Slushing Channel, joining it at an altitude slightly above Level 2. It probably originated at the Pudding Beck, but much of the first 30m has been buried beneath a spill of scree, while a short section must have been formed solely by a wooden channel. However, at NGR NY 1975 2154 a section 20m long is relatively well preserved as an earthwork, surviving as a terrace 0.8m wide that curves gently to follow the contour and inclines very slightly downhill from south-west to north-east. The northernmost end is entirely buried beneath the second phase of the spoil tip outside Level 1; a sheep track follows roughly the same course across the spoil, but this is not strictly connected with the earlier channel. The relationship of the leat to the slushing channel suggests it to have been constructed *c*.1867 and it must have been disused by *c*.1881.

Leat 10 is depicted on the First Edition map surveyed in 1861 (Ordnance Survey 1862). It evidently carried water from the Pudding Beck south-eastwards into Building 2, where it was presumably used in the ore-washing process, and then returned it eastwards to join the Coledale Beck a few metres upstream from the natural confluence of the two streams. A short length of drystone walling of unknown height projects from the spoil heap east of Mill 1 on the south bank of the Pudding Beck. This lies on almost the same alignment as the channel depicted on the map, and may represent an associated revetment. Between Building 4 and the Coledale Beck,

centred at NGR NY 1970 2159, the final section of the leat survives as a very slight earthwork no more than 1.5m wide and 0.1m deep. For most of its 75m length, the channel meanders irregularly, perhaps because it had been allowed to find its own course. Immediately prior to the point at which it joins the Coledale Beck it broadens out into a rectangular depression some 6m long and 4m wide. The function of this feature is uncertain.

A line interpreted as Leat 11 is depicted on the First Edition map surveyed in 1861 (Ordnance Survey 1862), centred at NGR NY 1998 2157. The leat evidently carried water from the outflow from the old entrance of Level 1 eastwards to feed into the reservoir formed by Dam 5. At the point where the leat diverged from the outflow, a section of channel some 10m long survives as an earthwork, and still drains the water that issues from the outflow, which is now buried. However, the depth of the channel and its altitude relative to Dam 5 suggest that its current state may largely reflect erosion on the same line as the leat itself. The remainder of the channel has been disturbed by Settling Ponds 1 and later dumping.

Leat 12 is evidently the remnant of a longer channel running from south-west to north-east. It may in fact be part of Leat 13, which supplied the water wheel of Mill 2. At NGR NY 2009 2167, a section 29m long survives relatively well as a level terrace 0.7m wide with intermittent traces of a narrower channel of minimal depth. It is embanked slightly on the downhill side.

Leat 13 seems to have been the original supply of water to the wheel at Mill 2, probably from the reservoir formed by Dam 5. Leat 12 may be part of the same watercourse. The relationship with Mill 2 suggests that it was constructed *c*.1854 when the water wheel was probably first erected. It was replaced by Leat 14 at some point before 1861 (Ordnance Survey 1862. At NGR NY 2021 2175, a 38m long stretch is well preserved as an earthwork. The channel is 1.5m wide on average and up to 0.2m deep, inclining gently downhill from south-west to north-east. At its south-western end it is cut by Leat 14, and at its northern end it is overlain by the embankment of Track 9.

Leat 14 supplied water from the pond formed by Dam 5 to the water wheel at Mill 2. In this was evidently built to replace Leat 13, which it cuts through, and must therefore have been built somewhat after 1854. However, it is depicted on the First Edition map surveyed in 1861 (Ordnance Survey 1862). Its relationship to Leat 13 indicates that it was constructed somewhat later than 1854, but before 1862, and it presumably became redundant *c*.1881, when Mill 2 was used for the last time. At NGR NY 2020 2176, a 40m long stretch is well preserved as an earthwork. The channel is between 1.5m and 3.0m wide across the top and up to 0.5m deep, inclining gently downhill from south-west to north-east. At its south-western end it cuts through Leat 13, and at its north-eastern end it is itself cut by Track 12. Track 13 also cuts through the south-western end of the leat, but beyond this a poorly preserved remnant of the channel 10m long still survives.

A feature interpreted as Leat 15 is depicted on the First Edition map surveyed in 1861 running between the Birkthwaite Beck at NGR NY 2031 2162 to a point on the southern side of the natural river terrace of the Coledale Beck at NGR NY 2012 2158

(Ordnance Survey 1862). Some 30m from its point of origin at the beck, the watercourse bends sharply to the west and Leat 16 diverges from it. The chronological relationship between the two is slightly ambiguous, but there is some evidence that Leat 15 originally bent at this point and that Leat 16 was a later addition. Almost the whole course of the leat, 220m in length, is well preserved as an earthwork. The channel is 1.5m wide on average and up to 0.2m deep, inclining gently downhill from east to west. It is embanked slightly on the downhill side. The purpose of the leat is unclear, since it terminates at a point that lies some distance from any of the mills. The earthwork remains suggest that water could be taken off from the leat at two points 20m apart, or directed back into the Coledale Beck along a by-pass channel. The two points where water could be taken off are marked by spreads of eroded material which spill down the natural scarp of the river terrace. The more westerly of the two is depicted on the First Edition map surveyed in 1861 (Ordnance Survey 1862). In neither case is there any evidence for a structure on the valley floor. However, a few grains of crushed barytes ore are scattered over the surface of a natural bank of stone deposited by the beck; it is uncertain these have been washed down by the stream or represent the residue of a process such as ore-washing.

Leat 16 diverges from Leat 15 at NGR NY 2030 2164 and runs almost straight towards the site of Mill 2, following the eastern edge of the natural gulley eroded by the Birkthwaite Beck, disappearing at the edge of the natural river terrace at NGR NY 2026 2171. As described above, the chronological relationship with Leat 15 is not clear-cut, but there are hints that Leat 16 may be the later of the two. It is not depicted on the First Edition map surveyed in 1861, but was evidently not a major watercourse and may have been ignored (Ordnance Survey 1862). For most of its length, the channel is only 0.3m wide and of minimal depth. Although it probably post-dates the construction of Leat 15, its relationship to Mill 2 suggests that it was probably constructed at some point between *c*.1854 and *c*.1881.

5.4 PROCESSING THE ORE

Hand-Dressing Floors

No trace now survives of Hand-Dressing Floor 1, but its existence is inferred from the available documentary and field evidence. As noted above, Tyler (1990, 14) states that *c*.1854, ore was being brought out of Level 2 and taken down an 'inclined track' to a plateau *c*.6m below Level 2, where it was tipped into a hopper and broken up by hand. From there, it was transferred to a smaller hand-dressing floor and taken to Mill 1 to be crushed. It is unclear whether this conclusion is based on documentary research or field observation, but Tyler also states that the hand-dressing floor could still be seen in 1990. The 'inclined track' seems to equate to Tramway 3, which passes the tip outside Level 2 and would have terminated approximately 6m lower than the entrance to the adit and directly above Mill 1. However, the end of Tramway 3, and therefore the site of the hand-dressing floor, was entirely destroyed by the quarrying for roadstone that took place in 1961. The site would have been at approximately NGR NY 1981 2155. Aerial photographs taken prior to 1961 (RAF 1947; 1957) suggest that the natural slope was originally fairly steep at this point, so it seems likely that the 'plateau' would have been created artificially.

A bounded area immediately below Level 1, connected to Mill 1 via Tramway 2, is depicted on the First Edition map surveyed in 1861 (Ordnance Survey 1862); this is interpreted as the site of Hand-Dressing Floor 2. Given its position, it seems likely to have received ore solely from Level 1. Although the easternmost end of Tramway 2 survives as an earthwork, the dressing floor itself was partly quarried away in 1961, the remainder being buried beneath spoil tipped from the tramway serving Level 1. The depiction on the First Edition map indicates that it was approximately 12m square, centred at NGR NY 1990 2160.

The 19th-century processing buildings (Mill 1 and Mill 2)

History

On the basis of his field observations, Tyler has identified three sites where ore might have been processed prior to 1881, which he has cautiously linked to the documentary evidence (Tyler 1990, 11; 14; 17-9). Although there were certainly buildings in all three locations at various dates, only two can be securely interpreted as the sites of early mills. In the light of this, and the depiction of the complex on the First Edition map surveyed in 1861 (Ordnance Survey 1862), the sequence proposed by Tyler has been revised. This re-interpretation has formed the basis of the dating of the features associated with the mills throughout Section 5, and is discussed more fully in Section 6. To avoid greater confusion, the documentary evidence for the history of the mines is presented here without reference to the specific sites that have been identified.

The first water wheel had been erected by September 1839, and would have powered a relatively simple crusher consisting of two iron rollers (Tyler 1990, 9). Lead ore was supplied to the mill from Levels 2 and 3. In 1854, a new mill was built to

process the lead ore being extracted from Level 1 (*ibid.*, 14-5). The mill comprised a water wheel 30 feet (*c.*9m) in diameter and associated buildings and structures. A smithy was also built. By 1856, the new wheel powered a stamp battery (consisting of four large iron hammers) for crushing the ore, and a full washing and processing plant had been built. However, after the abandonment of the mine in 1865, the buildings quickly fell into disrepair. In 1867, a new grinding wheel was installed to process barytes ore being extracted from Level 4 (*ibid.*, 17). In about 1872, a bleaching plant was installed to achieve a pure white product (*ibid.*, 20), but the documents record no further major changes prior to the closure of the mine in 1881.

Description of Mill 1 (Figure 17a-b)

The First Edition map surveyed in 1861 (Ordnance Survey 1862) depicts a rectangular feature which seems to represent a water wheel pit (possibly roofed over) on the southern bank of the Pudding Beck at the northern end of Leat 2, at NGR NY 1981 2150. However, the feature is not annotated as a water wheel, which may indicate that it was not in use at the time of the map-making. Tramway 2 is depicted as terminating adjacent to the feature, and the field remains of Tramway 3 and the Slushing Channel suggest that they also terminated at approximately the same point. Much of the surrounding area has been either destroyed by the roadstone quarrying that took place in 1961, or is now buried beneath the bank of spoil dumped around the edge of the quarry. However, what little is still visible on

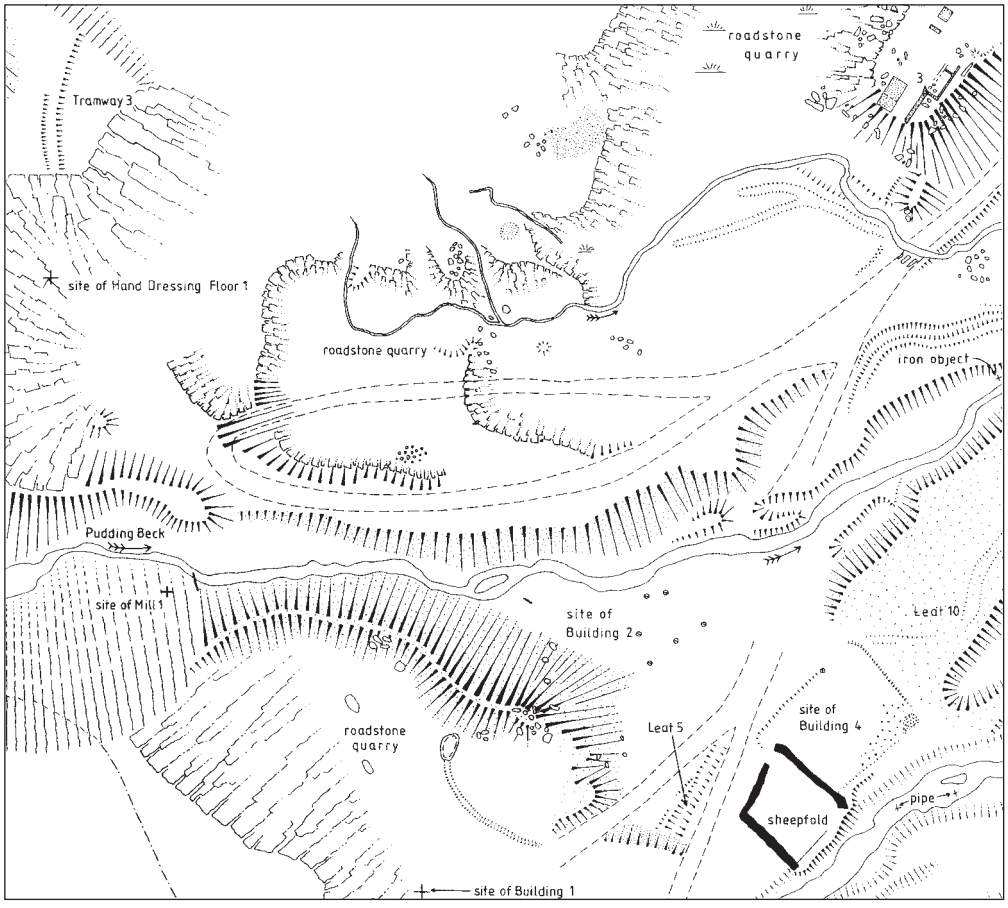


Figure 17a. Extract from survey reduced to 1:1000 scale showing Mill 1.

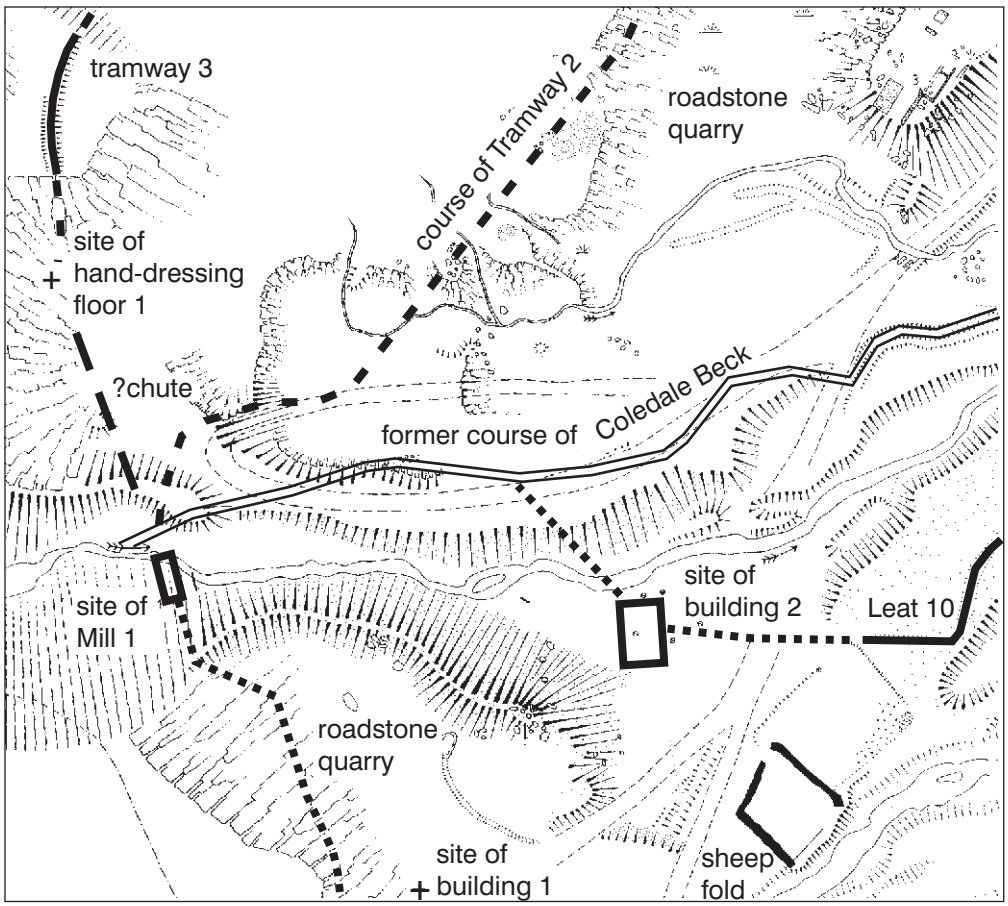


Figure 17b. Annotated extract from survey reduced to 1:1000 scale showing Mill 1.

the surface supports the interpretation of the feature as the site of a water wheel. Assuming the gradient of Leat 2 remained constant across the quarried area, it would have arrived at the top of the natural slope down to the Pudding Beck at a height approximately 4m above the stream, *ie* at the right height to supply an overshot wheel. Slightly downstream from this on the south side of the beck, a short length of drystone walling at least 1m high projects from the base of the bank of overlying spoil. This is on the same alignment as the feature shown on the map, but it is crudely built and does not appear to have been part of a substantial structure; it may have been a revetment built to retain the material upslope.

Tyler (1990, 17) mentions that a grinding wheel was discovered during a 'dig' undertaken in the vicinity shortly before 1990, but no other details are available.

Some 70m due east of the supposed site of the water wheel lies an extensive mound up to *c*.1m high, formed of mill tailings and waste products from the washing process. This too is partly overlain by the bank of spoil dumped around the edge of the quarry dug in 1961. In the southern bank of the Pudding Beck a few metres to the north, the lower part of the section eroded through the deposits is composed almost entirely of thin layers of fine ore-bearing slurry laid down in water. This, together with the survival of the tops of wooden posts in the vicinity of Building 2, indicates that there is almost certainly excellent sub-surface preservation in this area.

Building 1, which lay on the slope overlooking the processing area, and Building 2 which lay on the valley floor downstream from the water wheel, were evidently connected with Mill 1, but their precise functions remain unclear (see below).

Description of Mill 2 (Figure 18a-b)

The First Edition map surveyed in 1861 (Ordnance Survey 1862) depicts a rectangular feature annotated with the words 'water wheel' on the northern bank of the Coledale Beck adjacent to the ford, at the eastern end of Leat 14. It is located at NGR NY 2024 2177. The wheel pit is extremely well preserved as an earthwork, although its upper end is partly overlain by the embankment of Track 12. It survives as a rectangular depression at least 6m long and *c*.5m wide stepped into the natural slope, so that at its deepest point the base is 2.6m below natural ground level. Within this pit, along its northern side, is a slighter depression 1.5m wide; the fact that Leat 14 is perfectly aligned on this suggests it to be the site of the wheel itself. On the same alignment are intermittent traces of a narrow channel up to 0.2m deep extending from the bottom edge of the wheel pit as far as the Coledale Beck. This is almost certainly the remnant of the tailrace, as depicted on the First Edition map.

On the raised area to the north of the wheel pit, a possible wall or foundation can be traced as a carefully laid line of squared stones 3.0m long, aligned at right angles to the wheel. This lies flush with the surface, which entirely comprises tailings from the mill. A square structure is depicted in approximately this position on the First Edition map, and seems to have been enlarged by 1881 (Ordnance Survey 1862; 1900). Two distinct mounds of material, now grassed over, lie on the surface of the raised area.

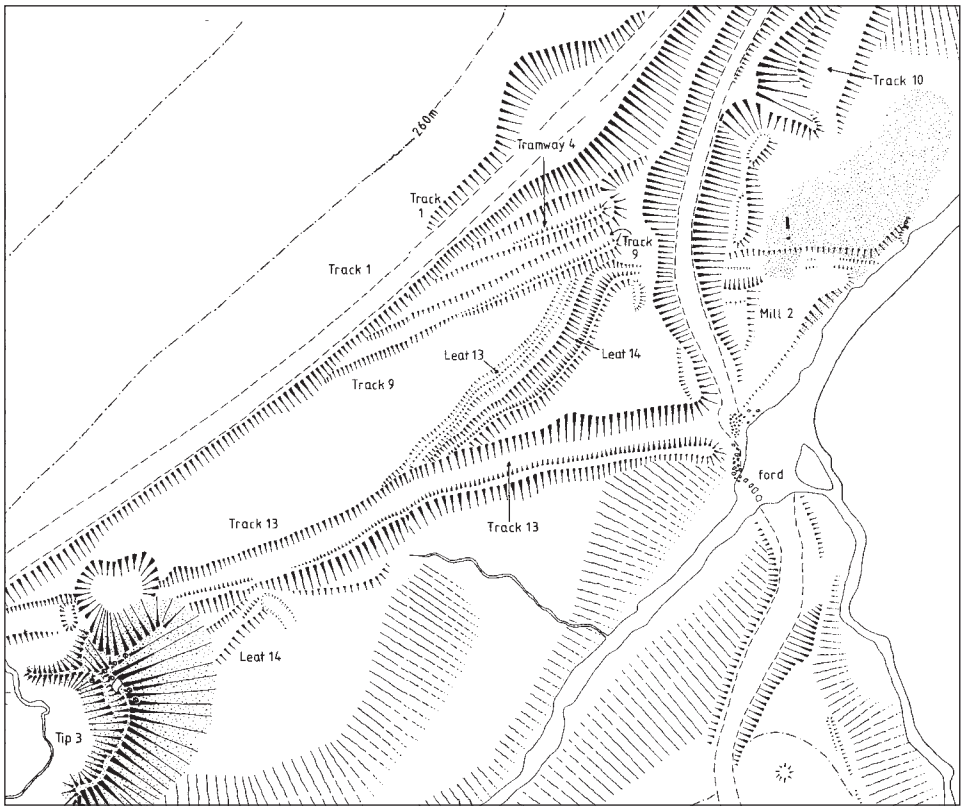


Figure 18a. Extract from survey reduced to 1:1000 scale showing Mill 2.

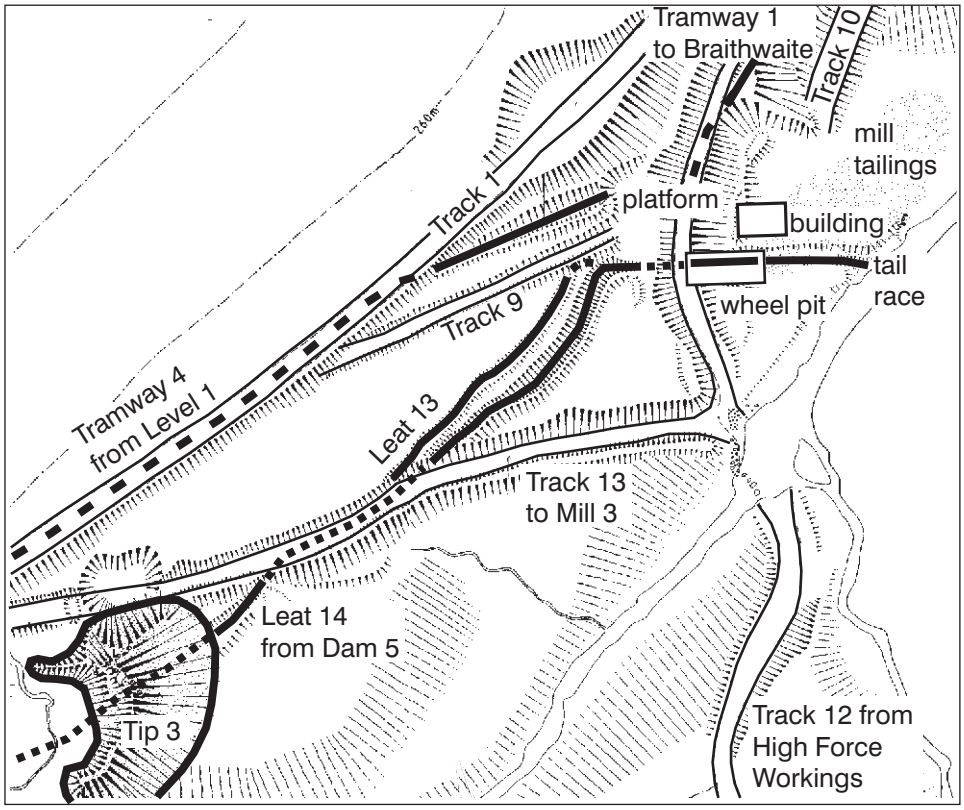


Figure 18b. Annotated extract from survey reduced to 1:1000 scale showing Mill 2.

Above the wheel pit, the present course of Track 12 cuts through a level platform terraced into the natural slope. The First Edition map surveyed in 1861 indicates that the track originally terminated at the platform (Ordnance Survey 1862). Track 9 and Tramway 4 also terminate at this level area, which lies *c*.4m above the structure below. Ore would presumably have been tipped from here into the crusher.

From the north-eastern edge of the tailrace, a mound up to 0.7m high and 365m^2 in extent stretches eastwards, covering much of the flat area on the northern bank of the Coledale Beck. The surface of the mound mostly comprises mill tailings, but a sparse scatter of clinker was also noted. The edge of the mound was evidently retained by a timber hoarding, the ghost of which can be traced along the northern bank of the Coledale Beck. Where the stream has eroded into the mound due to the absence of the hoarding, two horizontal wooden planks are visible, which apparently formed the base of a timber settling tank. The deposits overlying the planks are composed entirely of thin layers of fine ore-bearing slurry laid down in water. This, together with the high standard of earthwork survival of the rest of the mill site, indicates that there is almost certainly excellent sub-surface preservation.

The extant processing building (Mill 3)

History

A small mill was constructed on the site of the extant building *c*.1906, but this proved inadequate for the milling of zinc ore, so it was replaced with a new building in 1908-9 under the ownership of Cumberland Mines Limited (Tyler 1990, 33). A

photograph records a formal gathering in front of the building while the building work was evidently under way (*ibid.*, figure on page 38). Power for the mill and for newly-acquired compressed-air drills was initially supplied by two gas engines, but after *c.*1912 under the ownership of The Coledale Syndicate, the pelton wheel supplied by Leat 5 generated the necessary power. A sophisticated Elmore Flotation Plant was also installed at this time (*ibid.*, 35-6). In about 1913, the building and equipment were again modified slightly. In 1916 a larger crusher was installed, together with a Harding Pebble Mill and three separation tables (*ibid.*, 37). Photographs taken by James Hindmarch *c.*1916 record views of the exterior from the north-west and the north-east, and a close-up of some of the processing plant within the building (reproduced in Tyler 1990, figures on pages 39, 42 & 44). Shortly after this, a Silex Ball Mill was installed to replace the pebble mill, and two new concentrate tables were added (*ibid.*, 46). However, the building fell into disrepair soon after production ceased in 1922, and in 1928 some of the machinery was sold off.

The mill was rebuilt in 1939-40 under the ownership of Tampimex Oil Products Limited, and most of the processing plant installed was brand new (*ibid.*, 52). A schematic plan, annotated 1943, in fact appears to show the condition of the building *c.*1940, prior to the installation of the aerial ropeway (Cumbria CRO g and Figure 22). Certain modifications were made when the ropeway was installed, and some of these are evident on a plan dated 19 May 1944 (Cumbria CRO f). No major changes to the mill are recorded under the tenure of the La Porte Chemical Company, possibly because no actual ore was extracted. In 1952, when the mine closed, the building gradually fell into disrepair.

The mill was put back into working order between 1960 and 1962 under the ownership of McKechnie Brothers Limited (*ibid.*, 69-70). A letter to WT Shaw dated 15 March 1962 (Cumbria CRO b) suggests that mains electricity was finally installed in that year (*contra* Tyler 1990, 88). Much of the plant was auctioned off when the operation ceased in March 1967, but it may have been acquired for WT Shaw, for the mill was in operation at his instigation from the beginning of June of the same year (*ibid.*, 87-8). In 1982, when Force Crag Mines (UK) Limited was forced to close the mine, the machinery was again sold off (*ibid.*, 100-1). Many of the items of equipment in use between 1984 and 1991 were initially removed when the mine was finally abandoned. They have subsequently been acquired by the National Trust and returned to the building, but not all to their correct positions.

Description (Figure 19a-d; 20-24)

Mill 3 is sited at NGR NY 1997 2163, some 50m south-east of Level 1 and 10m downslope from it. In addition to the survey at 1:500 scale that formed the basis of the field investigation, limited additional architectural recording was undertaken, comprising a photographic survey and analytical examination of the interior, and a measured survey at 1:100 scale of an elevation/section through the building (Figure 20). In conjunction with the documentary evidence, seven constructional phases can be identified (Figure 21), but it seems likely that the internal arrangements may have changed more frequently to accommodate new machinery. Scars resulting from the

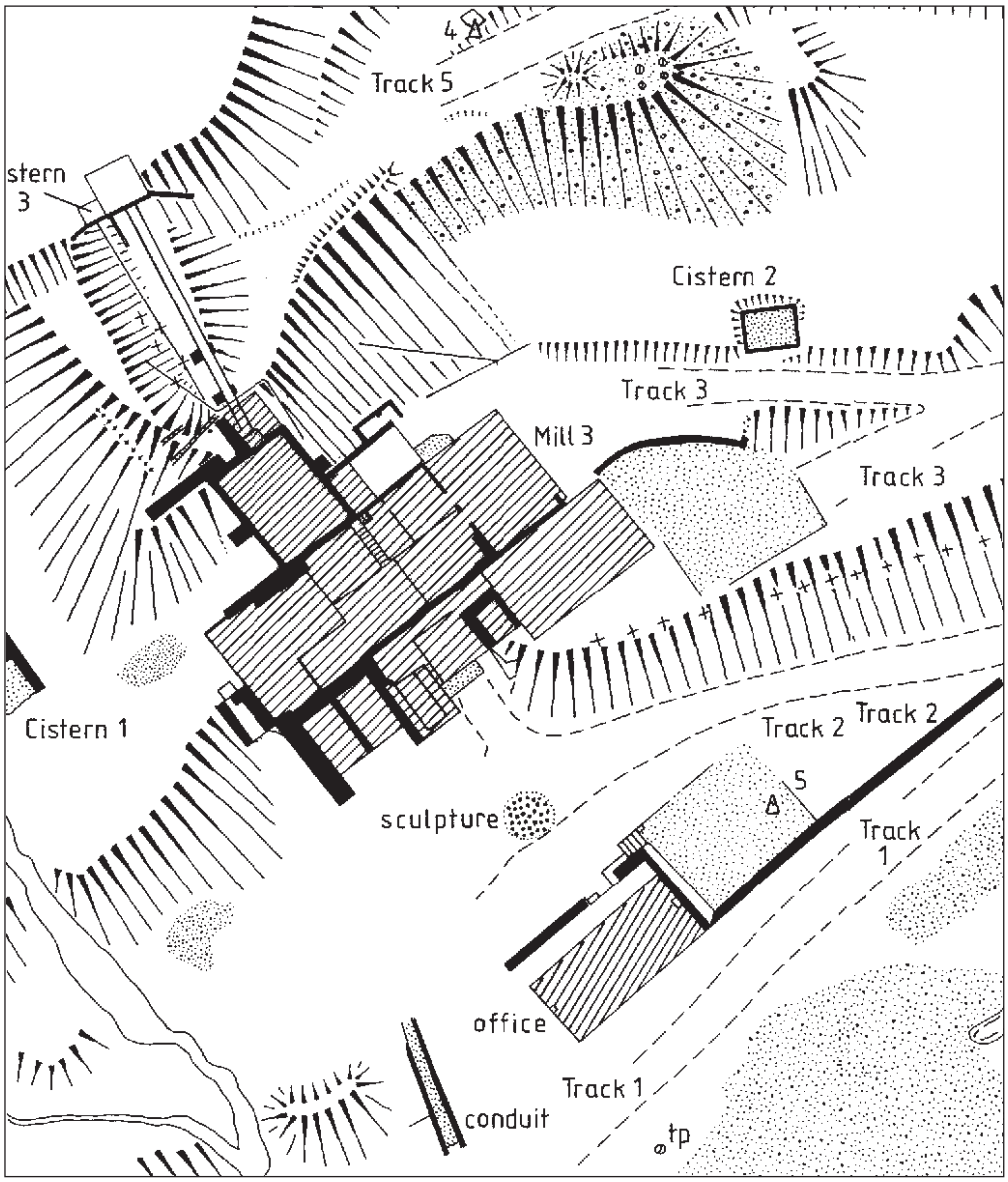


Figure 19a. Extract from survey showing Mill 3.

removal of internal floor levels and staircases were noted, but without more detailed survey of the building it was not possible to work out the constructional sequence or to ascribe functions to some of the working areas.

There is a concentration of small tips of coarse waste from the mill to the east of the building. Tip 2, to the south-west, seems to be the main dump of smaller tailings. Both dumps probably represent numerous episodes of activity.

Phase 1 (1908-9)

The building completed in 1909 under the tenure of Cumberland Mines Limited seems to have comprised two rectangular ranges, each two storeys high, placed end to end and stepped down the natural slope. The masonry elements are constructed in roughly dressed slate blocks with quoins of orange/brown brick. The foundations and lintels are of concrete, the aggregate comprising tailings from the mill. Most of

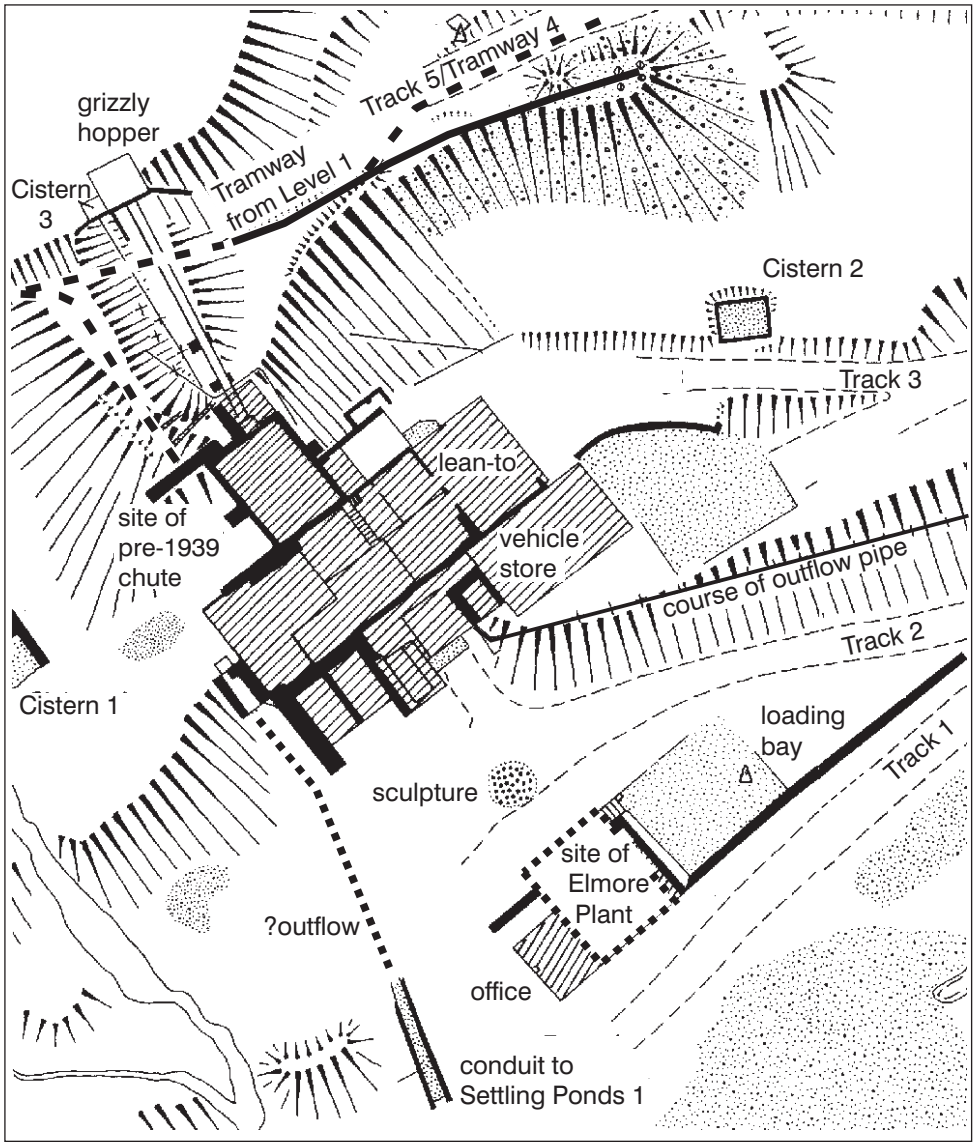


Figure 19b. Annotated extract from survey showing Mill 3.

these more substantial elements survived to be incorporated into the 1940 rebuild (Phase 3) and can still be identified. Tyler (1990, 34) reproduces a mill flow sheet of *c*.1909, which details how the zinc ore brought out from Level 1 was refined:

Hand sorting
⇓
20 x 10 inch stone crusher
⇓
Crushing rollers
⇓
Trommel Screens
⇓
Green's Jigs
⇓
Diester Slimes Tables
⇓
Ball Mill (possibly a pebble mill)
⇓
Buss Table

The upper range measured 6.0m wide by 9.0m long with its long axis aligned north-west to south-east, *ie* up and down the natural slope. Ore was fed into the room on the first floor at its upslope end, arriving via a steeply inclined timber chute which rested on the rear wall of the building and a taller free-standing pier. The chute no longer exists but the pier survives to its full height of at least 8m. Immediately behind the top of the pier, two horizontal timbers attached to vertical posts are partially buried in spoil and fairly well preserved, and it seems likely that some of the rest of the structure may survive beneath the surface. This structure may correspond to a timber gantry carrying a tramway from Level 1 out to the top end of the chute, which is shown on the photographs of *c*.1916. The floor of the room on the first storey was supported by massive beams, of which a number still survive, each 0.3m square. However, the photographs of *c*.1916 suggest that the superstructure was relatively lightly constructed of timber and corrugated iron, doubtless to reduce its weight. In the room on the first floor, the barren and oversize rock was presumably sorted by hand before being fed down to the crusher on the floor below. At ground-floor level the range was open on both sides, with massive walls at each end, which still survive. Vehicular access to the machinery would have been possible along Track 3. A door in the downslope wall (blocked in Phase 3 and re-opened subsequently) would have provided access into the lower range at first floor level.

The lower range was 6.0m square, and constructed in a similar way to the upper range. The floor of the room on the first storey was supported by massive beams, each 0.3m square. Although the original superstructure has been removed, the scar of the steeply pitched corrugated iron roof can be traced on the exterior of the end wall of the upper range. A line of circular timber studs, all sawn off just above floor level, appear to represent a remnant of the south-western wall. To the east of the main part of the lower range is another wall constructed in the same materials on the same alignment, which gives the building as a whole a T-shaped plan. This wall is much less massively

Figure 19c. Mill 3 viewed from the south-west (NMR AA99/04044).

Figure 19d. Mill 3 viewed from the west (NMR AA99/04042).

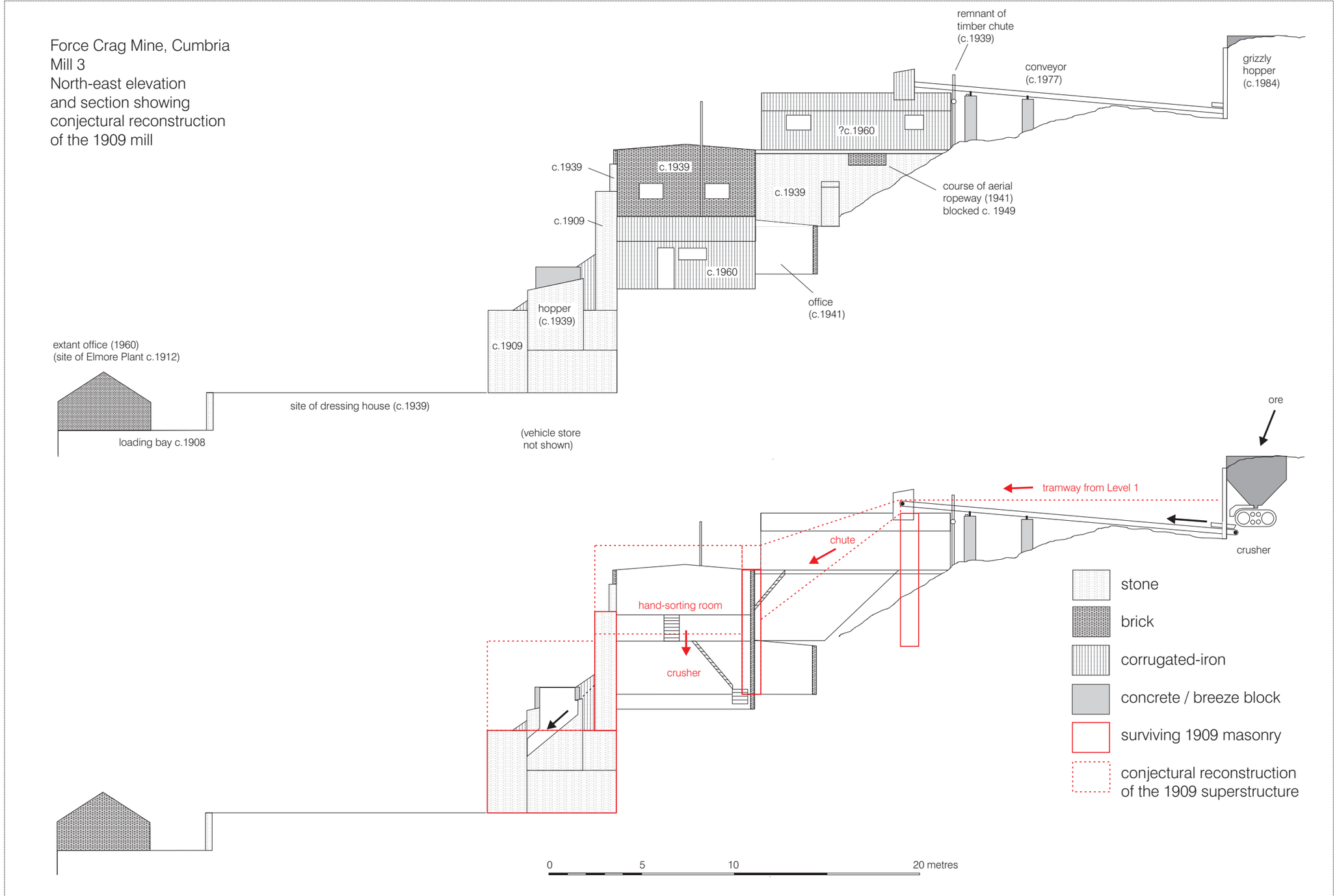


Figure 20. Elevation and section through Mill 3.

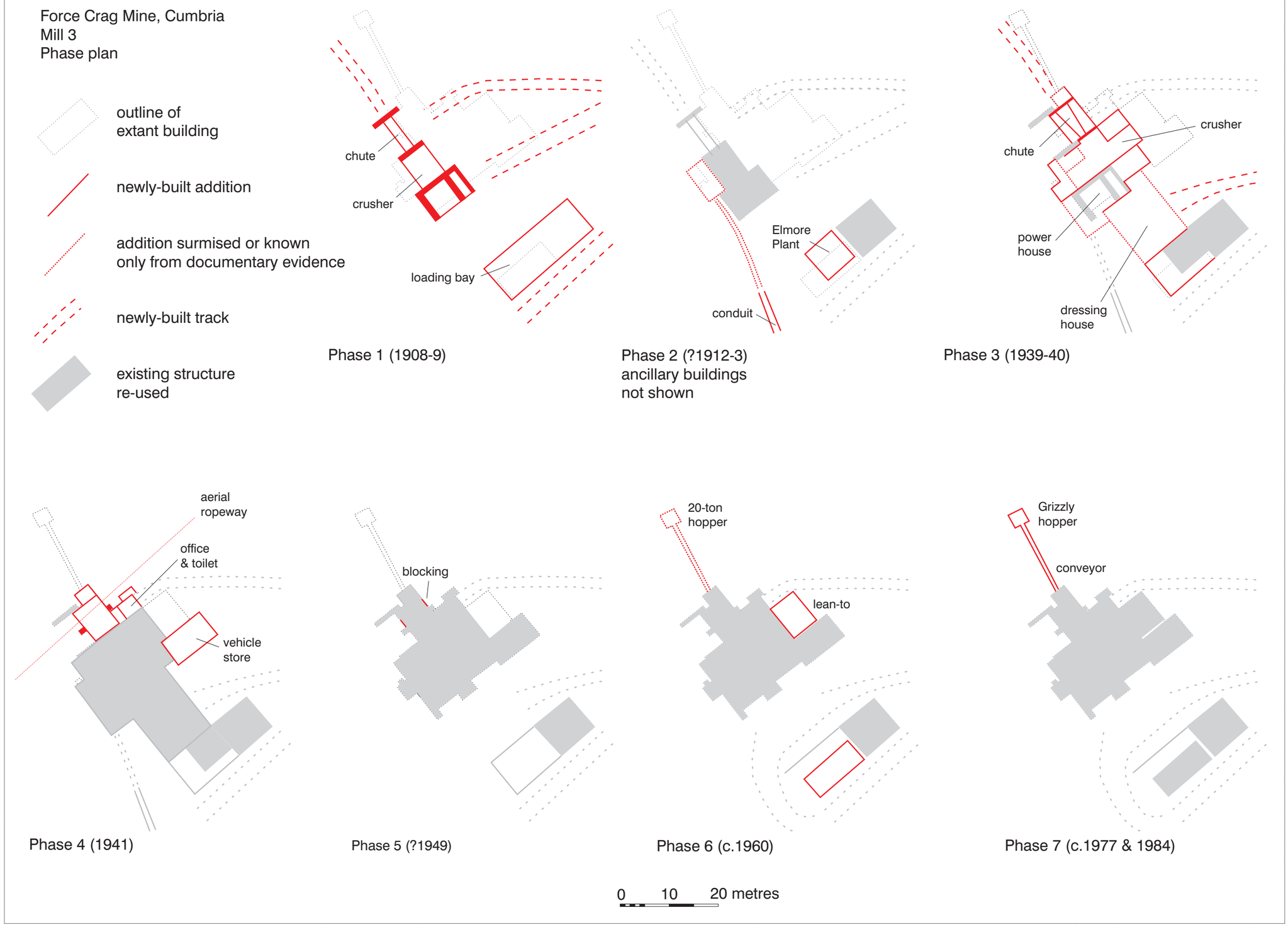


Figure 21. Phase diagram of Mill 3.

constructed than the walls of the main part of the lower range. Although its function is unclear, its smaller size may indicate that it did not support an upper storey or that ore was not processed there. The arrangement of the equipment mentioned above within the rooms of the lower range as a whole is uncertain.

The photograph taken while the construction of the mill was under way shows the workers standing along the top of a white-washed wall enclosing the rear of a platform terraced into the slope. This is interpreted as a loading bay for transferring the ore into carts stationed on Track 1. This corresponds to the area occupied by the extant Office and the Phase 3 loading bay immediately to its north-east. The south-western end of the original platform was dug away in Phase 2, but the north-eastern half of the rear wall, now in a somewhat dilapidated condition, continued in use as a revetment along the rear of the Phase 3 loading bay. The upper part of the original wall on the north-eastern side was demolished in Phase 3, but the lower part of the end of the wall, with characteristic brick quoins, was incorporated into the wall along the front of the loading bay.

The same photograph of *c*.1908, together with the type of brick used, indicates that the first phase of Cistern 1 was constructed at this date. The type of brick used to construct the extant Explosives Store suggests that it too was built in this phase of work.

Phase 2 (?1912-3)

A number of additions were made to the main building in the same materials and style, apparently soon after the building was first constructed, probably under the tenure of The Coledale Syndicate. The lower range was widened slightly and raised on the south-western side. The resulting butt joint can be seen most clearly in the exterior of the south-eastern wall. These modifications were presumably made to accommodate new equipment, but the change to the processing sequence is not fully understood.

A stone-built drain, which was enlarged and modified in Phase 4, was also added adjoining the south-western side of the lower range. The drain appears to have fed the outflow from the mill into an underground conduit, which is only visible where it emerges onto the surface some 25m to the south. The conduit is 0.8m wide, with its base and walls built in stone, and a covering of timber boards, presumably to allow it to be cleaned out when necessary. It can be traced for 9.5m on an alignment that lines up with the position of the opening in the sump, but curves very slightly, possibly in order to avoid the south-western end of the pre-existing loading bay. At its southern end, the conduit evidently dived underground again to pass under Track 1. Impressions in the mortar on the end of the side walls indicate that beyond this point, it was constructed using timber shuttering. On the southern side of the track, an arrangement of timber boards that probably corresponds to the base or top survives *in situ* for a length of 1.6m. The alignment of the conduit would suggest that it carried the outflow from the mill into Settling Ponds 1.

The photographs of *c*.1916 suggest that by that date several other lean-to sheds and ancillary structures, including the structure holding the Elmore plant, had also been

added to the original ranges in a somewhat organic fashion. Most of these were evidently relatively lightly constructed in timber and corrugated iron, and little trace of them survives. The tower in which the Elmore plant was located apparently stood three or four storeys high; to accommodate the base of the tower, part of the south-western end of the Phase 1 loading bay was dug away. The remnants of the masonry part of its ground floor that still survive comprise an L-shaped arrangement of walls incorporated into the wall that currently forms a revetment around the north-eastern end of the extant Office. The overall dimensions of what little can be seen of these walls suggest that the base of the tower would have been approximately 7.5m square, on a very slightly different alignment from the main mill building. In what would have been the north-western wall of the tower, there is what seems to be a conduit entering at floor level and part of a flue built into the wall at a height of 1.5m above floor level.

Phase 3 (1939-40)

The design of the mill built in 1939-40 under the tenure of Tampimex Oil Products Limited had much in common with the earlier building, in that unprocessed ore was fed in at the upper end and was brought out in the form of the refined product at the lower end. As a result, it was possible to incorporate the existing masonry into the new building. The plan inferred to be of *c*.1940 indicates the functions of the rooms at that date, but field survey indicates that the plan was not metrically accurate (Cumbria CRO g and Figure 22). The foundations of the new mill were formed by revetment walls built of slate, infilled with scree and rubble. This may have included debris from the earlier buildings, for a number of fist-sized flint beach pebbles, which presumably came from the Harding Pebble Mill installed in 1916, were

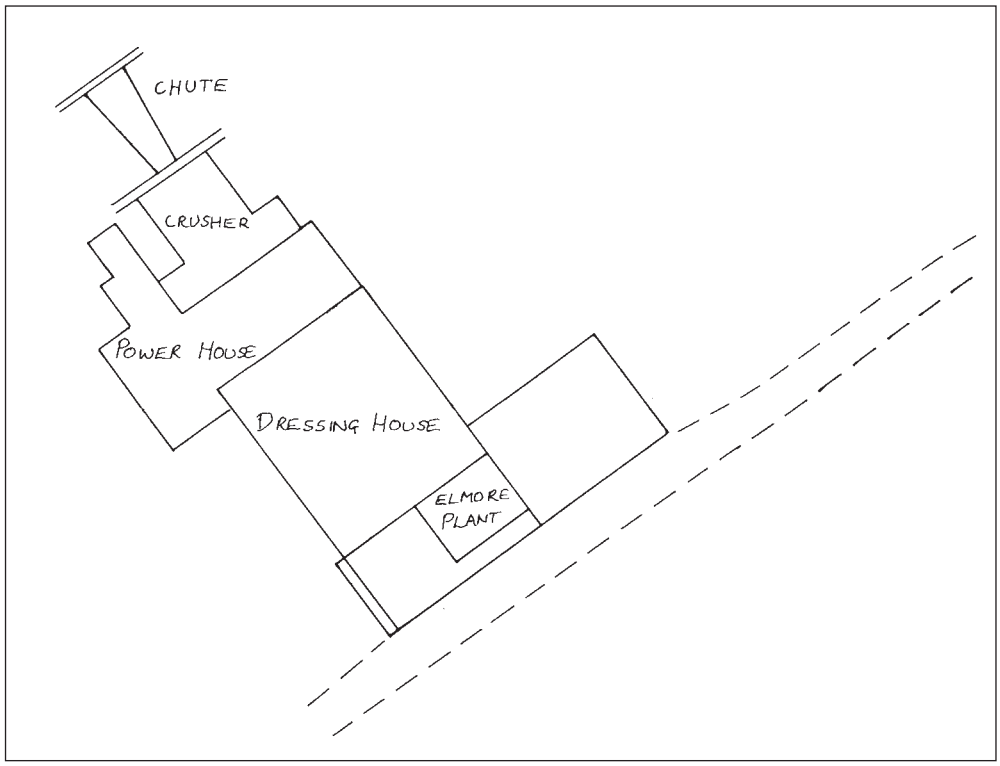


Figure 22. Mill 3 c.1940 redrawn from a 'Plan of levels and surface buildings' (WT Shaw archive).

certainly incorporated into the walls. The shell of the superstructure of the main range was built in red brick, with timber floors and a corrugated iron roof at a very shallow pitch. The upper storey of the rear wing, as well as various lean-tos and ancillary structures, were again built more lightly in timber and corrugated iron.

At the upper end of the building, a wing was built in stone in order to enclose a more robust concrete chute. The new wing was built adjacent to the pre-existing masonry pier, but partly incorporated it, so that the new chute lay parallel to the earlier one. The masonry element still survives intact, with a superstructure must have been added in Phase 5 or later. The machinery within the upper room is also of later date.

The brick-built shell of the main range essentially formed a single large rectangular room with internal dimensions of 17.5m by 7.5m by 7.5m high, its long axis aligned along the contours from south-west to north-east. The interior was lit at the ground and first floor levels by windows with galvanised-steel frames. The arrangement of the timber floors within the building is uncertain, but it seems likely that there were fewer mezzanine levels than at present. The precise arrangement of the plant within the room is also uncertain, and it is difficult to reconcile the plan of *c.*1940 with the extant wall lines. It seems likely that the extant wall extending along part of the long axis of the building probably corresponds to an original subdivision at ground floor level between the crusher and another room not portrayed on the plan. This room may have been a workshop or had some other function not directly related to the ore-processing.

The lower range of the earlier building evidently formed the basis of the power house of the Phase 3 mill, but its form is again difficult to interpret.

From the room which held the crusher, the ore was evidently fed through an opening in the south-eastern wall of the main range (blocked in Phase 5), down a chute and into the top of a free-standing brick built hopper, from which it passed into the dressing house. This building, which corresponds to the area of the present forecourt of the mill, is depicted on the plan of *c.*1940. It was evidently of lightweight timber and corrugated iron construction, for little trace of it now survives other than patches of the mortar floor exposed where the present gravel covering of the forecourt is thin. The building may have been open on the north-eastern side, since Track 2 gave access to that point.

The plan of *c.*1940 indicates that the Elmore plant (or at least part of it) installed *c.*1912 still stood in its original position at that date. The remnant of the original loading bay as it survived after the modifications in Phase 2 was evidently retained, but the upper part of the side wall was partially demolished to allow vehicular access from Track 2, as well as from Track 1 at the front.

The plan of *c.*1940 indicates that at that date the mine office was located in a separate building some 75m to the east. It had been demolished by May 1944 (Cumbria CRO f). No trace of the building itself now survives, but the level area where it was sited lies on the northern side of the Track 1, immediately east of the point where Track 3 branches off. In addition, the type of brick used to enlarge Cistern 1 indicates that this work was probably carried out in this phase.

Phase 4 (1941)

With the completion of the aerial runway in April 1941, the chute in the rear wing of the building would have had to receive ore tipped automatically from above, as well as from lorries when the ropeway was not working. A plan of May 1944 sheds little light on precisely how this was achieved (Cumbria CRO f), but the superstructure of the rear wing must have been added or extensively rebuilt in order to allow the ropeway to pass through the building and deposit the ore. An opening 2.0m wide was evidently cut at the top of each of the stone-built walls on each side of the concrete chute. Substantial external buttresses were also probably added at this date to cope with the additional stresses of the ore falling from the buckets.

On the exterior of the south-western end of the main range, the stone-built drain added in Phase 2 was raised in red brick. Its south-eastern side was bricked in to form a sump, with a square opening 0.4m above ground level to allow the outflow to drain into the existing conduit from a higher level. The lintel above the opening was originally timber, but was replaced at an unknown date with concrete.

The 1944 plan indicates that the dressing house on the south-eastern side of the building had been removed by that date. The Elmore plant also seems to have been removed, though this is less certain.

Additions to the building were made on the eastern side of the main range at approximately this date, and are depicted on the 1944 plan. A building that seems to correspond to the extant vehicle shed was added. The shed is constructed of corrugated iron over a light timber frame. The roof frame is a variant on a Belfast truss and there is a vent running along the length of the apex. These characteristics may indicate that the vehicle shed was originally a military building, which had been disassembled and transported to the site. The mine office, formerly housed in a separate building, was moved into a room fitted into the corner between the main range and the rear wing. This is the only part of the building with internal plaster. A toilet and small washroom were added in an adjoining block, separate from the main building. These additions presumably all became redundant in Phase 6. Building 3 is also depicted on the 1944 plan.

Phase 5 (?1949)

The openings cut for the aerial ropeway in the side walls of the rear wing were blocked up again in red brick, and the timber and corrugated iron superstructure was replaced, though probably not by the extant structure. The aerial ropeway had been disused since *c.*1947, and it would seem likely that this minor modification was carried out soon after, quite probably when the La Porte Chemical Company took

over in 1949. The brick type is different from that apparently used for all the work undertaken in Phase 6.

The free-standing hopper built in Phase 3 on the south-eastern side of the building may also have been raised in this phase, using concrete cast in a mould formed by timber boards. This addition certainly occurred before Phase 6, when the opening through which ore passed into the hopper was blocked, but it may have been carried out in Phase 4, or indeed at some other point.

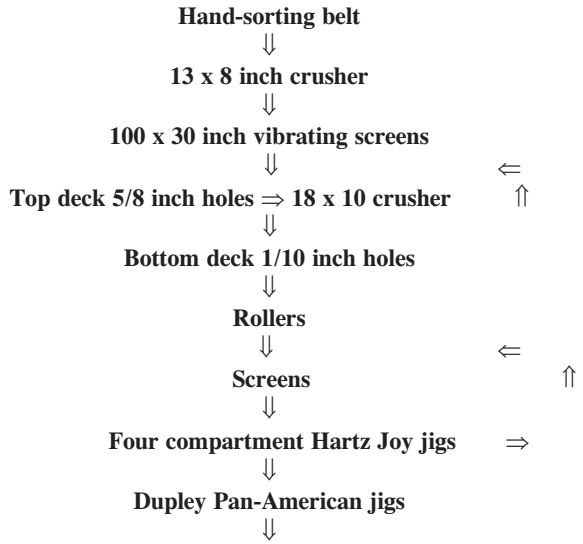
Phase 6 (*c*.1960)

The most obvious (and probably least significant) of the changes made under the ownership of McKechnie Brothers Limited *c*.1960 was the construction of the extant Office (see Figure 23) on the site of the building that had formerly housed the Elmore plant. It is shown on a small-scale plan of 1960 (Cumbria CRO h.3). The building is single storeyed and rectangular, measuring 11.0m long by 5.0m wide. The long axis is aligned parallel to the rear of the loading bay built in Phase 1, so that it fronts onto Track 1. The walls are constructed in pink mortar brick, and the pitched roof was probably felted but is now in a state of disrepair. Small smoke stacks built in red brick run up to the gable at each end of the building. A single central door and four windows face south-eastwards onto Track 1. There are four more windows at the

Figure 23. The extant Office and loading bay viewed from the east (NMR AA99/05407).

rear of the building, one of which has been blocked up. The window frames, and a number of small vents, are made of galvanised-steel. The interior of the building was not investigated, but was evidently divided into two by a thin partition wall.

Since the aerial ropeway was no longer in service and ore was again regularly being brought to the mill by lorry, a 20 ton capacity hopper was installed, from which the material was fed to the crusher by conveyor belt (Tyler 1990, 70). The 1960 plan seems to indicate that a track extended right up to the rear wing of the building at that date, but the field evidence suggests that this would not have been sufficiently wide or stable to carry lorries on a regular basis. It is therefore likely that the hopper lay in the same position as the extant crusher, and that the conveyor belt was similar in form to the extant one. A mill flow sheet of 1962 (*ibid*.) details how the ore was refined:



The 1960 plan indicates that the timber and corrugated iron lean-to at the north-eastern end of the main building, through which it is currently entered, was added at this date. The opening in the south-eastern wall of the main building, through which ore had formerly passed to reach the free-standing hopper built in Phase 3, was blocked using the same pink mortar brick used to construct the new Office. The small store adjacent to the extant Explosives Store, the Settling Tank, and various more minor structures were constructed in the same pink brick and can therefore be assigned to this phase of work.

Phase 7 (*c*.1977 & *c*.1984)

A number of additions were constructed in breeze block in broadly the final stages of the use of the mine. These are very approximately dated on the basis that the portal to the new entrance of Level 1, known to have been constructed in 1977, is also made of breeze block. Most significantly, the extant crusher and conveyor belt were put in place, the former flanked by revetment walls and the latter supported on piers constructed in breeze block. The rest of the equipment in use in 1985 is known from a

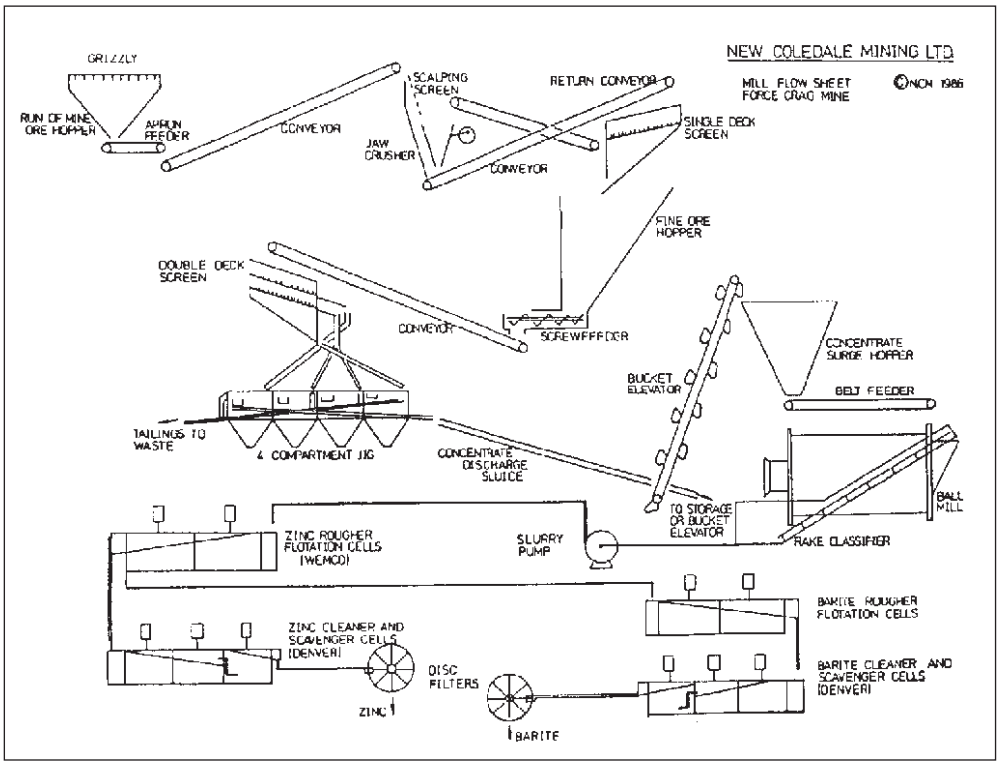


Figure 24. Mill 3. Diagrammatic mill flow sheet (after Sutcliffe 1985 unpublished).

diagrammatic mill flow sheet produced by the New Coledale Mining Company (Sutcliffe 1985 unpublished and Figure 24). Minor changes to the structure of the mill include the construction of a curving revetment wall above the extant vehicle store, and probably the addition of Cisterns 2 and 3. Building 4 was also probably constructed in this phase.

Miscellaneous buildings

The site of Building 1 lay on the slope quarried away in 1961, at NGR NY 1985 2146, and no longer survives. It is depicted on the First Edition map surveyed in 1861, and the Second Edition 6-inch map revised in 1898 (Ordnance Survey 1862; 1900). The main range of the building, some 14m long by 3m wide, was aligned roughly west to east, apparently somewhat obliquely to the natural slope. A benchmark was placed on the south-west corner of the building by the Ordnance Survey, and this indicates that it stood at an altitude of about 919 feet (280m), ie some way above the valley floor. The First Edition map suggests that Leat 2 passed upslope behind the building, and did not supply water to it. However, it is possible that Leat 1 may have done this at an earlier date. The fact that a benchmark was placed on the building and that it survived until after 1898, suggest that it was constructed partially or wholly in stone. It appears to have been connected with Mill 1, but its function is unclear. Whether or not the building was actually used after the closure of the mine in 1881 is also uncertain.

Building 2 lay on the valley floor some 55m east of Mill 1, at NGR NY 1989 2150. It is depicted on the First Edition map surveyed in 1861, as a rectangular structure, apparently roofed, approximately 8m long by 5m wide (Ordnance Survey 1862). There are six poorly preserved timber posts projecting from the surface to a maximum height of 0.2m at this location, but none of them seem to correspond exactly to the

outline of the building. The building was supplied with water from Leat 10, and is interpreted as a possible ore-washing house, or covered washing floor or settling tank. The timber posts may well be the remnants of related features.

Building 3 is depicted on the plan of May 1944 at NGR NY 2011 2168 and is annotated as a 'store' (Cumbria CRO f). It is visible on aerial photographs taken in 1947 (RAF 1947). No trace of it now survives, either because the area was affected by the creation of Settling Pond 2 or because the building was of very lightweight construction. It was approximately 20m long by 5m wide.

Building 4 lay adjacent to the north-eastern side of the sheepfold at NGR NY 1991 2149. It was built at some point between August 1970 and 1976 (Ordnance Survey 1970; 1978). The outline of the rectangular building can still be traced as a slight earthwork, 17m long by 13m wide, with its long axis aligned from south-west to north-east. At its south-western end, it may have used the wall of the sheepfold as a sleeper wall. On the northern side, the stump of a timber upright may be the remnant of a door post, for it coincides with one end of a gap in the earthwork. The building was evidently of lightweight construction, and probably served as some form of storage shed.

5.5 WASTE DISPOSAL

Tips

In addition to the small tips outside the entrances to the levels, three much larger dumps of material were recorded.

Tip 1 covers an area of some 950m^2, its extent defined broadly by the confluence of the Pudding Beck and the Coledale Beck, centred at NGR NY 1993 2151. The spoil comprises small and medium-sized chips of slate up to *c.*1m in depth. The surface appears to have been compacted, possibly for use as a working area. Leat 10 cuts into the surface, which suggests that the dump may have originated in the late 19th Century, possibly as early as 1839. The area seems to have been used until at least the mid-20th Century, for a steel drum (now largely rusted away) has been sunk into the surface apparently in order to form a sump.

Tip 2 comprises a series of large dumps of small tailings from the refining process, lying to the south-west of Mill 3 and to the north of Track 1, centred at NGR NY 1994 2159. Where streams have eroded gulleys through the dumps, they appear to comprise numerous interleaved layers of chips of slate, all differing slightly from each other in colour. This suggests that each dump may represent numerous separate episodes of activity, and perhaps accumulated from *c.*1906 onwards. The largest of the tips was probably levelled to some degree to form a platform on which to build the lower terminus of the aerial ropeway.

Tip 3 is an approximately kidney-shaped mound some 3m high, lying adjacent to Track 1 at NGR NY 2016 2171. The fine material of which it is composed contains relatively large quantities of various minerals, and it is possible that it was a stockpile

of ore awaiting processing or removal. The form of the mound would suggest that it was piled up by a mechanical digger. Seven well-preserved vertical posts project from the top of the mound to a maximum height of 0.8m. These are evidently arranged so as to form some kind of structure, but their purpose is uncertain. Aerial photographs taken in 1970 (Ordnance Survey 1970) indicate that there was a tip of slightly different form in the same location at that date, and it is possible that the extant tip comprises essentially similar material. A plan of *c*.1967 is titled 'No. 1 Level and survey for map of big heap' though it does not make clear whether Tip 3 is the 'big heap' in question (Cumbria CRO h(2)).

Settling ponds

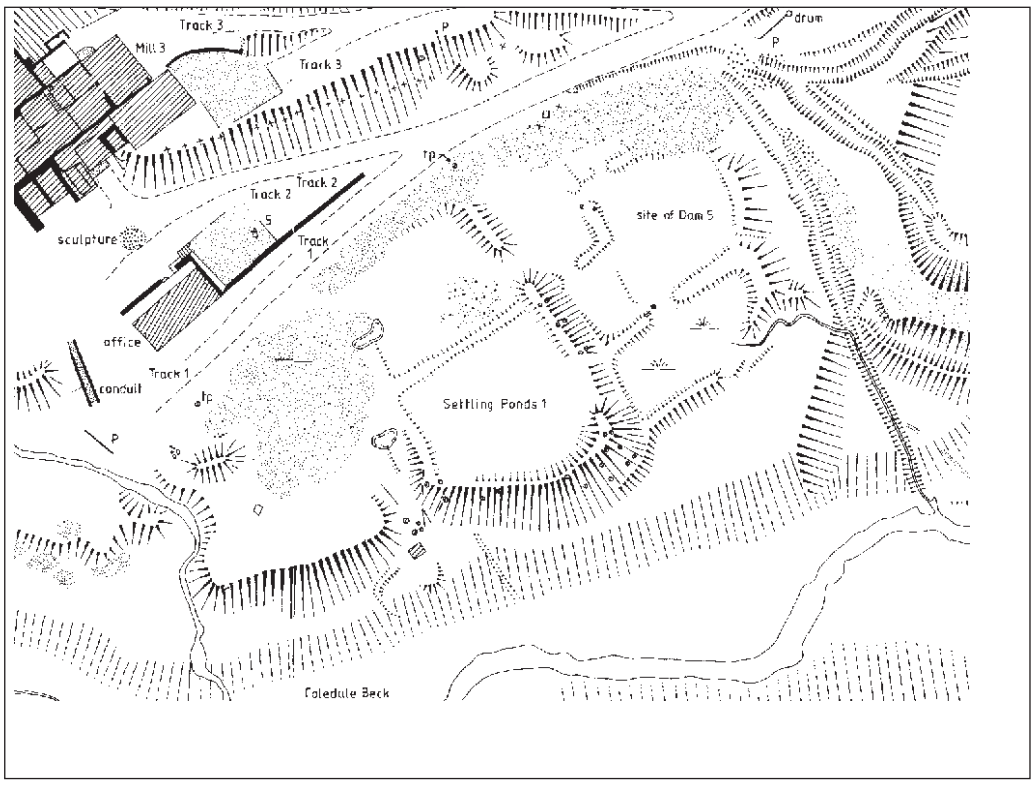


Figure 25a. Extract from survey reduced to 1:1000 scale showing Settling Ponds 1.

Settling Ponds 1 were sited at NGR NY 2002 2160 in order to make use of the pre-existing embankment of Dam 5 (Figure 25a-b). Documentary evidence suggests that the ponds were constructed *c*.1907 in order to fulfill a condition of the lease (Tyler 1990, 33). However, as described above, the conduit that apparently carried the outflow from Mill 3 into the ponds appears to be contemporary with secondary additions to the building, which are thought to date to *c*.1912-3. Parts of the settling ponds are visible in the background of a photograph of c.1916 (*ibid.*, figure on page 39).

In addition to the embankment of the earlier dam, further banks up to 0.3m high were constructed so as to form a total of six adjoining settling ponds, forming a rectangular arrangement 90m long from south-west to north-east by 40m wide. Most of the ponds are rectangular in plan, and range from approximately 100m^2 to

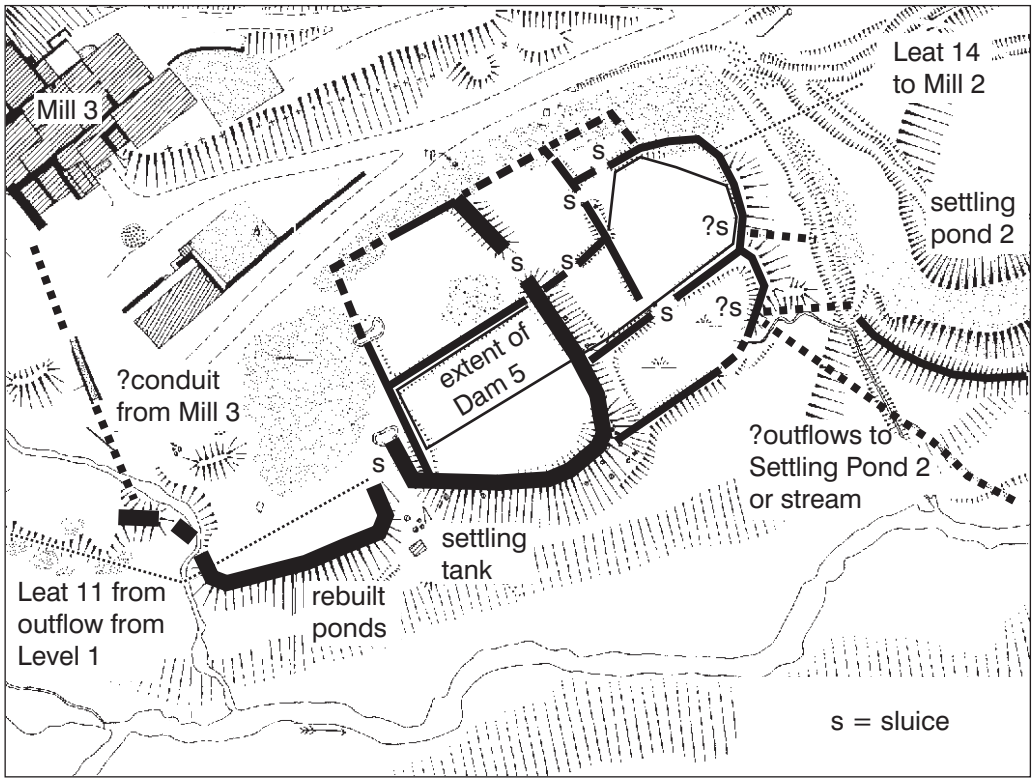


Figure 25b. Annotated extract from survey reduced to 1:1000 scale showing Settling Ponds 1.

400m^2 in extent, but one is L-shaped because its outline follows the plan of the pre-existing dam. The three ponds at the eastern end of the arrangement remain boggy and are now clogged with rushes. Some of the ponds were evidently interconnected by sluices; timbers that are probably the remnants of two wooden sluice gates survive. It is possible that the outflow from the easternmost pond was fed directly bank into the Coledale Beck. Alternatively, it may have been fed into a larger pond on the site of Settling Pond 2, and from there back into the Coledale Beck.

At some later date, the three ponds at the western end of the arrangement were apparently modified so as to form two larger ponds. Using tailings from the mill, the enclosing banks were broadened to a maximum width of 7.0m and raised to a height of *c*.0.6m. An arrangement of partly buried timber hoardings, which survive in fairly good condition, suggests that there may have been an outflow between the two, presumably regulated by a sluice gate. Finally, the ponds appear to have been filled in, possibly in order to seal the deposits beneath. The date of this act, which presumably marked the disuse of Settling Ponds 1, is uncertain, but the surfaces appear relatively fresh on aerial photographs of August 1970 (Ordnance Survey 1970).

Settling Pond 2, centred at NGR NY 2012 2164, appears to have originated as a large pond to the east of Settling Ponds 1, and indeed may have been contemporary with their construction (Figure 26a-b). It is unclear whether water was fed into the pond from Settling Ponds 1, or directly from a separate drainage channel that by-passed the other ponds. What may be a remnant of such a channel extends along the southern edge of Track 1. Sections through the sub-surface deposits are exposed in the northern bank of the Coledale Beck and both sides of a recut drainage ditch to the east

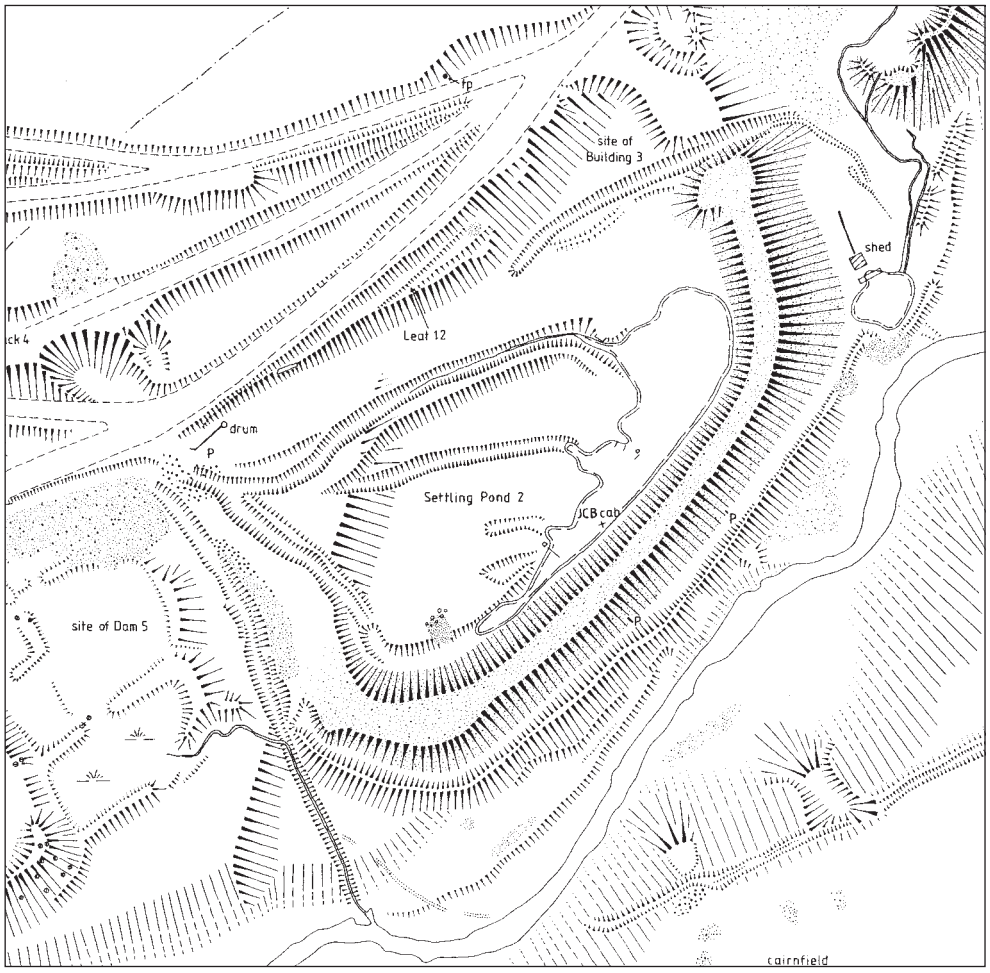


Figure 26a. Extract from survey plan reduced to 1:1000 scale showing Settling Pond 2.

of Settling Ponds 1. In these sections, the thin natural topsoil is overlain by a layer of fairly clean yellow clay up to 8cms thick, which may have been deliberately laid across a large area to form an impermeable lining prior to the construction of the settling ponds. The clay may be a glacial deposit occurring naturally in the vicinity, since clay of similar appearance (though less clean) is visible below the topsoil in the sides of the cutting made for Level 0 and elsewhere. The pond itself then appears to have been formed by the construction of an earthen bank up to 0.9m high on the downslope side. An outward projection at the eastern end of the bank coincides with a small pool from which a rush-filled channel leads to the Coledale Beck, through which the outflow was apparently allowed to rejoin the stream. The pool was apparently deepened in a later phase of use.

During the most recent phases of the use of the mining complex, the earthen embankment that originally enclosed the settling pond was replaced by a more massive bank up to 2.5m high. This is formed entirely of fairly small slate fragments that appear to represent spoil from mining operations underground. Prior to the construction of the new bank, some topsoil and turf was evidently bulldozed onto the earlier earthen bank in order to create a broader depression at the rear of the new bank. A plan dated March 1972 depicts the new bank as a 'proposed extension' of the tip outside Level 0 (Cumbria CRO k). However, it seems unlikely that the plan was actually followed precisely, although the outcome was effectively the same. Instead

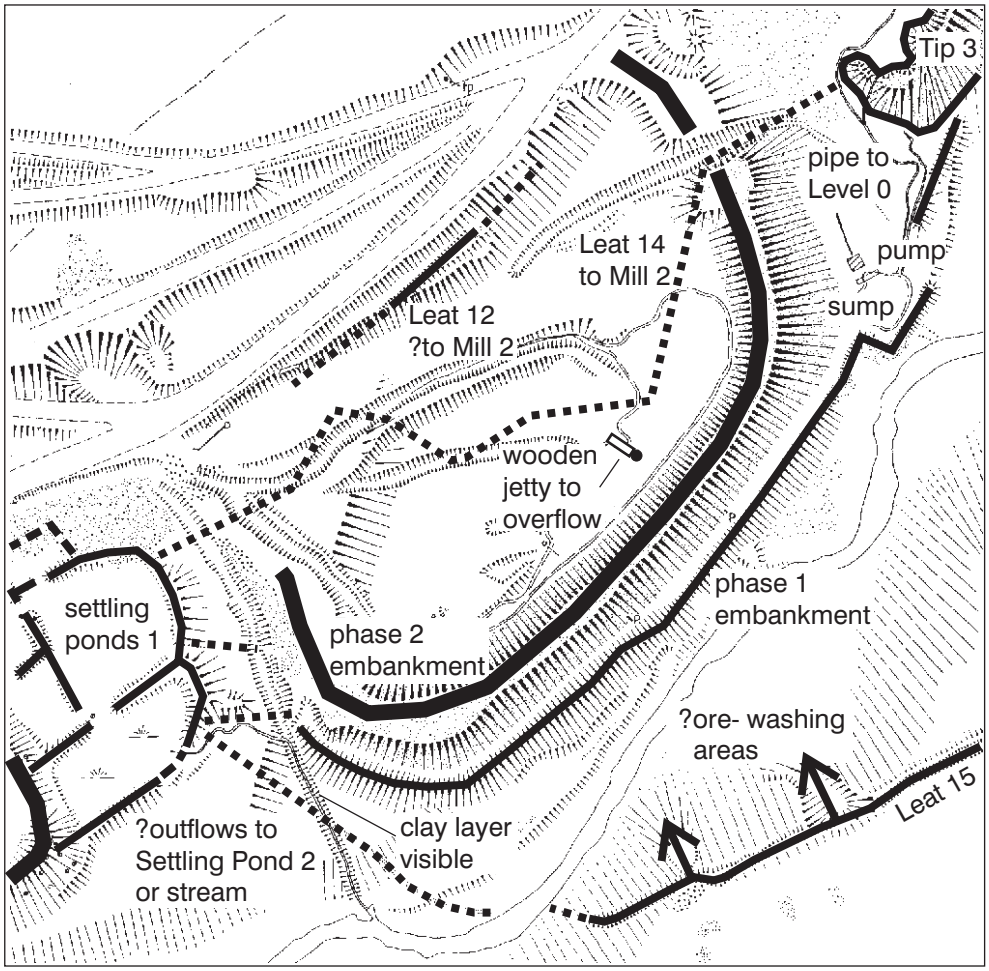


Figure 26b. Annotated extract from survey reduced to 1:1000 scale showing Settling Ponds 2.

of extending the bank westwards from the existing tip outside Level 0, lorries appear to have delivered loads of spoil from the opposite direction, extending the bank eastwards to within a few metres of the tip outside Level 0. Water was evidently allowed to escape from the pond, when its level was high enough, by flowing down into two timber lined shafts and into pipes that pass beneath the bank of spoil. This would have allowed the mineral residues to settle to the bottom of the pond while the relatively clean water was occasionally strained off the surface. The shafts could have been maintained from two timber piers projecting into the pond, which are now both in a poor state of repair. The settling pond still holds water to a maximum depth of 0.2m, and the wooden shafts continue to function fairly effectively, as do the pipes that pass beneath the bank. The outflow from the pipes is still channeled along the rear of the earlier earthen bank and into the small pool. This was evidently deepened in the latest stages of its use to form a sheer-sided sump 1.2m deep, which still holds water. A steel frame above the pool evidently supported a pump, presumably powered by a generator housed in the adjacent corrugated steel shed. The grey plastic pipes along which the water was pumped survive, but it is uncertain where the water was actually being pumped to, and for what purpose.

Settling tank

An isolated free-standing tank lies at NGR NY 2002 2158, adjacent to the Settling Ponds 1. It measures 1.9m by 1.4m by 1.5m deep, has internal render and is roofed over. The walls are built in the pink mortar brick used to build the extant Office, indicating that it was probably constructed *c*.1960. The original ceramic pipe that supplied water to the tank has been replaced with a grey plastic one, indicating that it may have remained in use until *c*.1991. Water appears to have been fed into the tank from the direction of the Office, but the precise point of origin is uncertain. The cleaner water would have spilled through an opening at the top of the tank, and was then allowed to find its own way down the slope to return to the Coledale Beck.

5.6 MISCELLANEOUS REMAINS

Cairnfield

Most of the concentrations of scree on the southern side of the valley are natural in origin, but a number of small mounds of stone are interpreted as being man-made cairns. Such cairnfields are generally thought to have been formed during the Bronze Age by the clearance of scree to create fields, but there is increasing evidence from excavations elsewhere in northern England and Scotland that individual cairns were sometimes re-used as burial monuments (for example Jobey 1981; Leach 1983; Barnatt 1994). Furthermore, although a Bronze Age date seems likely, field clearance of a similar nature carried on well into the post-medieval period, so a later origin cannot be ruled out entirely. The cairns identified at Force Crag all lie on the gentle north-facing slope between the confluence of the Coledale Beck and the Birkthwaite Beck, centred at NGR NY 2023 2166. The choice of a north-facing slope is unusual in a regional context, but the south-facing slope of the Coledale Valley is too steep to have allowed agriculture.

The cairnfield comprises at least thirty-three mounds of stone, scattered across an area of approximately 0.55ha, at an altitude of between 250m and 260m above OD. On the north and east, the area is bounded by the steep scarps of the valleys eroded by the streams; erosion may well have considerably reduced the original extent. On the west, it is defined by a band of denser natural scree, which may also include some cleared stone. On the south, although there is no clear boundary, it seems to extend to the point where the natural slope becomes somewhat steeper. The cairns are mostly oval or circular, between 1.8m and 4.5m in diameter and up to 0.3m high. Many are partly or wholly grassed over. In several places, groups of three or four cairns appear to cluster together, sometimes following a fairly straight line up the hillside. This may reflect the existence of natural bands of scree, similar to those that occur elsewhere on the southern side of the valley, prior to clearance taking place.

There is no convincing evidence for settlement structures contemporary with the field clearance. However, four of the cairns appear to have been levelled and enlarged at some later date to form the floors of temporary shelters (Huts 1 and 2 a-c).

Sheepfold

A sheepfold stands adjacent to the Coledale Beck at NGR NY 1990 2147. It was certainly constructed before 1861 and may be of considerably earlier origin (Ordnance Survey 1862). It is approximately square in plan, measuring 9m by 11m internally, with an entrance on the north-west. It is formed on three sides by thick dry-stone walls and on the fourth, adjacent to the stream, by a cast iron fence, apparently put in place after the collapse of the wall. The north-eastern wall of the sheepfold may have been used as a sleeper wall for the roof of Building 4, as described above. The ground within the sheepfold has been terraced to form a level surface, which may indicate that it was used for some more specific purpose than simply shelter, for example shearing or washing the sheep.

The sheepfold is one of many scattered around the head of the Coledale Valley (see Appendix 2) and its proximity to the mine is not significant.

Huts

The site of Hut 1 (NGR NY 20206 21631) is identified as a nearly circular level platform 4.6m in diameter, formed of small stones apparently from a spread clearance cairn. There are slight traces of narrow gulley running in an arc around the downhill side of the platform, which may represent part of a ring groove, or circular slot dug to hold timber uprights. The hut is noticeably isolated, lying some 40m to the west of Huts 2 a–c. The ring groove construction is comparable to many examples of later prehistoric roundhouses, but the siting of the building on the surface of a clearance cairn would be extremely unusual in a prehistoric context. The dating of the hut therefore remains uncertain.

Huts 2 a - c were all constructed in a similar fashion to each other: they almost certainly re-used levelled clearance cairns as flooring platforms and are all nearly rectangular in plan. The sites cluster within 20m of each other.

The site of Hut 2a (NGR NY 20233 21660) is a nearly square platform of small stones 4.0m in diameter. A low ridge of more densely packed stone defines an L-shaped corner on the uphill side of the spread.

The site of Hut 2b (NGR NY 20242 21656) is a sub-rectangular platform of small stones 5.5m long by 4.8m wide, with its long axis aligned up and down the natural slope. On the uphill side, pairs of large stones up to 0.3m square have been placed back to back to form a single course of walling. On the western side of the platform, this walling merges into a narrow earthen embankment of minimal height. The entrance would seem to have been on the downslope end.

The site of Hut 2c (NGR NY 20245 21641) is a sub-rectangular platform of small stones 3.7m long by 2.5m wide, with its long axis aligned up and down the natural slope. Except on the downhill side, the platform is bounded by a low earthen ridge interspersed with larger stones. The entrance would therefore seem to have been on the downslope end.

The sites of Huts 3 a - b lie only 5m apart. The earthwork remains are similar in form to each other, both surviving as shallow rectangular depressions, but dissimilar from Hut 1 and Huts 2 a–c. They are also comparable in form to Hut 4, which lies on the valley floor and is cut into the edge of Tip 1. This may indicate that Huts 3 a-b are also of late 19th-century date, and perhaps associated with the mining operation. They occupy one of the few level areas on the southern side of the valley; it is also worth noting that there is no bracken growth for approximately 10m around them on every side. This may indicate that a small plot was cultivated or used for the corralling of horses or livestock. On the eastern fringe of this area, a scatter of stones up to 0.3m in diameter forms a vaguely circular arrangement that may represent a third structure. Hut 3a (NGR NY 20028 21538) is a shallow rectangular depression 4.1m long by 3.5m wide with an embankment up to 0.2m high around its downhill side. Hut 3b (NGR NY 20031 21533) is a rectangular depression 3.5m long by 2.2 wide, of minimal depth, with slight traces of an embankment at its upper end.

The site of Hut 4 is marked by a shallow rectangular depression which cuts into the edge of Tip 1 at NGR NY 1996 2153. This stratigraphic relationship indicates that the hut must have been built in the late 19th Century or later. The depression is 3.8m long by 2.1m wide, and of minimal depth. A narrow trench, which presumably acted as a drainage channel, extends parallel to the north-eastern side of the depression.

Sculpture

A sculpture lies in the level area between Mill 3 and the extant Office, centred at NGR NY 1998 2162. It comprises a perfectly circular disc 3m in diameter, formed of fist-sized lumps of stone, and is believed to have been created in 1999 by the artist Andy Goldsworthy (information from Robert Maxwell, National Trust).

6. DISCUSSION AND CONCLUSIONS

The development of the complex as a whole can be divided into several phases.

The use of the complex before 1839

The only firm evidence for very early lead and silver extraction at Force Crag itself is the documentary reference of 1578. However, the traces of surface extraction and the block of slate split using a steel wedge downslope from the Milkhouse Level may predate the start of intensive mining in 1839. Huts 1 and 2 a –c may also be associated with this phase of the mine's use, although there is nothing to confirm this in their form or siting.

The use of the complex 1839 – 1881 (Figure 27)

Most of the individual components of the complex that were in use between 1839 and 1881 are fairly typical of contemporary lead and other mineral mines, and pose no major problems in terms of interpretation. The most important issue is that of their dating, which is fundamental to the understanding of how the complex as a whole developed. Tyler has tentatively suggested the following sequence:

- *c.*1839 the earliest mill was built adjacent to the ford across the Coledale Beck

- in 1854 a new mill was built 'beneath the crag on the south side of the stream, adjacent to an old sheepfold' (*ibid.*, 14)

- *c.*1867 a third mill was built 'on the north side of the beck and directly under the crag' 'a few yards away' from the second (*ibid.*, 17-9).

However, there are good grounds for thinking that the mill at the foot of Force Crag (Mill 1) was the one built *c.*1839, that the mill adjacent to the ford (Mill 2) was the one built in 1854, and that the first mill and processing area (or parts of them) were re-used after *c.*1867. This re-interpretation has formed the basis of the dates ascribed to some of the features in Section 5, but the arguments on which the revised sequence is based have not yet been put forward.

In the first place, Tyler's rejection of Mill 1 as the earliest site is founded primarily on the presence of crushed barytes in the vicinity, since lead was the ore being milled in the early years of the mine's use. This argument is rather undermined by Tyler's own observation that barytes was brought to very nearly the same place (*ie* his third mill) after 1867, when Level 4 went into production, for this could be expected to have concealed most surface traces of the earlier processing of lead ore. More importantly, lead ore extracted in both Levels 2 and 3 was brought up to the surface along Level 2 after the completion of the connecting rise in the early 1840s. Track 7 climbs steeply up from the entrance of Level 2, so it seems very probable that this was intended to provide vehicular access to the entrance, but not from it. It seems likely that the ore would have been transported along Tramway 3, which passes

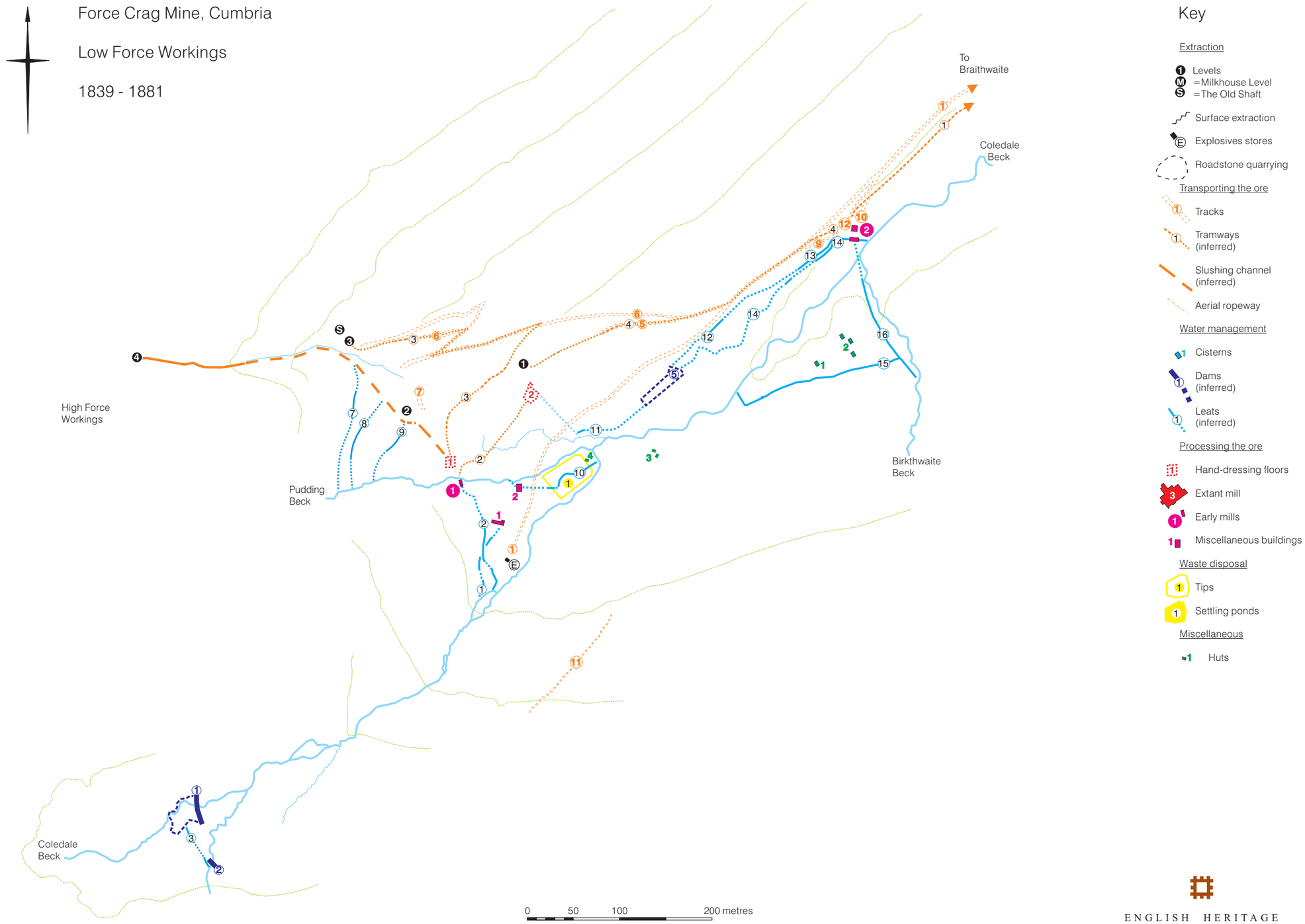


Figure 27. The development of the complex 1839-1881.

immediately below the entrance to Level 2, to Hand-Dressing Floor 1, which would have directly overlooked Mill 1. Tyler's alternative theory would have involved transporting ore along one of two more difficult and inefficient routes to Mill 2, which lies almost 500m away. Thus, the field evidence strongly suggests that Mill 1 was precisely sited so as to minimise the length and difficulty of the descent from Level 2, which must indicate that it was the earliest mill site.

The mill built in 1854 was intended specifically to process the ore being extracted from Level 1, which first went into production on a large scale in the following year. Tramway 2 evidently served to transport ore from Level 1 via Hand-Dressing Floor 2 to Mill 1 at some point. The tramway and Dam 1 were still in existence, and perhaps still in use, in 1861 (Ordnance Survey 1862). This would seem to support Tyler's suggestion that Mill 1 was the site of the more recently-constructed mill. However, Level 1 was equally well connected to Mill 2, via Tracks 5 and 9. There may also have been a tramway following the same route, *ie* a precursor of Tramway 4, although this does not seem to have been in use at the time of the map-making in 1861. If such a tramway existed *c*.1855, it would have allowed the same ore tubs to be used to transport ore from underground directly to the crusher, without the need for any intermediate handling. By contrast, transporting the ore from Level 1 to Mill 1 would have involved it passing through three additional stages of handling along a route that doubled back on itself away from the ideal direction of travel (*ie* towards Braithwaite). However, it could be inferred from the depiction on the First Edition map that at least some material may have been taken from Level 1 to Mill 1 in 1861. It is known that the adit was producing very small quantities of ore by that date, and it may be that it had again become more economical to concentrate all the ore-processing at one site.

Prior to the completion of The Old Shaft *c*.1872, it would probably have remained more efficient to process the ore being extracted from Levels 2 and 3, which still had to be brought out through Level 2, at Mill 1. In addition, between 1867 and 1870 barytes ore from Level 4 was probably brought down the Slushing Channel to Mill 1, clearly because that was the most efficient route. In fact, the field evidence suggests that the Slushing Channel terminated at almost precisely the same point as the place to which the ore from Levels 2 and 3 had originally been brought. In short, the earlier mill site must have remained operable after the new mill was built in 1854, but would only have been used to process the ore being extracted from Levels 2 and 3 until *c*.1872, the ore from Level 4 between 1867 and 1870, and until *c*.1872 the ore from Level 1 when little was being produced. After *c*.1872, Mill 1 would presumably have fallen rapidly into disuse, since ore extracted from Levels 1, 2 and 3 would have been hauled out through Level 1 and taken directly to Mill 2 along Tramway 4, while ore from Levels 5, 6 and 7 would have been brought there along Track 12.

The small quantity of clinker found at Mill 2 could result from a number of activities, including smithing. Since the smithy recorded by Tyler's documentary research was built in 1854, the presence of the clinker adds further weight to the identification of Mill 2 as the site of the new building.

The fact that Tramway 4 postdates Leat 13 indicates that this link between Level 1 and Mill 2 was installed at some point after the initial construction of the mill in 1854. It seems quite likely that it was built *c*.1872 when The Old Shaft was completed or in 1873-4, when Tramway 1 was constructed. With the completion of The Old Shaft and Tramway 1, ore extracted from Levels 1, 2 and 3 could have been moved along what was in effect a single, efficient production line beginning at the vein underground and ending at Braithwaite station.

Further evidence that supports this revised interpretation of the sequence of development is provided by the depiction of the site on the First Edition map surveyed in 1861 (Ordnance Survey 1862). The map-makers specifically annotated the water wheel at Mill 2, and portrayed it as being appreciably larger than the feature interpreted as a wheel pit at Mill 1. Given that the water wheel installed in 1854 was larger in diameter than the earlier wheel and would have been only seven years old when the map was made, it seems highly probable that it was the more recently built mill that was singled out. The map also confirms that some of the buildings and other features around Mill 1 remained in use after 1854, although the wheel would probably have been annotated had it been in regular use. However, the Second Edition 6-inch map revised in 1898 (Ordnance Survey 1900) indicates that Building 1 and the Explosives Store were the only structures still standing in the vicinity of Mill 1 at that date, while Mill 2 had evidently been enlarged. All this is entirely consistent with the revised sequence proposed above.

Building 2 can be interpreted with some confidence as an ore washing plant or a related structure. The function of Building 1 is unclear, but the fact that it was sited some way above the valley floor and the likelihood that it was maintained after *c*.1872 suggest that it was not directly involved in the refining process. However, it may have been supplied with water along Leat 1 at a very early stage in the development of the complex. The likelihood that it was built at least partially in stone may indicate that it included an accommodation block for the miners, although it seems too large for that to have been its only function. Hut 4 also appears to be a small structure of late 19th-Century or later date, which may have served as a temporary shelter. It is very similar in form to Huts 3 a-b, which may indicate that they too were associated with the mining activity.

Another unresolved issue is the purpose of Leat 15, which terminates at a considerable distance from both Mill 1 and Mill 2. There are a few grains of crushed barytes on the surface of a natural mound adjacent to the Coledale Beck below the end of the leat, but the quantity is so small that this might be interpreted as mere coincidence. Leat 15 was certainly constructed at some point before 1861 (Ordnance Survey 1862), and the likelihood that it predates Leat 16, which appears to be associated with Mill 2, suggests that it may have been constructed before 1854. It may have been used for washing ore, although its siting remains difficult to explain. At some point between 1854 and 1881, it may have been convenient to divert the flow from Leat 15 into Leat 16 to provide a supply to Mill 2.

In terms of the condition of the surviving remains associated with the operation up to *c*.1881, the entrance to Levels 2 and 4 have almost certainly been left untouched since the 1870s, and are in a fairly good state of preservation. Despite the

destruction of a large part of Mill 1 by the roadstone quarrying carried out in 1961, the remnant is probably very well preserved below the surface. Mill 2, together with some of the leats and tramways associated with it is extremely well preserved both in terms of the earthworks and sub-surface deposits.

The use of the complex 1906-1933 (Figure 28)

This period of the mine's use can be characterised as the transition from a relatively small-scale concern to a modern industrial operation. Most of the associated features can be identified and interpreted with relative ease. The main uncertainties relate to the use of Mill 3. Although the survey has demonstrated that much of the structure of the original Phase 1-2 building survives, the use of the various working areas within it and the precise function of some of the surviving features recorded requires more specialist investigation.

The sequence of modifications made to Dams 1 and 4 seems reasonably secure, and can be interpreted in terms of the increased efficiency of the machinery. The precise reasons for the abandonment of Dam 1 in an unfinished state remain uncertain. However, it seems likely that part of the reason may have been that the pelton wheel installed in 1912 required a much smaller water supply to maintain the same level of pressure, and therefore power. The precise site of the building that held the pelton wheel remains uncertain, which suggests that it was housed within a very lightweight structure. Building 4 (which Tyler appears to have linked with his second mill site), was not built until after 1970 and so is certainly not connected with the pelton wheel, despite its proximity to the end of Leat 5.

Track 14, which ascends the southern side of the Coledale Valley towards the cobalt mines at Scar Crags in a series of carefully planned and well-constructed switch-backs, appears by its form and condition to have been constructed before 1939. The most intensive period of activity at that mine was in the 1840s, but the First Edition map indicates that the track must have been built after 1861 (Ordnance Survey 1862). Adams (1988, 48) records that some work was done by the Thornthwaite Mining Company early in the 20th Century, in preparation for a venture at Scar Crags that was soon abandoned. This would seem to provide a plausible context for the construction of the track.

The use of the complex 1939-1952 (Figure 29)

This period is characterised by massive capital investment in the infrastructure of the mining operation. Amongst the most significant projects undertaken were the rebuilding and refitting of Mill 3, the construction of Track 12, the completion of the aerial ropeway and the commencement of the underground La Porte incline. The last three of these projects were concerned with the transport of ore from the High Force Workings down to the processing building.

The discovery of the date of April 1941 on one of the pylons of the aerial ropeway assists the understanding of the development of the structure of Mill 3. The plan of the building inferred to be of *c.*1940 (Cumbria CRO g) also goes some way to explaining the functions of the various parts of the building at that date. However, a more

Force Crag Mine, Cumbria

Low Force Workings

1906 - 1933

High Force Workings

To Braithwaite

Coledale Beck

Birkthwaite Beck

Pudding Beck

To Scar Crags

Coledale Beck

0 50 100 200 metres

Key

Extraction

1 Levels
M =Milkhouse Level
S =The Old Shaft

Surface extraction

E Explosives stores

Roadstone quarrying

Transporting the ore

Tracks

Tramways (inferred)

Slushing channel (inferred)

Aerial ropeway

Water management

Cisterns

Dams (inferred)

Leats (inferred)

Processing the ore

Hand-dressing floors

Extant mill

Early mills

Miscellaneous buildings

Waste disposal

Tips

Settling ponds

Figure 28. The development of the complex 1906-1933.

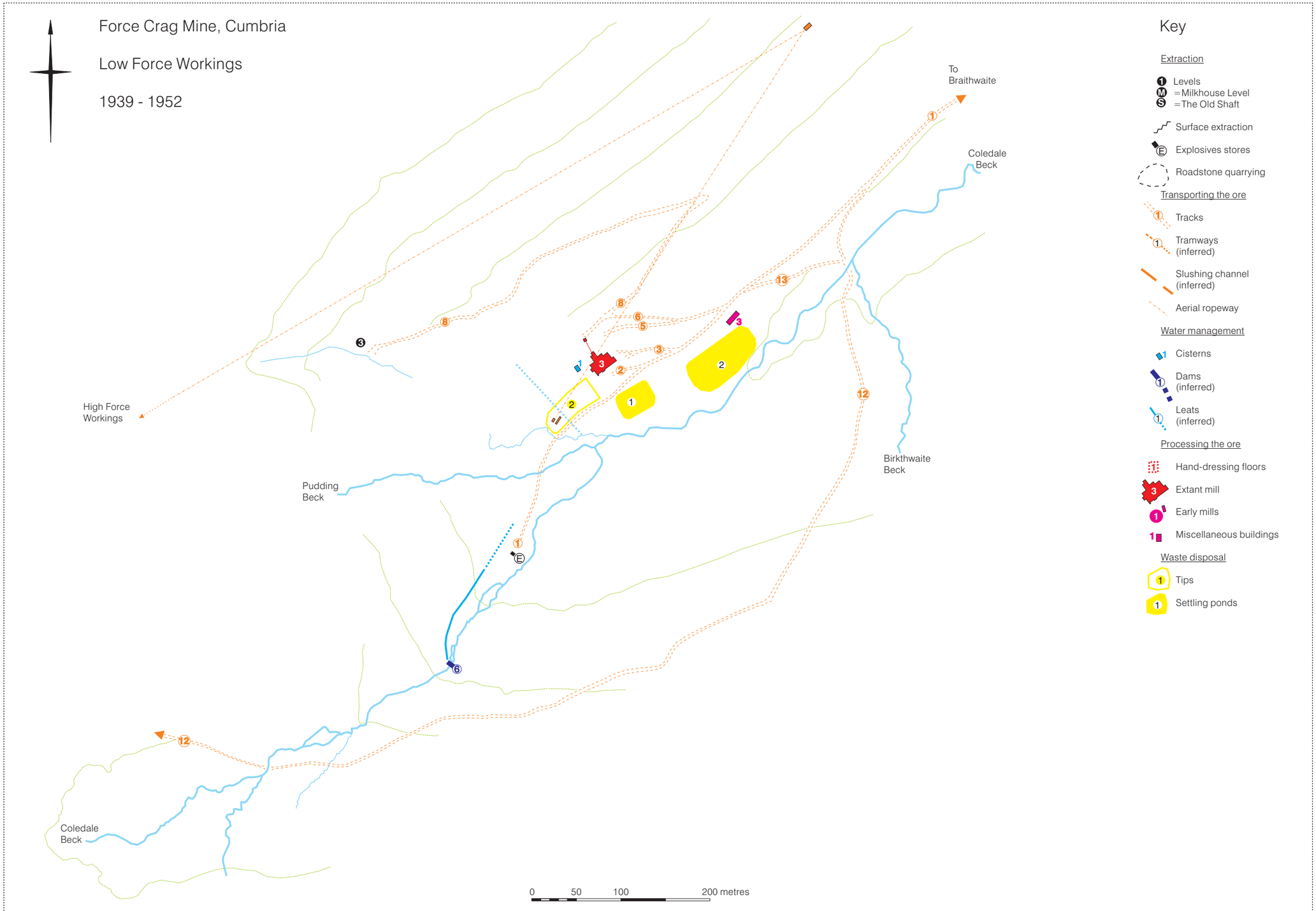


Figure 29. The development of the complex 1939-1952.

complete understanding of some of the features recorded would again require further specialist investigation.

One issue raised by the survey is the relationship of the features at Meikle Sikes to the rest of the mine, and in particular to the aerial ropeway. The field remains to the east of the mid-way station of the aerial ropeway seem to represent the start of the planned extension of the route all the way to Braithewaite. Given this, it may be that the possible trials at Meikle Sikes were sited at that altitude in order to fit in with the planned route, should they have proved successful. It is possible that the evident lack of success at Meikle Sikes contributed to the decision not to carry the proposals through to completion, or *vice versa*.

The dating of Dam 6 is not clear-cut, but it would appear to have been built in broadly this period of the use of the mine. The form of the dam and the pipe that was carried along Leat 6 suggest that it may have been intended to supply a pelton wheel. Tyler's documentary research throws no light on when this may have been installed or for what purpose, but it would seem to have been of a considerably more efficient design than the pelton wheel in use between 1912 and *c*.1922.

The use of the complex 1960-1991 (Figure 30**)**

The final episodes in the use of the mine can be characterised as a series of attempts to make the most of the major capital investments made between 1939 and 1952. With the exception of the completion of the La Porte incline under the tenure of McKechnie Brothers Limited in the early 1960s, most of the modifications were fairly cheap and small-scale.

Conclusion

In many respects, mining at Force Crag followed a pattern common in essence to many of the other metal mines that once existed in the Lake District. In this sense, the site could be regarded as unexceptional. However, the complex is important because there are surviving traces of most of the episodes of activity on the site, and because the relationship of the adits and processing areas to the industrial landscape that supported them is relatively well understood.

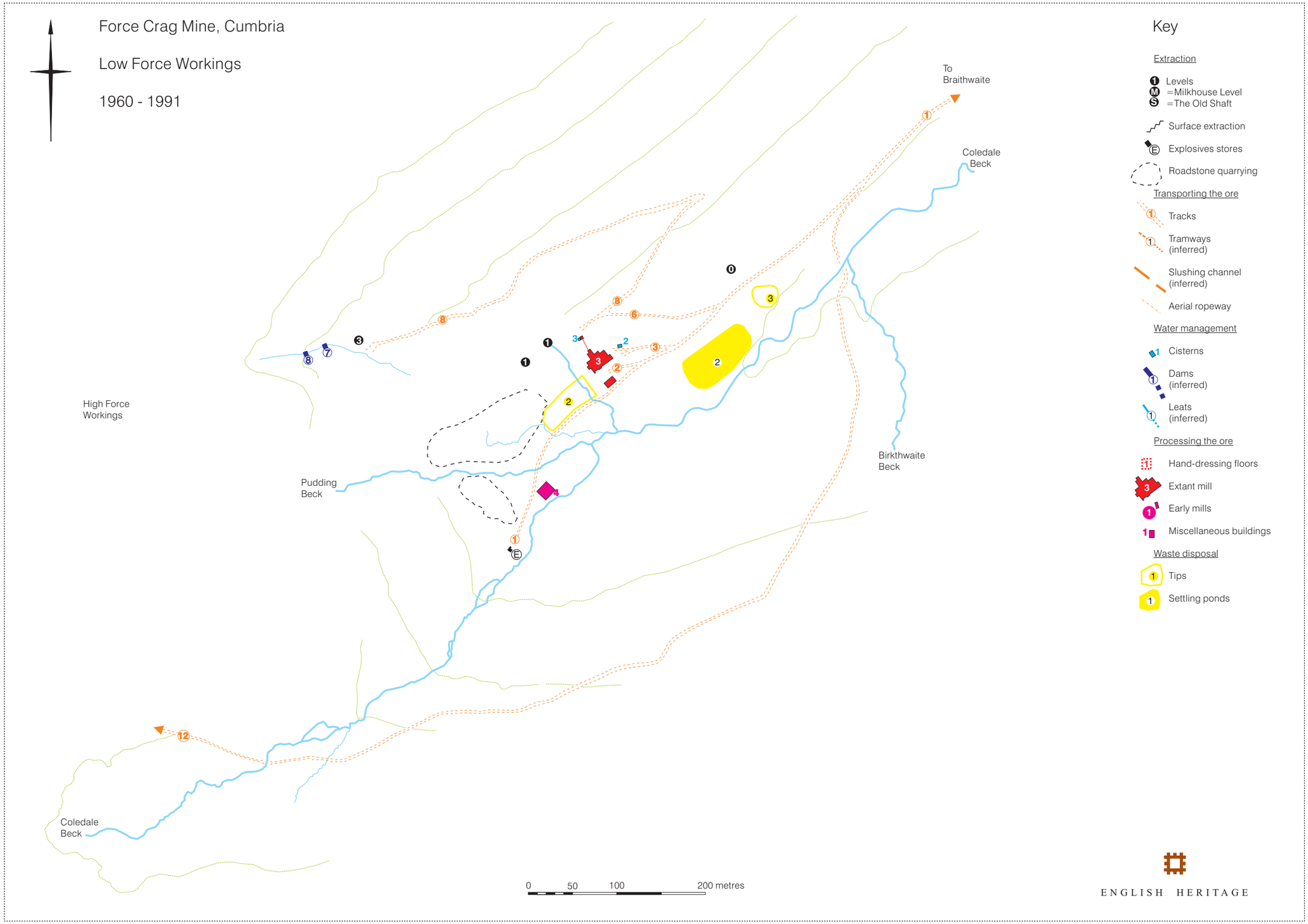


Figure 30. The development of the complex 1960-1991.

7. METHODOLOGY

The field investigation was carried out by Alastair Oswald and Trevor Pearson, with assistance from Stewart Ainsworth, Anne Ditchburn and Bernard Thomason. The medium-format photographic recording was carried out by Keith Buck, and the aerial photographs were taken by Peter Horne.

The measured survey was carried out using a Leica TC1610 Electronic Theodolite with integral Electromagnetic Distance Measurement (Total Station), based on a closed traverse of three stations around the head of the valley. A fourth station within this triangle was computed as a link traverse, and a fifth station was established on the summit of the Force Crag massif. From these five stations, observations were recorded to fix a network of additional temporary control points and the majority of the archaeological features. The three stations of the closed traverse and the fifth station on the summit of the Crag Force massif were subsequently related to the National Grid (OSGB36). This was done using a Trimble 4800 dual frequency Global Positioning Satellite (GPS) system, through a transformation programme based on their positions relative to Ordnance Survey trigonometrical pillar NY11/6, located 1km to the south on the summit of Crag Hill, at NGR (3)19266 (5)20364. Five permanent stations, marked by brass rivets, were established around the mining complex and their National Grid references calculated on the basis of the GPS data. Their positions are indicated on the 1:500 plans; further details are recorded in Appendix 3. From a GPS base station set up on the fifth station of the EDM traverse, data was gathered to contour the area above Dam 1 in detail. The resulting plan was plotted at 1:500 scale via Key Terrafirma and AutoCAD software. The remaining details of the plan and the section through the mill building were supplied with tape measures using standard graphical techniques.

The hand drawn archive plans were prepared by Trevor Pearson and Alastair Oswald, as were the CAD-based interpretative drawings, which were completed using CorelDraw8 software. The report was researched and written by Alastair Oswald, and edited by Stewart Ainsworth, with additional comments from Colum Giles.

The site archive has been deposited in English Heritage's National Monuments Record, Great Western Village, Kemble Drive, Swindon SN2 2GZ, to where applications for copyright should be made (reference number: NY 12 SE 11).

8. ACKNOWLEDGEMENTS

English Heritage would like to thank Robert Maxwell of the National Trust for commissioning the field investigation and for facilitating the project throughout; also Nick Edmunds of Wardell Armstrong for his co-operation in carrying out the health and safety assessment prior to the fieldwork. Thanks are also due to Mrs JM Firth for giving permission to make use of the archive material collected by her late father Mr WT Shaw; to the staff of Threlkeld Mining Museum for their assistance; to the staff of the Cumbria County Record Office in Carlisle for their assistance; and to Mr Ian Tyler for information and comments. Keith Blood (formerly of the Royal Commission on the Historical Monuments of England) gave the benefit of his long experience in field survey, and carried out a detailed examination of the Coledale Beck.

9. BIBLIOGRAPHY

Adams, J 1988. *Mines of the Lake District Fells*. Clapham, Dalesman Books

Institute of Geological Science 1971. *British Regional Geology: Northern England* [4th edition]. London, HMSO

Barnatt, J 1994. 'Excavation of a Bronze Age Unenclosed Cemetery, Cairns, and Field Boundaries at Eaglestone Flat, Curbar, Derbyshire, 1984, 1989-1990'. *Proceedings of the Prehistoric Society* 60, 287-370

Chapman, R 1993. 'Force Crag Mine: The Last Metal Mine in the North of England: Notes to accompany the videotape produced by Leeds University Television'. Unpublished leaflet

Cumbria Record Office a 1841. Tithe map for Braithwaite and Thornthwaite parishes [DRC/8/55/7]

b *c*.1960-1978. Miscellaneous papers in the WT Shaw archive [D/Sh/1/12]

c *c*.1960. 'Force Crag Mine: surface buildings' copy of plan D/Sh/Plans 42, c-e in the WT Shaw archive [D/Sh/Plans/36]

d 1913. 'Force Crag Mine: underground' plan in the WT Shaw archive [D/Sh/Plans/37]

e not dated. 'Force Crag Mine: upper levels' plan and section in the WT Shaw archive [D/Sh/Plans/38]

f 1944. 'Force Crag Mine: plan and profile' (2 copies) dated 19 May 1944, in the WT Shaw archive [D/Sh/Plans/39]

g *c*.1940. 'Force Crag Mine: plan of levels and surface buildings' in the WT Shaw archive [D/Sh/Plans/41]

h(1) *c*.1960. 'Force Crag Mine: section showing scree' in the WT Shaw archive [D/Sh/Plans/42a]

h(2) *c*.1967. 'Force Crag Mine: No. 1 Level and survey for map of big heap' in the WT Shaw archive [D/Sh/Plans/42b]

h(3) *c*.1960. 'Force Crag Mine: surface plans' in the WT Shaw archive [D/Sh/Plans/42c; d; e]

i not dated. 'Force Crag Mine: new west bunch' section in the WT Shaw archive [D/Sh/Plans/43]

j not dated. 'Force Crag Mine: High Force Level to Pudding Beck' plan and section in the WT Shaw archive [D/Sh/Plans/45]

k 1972. 'Force Crag Mine: plan and section' dated March 1972 and drawn by BG Lusher, in the WT Shaw archive [D/Sh/Plans/46]

Cumbria Sites and Monuments Record 11693, 11441, 11442

Eastwood, T 1921. 'The lead and zinc ores of the Lake District' *Memoirs - Geological Survey of Great Britain Special Report Mineral Resources of Great Britain*

Hall, GW not dated. 'An introduction to Force Crag Mine'. Unpublished leaflet

Hedley, I and Cranstone, D 1995. 'Monuments Protection Programme: minor metals and vein minerals'. Unpublished report by Lancaster University for English Heritage

Jobey, G 1981. 'Groups of small cairns and the excavation of a cairnfield on Millstone Hill, Northumberland'. *Archaeologia Aeliana* [fifth series] 9, 23-44

Leach, R 1983. 'Settlements and Groups of Small Cairns on Birkby and Birker Fells, Eskdale, Cumbria. Survey undertaken in 1982.' *Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society* 83, 15-23

Marshall, P and Davis-Shiel, M 1977. *Industrial Archaeology of the Lake Counties*. Newton Abbott

McFadzean, A and Tyler, I 1992. 'Barytes' in Cumbria Amenity Trust Mining History Society (ed) *Beneath the Lakeland Fells: Cumbria's Mining Heritage*. Ulverston, Red Earth Publications

National Trust 1997. Annotated copy of Waring and Netts 1996 unpublished, with additional sketch section (not to scale), carried out by 'HC' November 1997

Ordnance Survey 1862. First Edition 25-inch map sheet Cumberland LXIII.11 (surveyed 1861)

1900. Second Edition 6-inch map sheet Cumberland LXIII SE (revised 1898)

1970. Aerial photographs held in the National Monuments Record: 70/289 frames 195 & 212-3 04-AUG-1970

1978. 1:10,000 scale map sheets NY 12 SE and NY 22 SW

Postlethwaite, J 1913. *Mines and Mining in the (English) Lake District*. Whitehaven, WH Moss

RAF 1947. Aerial photographs held in the National Monuments Record: CPE/UK1940, frames 3206-8 19-JAN-1947.

1957. Aerial photographs held in the National Monuments Record: F21 58/RAF/2200, frames 4-5, and F22 58/RAF/2200, frames 26-7 18-JUN-1957

RCHME 1999. *Recording Archaeological Field Monuments: A Descriptive Specification*. Swindon, Swindon Press

Shaw, WT 1972. *Mining in the Lake Counties* [second edition]. Clapham, Dalesman Books

Sutcliffe, M 1985. 'New Coledale Mining Ltd: Mill flow sheet, Force Crag Mine'. Unpublished diagrammatic flow sheet

Tyler, I 1990. *Force Crag: the History of a Lakeland Mine*. Marton, Red Earth

Waring and Netts Partnership, 1996. Three unpublished floor plans of the processing plant building at 1:100 scale (approx.), surveyed October 1996

Young, B & Cooper, AH 1988. 'The Geology and Mineralisation of Force Crag Mine, Cumbria' Proceedings of the Cumberland Geological Society 5 [part 1:1], 5-11

APPENDIX 1. THE PHOTOGRAPHIC RECORD

Black and white medium-format record photographs taken during the field investigation

AA99/04023 Force Crag Mine: view from the SW towards Dam 3

AA99/04024 Force Crag Mine: view from the SW towards Dam 3

AA99/04025 Force Crag Mine: view from the SW towards Dam 3

AA99/04026 Force Crag Mine: view from SE across Dam 1 towards High Force Workings

AA99/04027 Force Crag Mine: view from the SE towards the High Force Workings

AA99/04028 Force Crag Mine: entrance to Level 0 (Zero)

AA99/04029 Force Crag Mine: view from E of Dam 5

AA99/04030 Force Crag Mine: general view from the SW

AA99/04031 Force Crag Mine: 22" diameter drainage pipe, formerly used to supply a pelton wheel

AA99/04032 Force Crag Mine: view from the SW towards Dam 3

AA99/04033 Force Crag Mine: general view from the N

AA99/04034 Force Crag Mine: foundation of the mid-way station of the aerial ropeway

AA99/04035 Force Crag Mine: the extant mill (3) seen from the SW

AA99/04036 Force Crag Mine: view from the S of Dam 3

AA99/04037 Force Crag Mine: fragment of cast-iron wheel unit from the aerial ropeway

AA99/04038 Force Crag Mine: view from the NW of Explosives Stores (c.1908 at right; c1960 at left)

AA99/04039 Force Crag Mine: view from the SW across Settling Pond 2, reconstructed c1972

AA99/04040 Force Crag Mine: general view from the SW

AA99/04041 Force Crag Mine: the extant mill (3) showing component no. 28

AA99/04042 Force Crag Mine: view from the SW of the extant mill (3) (brick & stone 1908-9; brick 1939-40)

AA99/04043 Force Crag Mine: general view from the S

AA99/04044 Force Crag Mine: view from the S of the extant mill (3)

AA99/04045 Force Crag Mine: wooden flume (not in situ)

AA99/04046 Force Crag Mine: view from E of Cistern 1

AA99/04047 Force Crag Mine: entrance of Level 0 (Zero)

AA99/04048 Force Crag Mine: view from the NE of Explosives Stores (c.1908 background; c1960 foreground)

AA99/04049 Force Crag Mine: general view from the SW

AA99/05403 Force Crag Mine: fragment of cast-iron wheel unit from the aerial ropeway

AA99/05404 Force Crag Mine: entrance of Level 3, with 'The Old Shaft' in the background

AA99/05405 Force Crag Mine: general view from the SW

AA99/05406 Force Crag Mine: view from the E of Dam 5

AA99/05407 Force Crag Mine: view from the E of the extant mill (3) with the Office and loading bay in the foreground

AA99/05408 Mill 3: Level 3, component No 29 from the SW

AA99/05409 Mill 3: Level 3, component No 31 from the W

AA99/05410 Mill 3: Level 4, component No 34 from the W

AA99/05411 Mill 3: lean-to on the SE side (component not in situ)

AA99/05412 Mill 3: Level 7, component No 9 from the SE

AA99/05413 Mill 3: Level 7, component No 8 from the SW

AA99/05414 Mill 3: Level 6, component No 24 from the SW

AA99/05415 Mill 3: Level 7, component No 5 from the SE

AA99/05416 Mill 3: bucket elevator from the ESE

AA99/05417 Mill 3: Level 4, component No 26 from the NE

AA99/05418 Mill 3: Level 4, components Nos 19 and 20 (ball mill) from the E

AA99/05419 Mill 3: grizzly hopper, view from the NE

AA99/05420 Mill 3: conveyor from grizzly hopper into extant Mill (3), view from the N

AA99/05421 Extant mill building (3) with vehicle store in backgound

AA99/05422 Extant mill building (3) from the NE

AA99/05423 Extant mill building (3) from the SE

Black and white aerial photographs taken 17 Jun 1999

17273/08 The head of the Coledale Valley from the north-east

17273/09 The head of the Coledale Valley from the north-east

17273/10 Force Crag Mine from the north-north-east

17273/11 Force Crag Mine from the north-north

17273/12 The High Force Workings from the south-west

17273/13 The High Force Workings from the south-west

17273/14 The Low Force Workings from the south-west

17273/15 The Low Force Workings from the south-west

17273/16 The Low Force Workings from the east

17273/17 The Low Force Workings from the east

17273/18 The Low Force Workings from the east

17273/19 The Low Force Workings from the south

17273/20 The Low Force Workings from the south

17273/21 The High Force Workings from the south

17273/22 The High Force Workings from the south

17273/23 The High Force Workings from the south-west

17273/24 The High Force Workings from the south-west

17273/25 The Coledale Valley from the north-east

17273/26 The Coledale Valley from the north-east

Colour aerial photographs taken 17 Jun 1999

17266/11 The head of the Coledale Valley from the north-east

17266/12 Force Crag Mine from the north-north-east

17266/13 Force Crag Mine from the north-west

17266/14 Force Crag Mine from the north-west

17266/15 Force Crag Mine from the south

17266/16 Force Crag Mine from the south

17266/17 Force Crag Mine from the south-east

17266/18 Force Crag Mine from the south-east

17266/19 Force Crag Mine from the east

17266/20 Force Crag Mine from the east

17266/21 Force Crag Mine from the north-east

17266/22 Force Crag Mine from the north-east

17266/23 Force Crag Mine from the north-north-east

17266/24 Force Crag Mine from the north-north-east

17266/25 Force Crag Mine - the extant mill building and environs

17266/26 The High Force Workings

17266/27 The High Force Workings

17266/28 The High Force Workings

17266/29 The Coledale Valley from the east

17266/30 The Coledale Valley from the east

APPENDIX 2. NMR NUMBERS ATTACHED TO THE SURVEY

SITE NAME	COUNTY	DISTRICT	PARISH
Force Crag Mine	Cumbria	Allerdale	Above Derwent

SITE NAME	NGR	NMR No.
Level 0	NY 2012 2173	NY 22 SW 4
Level 1	NY 1992 2165	NY 12 SE 15
Level 2	NY 1976 2158	NY 12 SE 16
Level 3	NY 1970 2165	NY 12 SE 17
The Milkhouse Level	NY 1968 2166	NY 12 SE 18
Level 4	NY 1947 2164	NY 12 SE 19
The explosives stores	NY 1987 2142	NY 12 SE 20
The High Force Workings	NY 1925 2150	NY 12 SE 13
Possible trials at Meikle Sikes	NY 2080 2246	NY 22 SW 7
'Coffin level' near Braithwaite	NY 227 234	NY 22 SW 12
Scar Crag Mine	NY 206 207	NY 22 SW 13
Tramway 1	NY 2025 2179	NY 22 SW 6
Tramway 2	NY 1986 2157	NY 12 SE 21
The aerial ropeway	NY 1992 2157	NY 12 SE 22
Cistern 1	NY 1994 2163	NY 12 SE 23
Dam 1	NY 1954 2115	NY 12 SE 25
Dam 4	NY 1997 2163	NY 12 SE 26
Dam 5	NY 2005 2161	NY 12 SE 27
Dam 6	NY 1980 2129	NY 12 SE 28
Mill 1	NY 1983 2150	NY 12 SE 14
Mill 2	NY 2024 2177	NY 22 SW 5
Mill 3 (PARENT RECORD)	NY 1997 2163	NY 12 SE 11

Office	NY 1998 2161	NY 12 SE 12
Building 1	NY 1985 2146	NY 12 SE 24
Cairnfield	NY 2023 2166	NY 22 SW 8
Huts 1 & 2	NY 2023 2166	NY 22 SW 9
Sheepfold	NY 1990 2147	NY 12 SE 30
Sheepfold	NY 1932 2129	NY 12 SE 31
Sheepfold	NY 1953 2093	NY 12 SE 32
Sheepfold	NY 2044 2076	NY 22 SW 10
Sheepfold	NY 2041 2130	NY 22 SW 11
Sculpture	NY 1998 2162	NY 12 SE 29

APPENDIX 3. DETAILS OF PERMANENT MARKERS

In the course of the survey, five permanent stations were put in by English Heritage, each marked by a brass rivet. From west to east, the positions of these are as follows:

1) On a slightly raised natural outcrop 1.5m to the east of the mid-point of the well-preserved dam (numbered 4), at NGR 319652.329,521216.959 and an altitude of 421m above OD.

2) On the north-eastern corner of the concrete doorstep plinth outside the entrance to the larger of the two explosives stores, at NGR 319868.926, 521421.202 and an altitude of 282m above OD.

3) On the concrete foundation of a demolished wall to the south of the former lower terminal of the aerial ropeway, at NGR 319920.946, 521569.030 and an altitude of 274m above OD.

4) On the southern corner of the concrete surround of a manhole cover 25m east of the extant grizzly hopper and ore crusher, at NGR 319975.359, 521668.836 and an altitude of 279m above OD.

5) On the surface of the concrete loading platform to the east of the extant mine office, towards its eastern end, at NGR 319994.900, 521617.628 and an altitude of 266m above OD.

NY 204 222

Force Crag Mine, Cumbria

Key to 1: 500 survey sheets

222
221
220
219
218
217
216
215
214
213
212
211

NY 193 210 194 195 196 197 198 199 200 201 202 203 204

1 2 3 4 5 6 7 8 9 10 11 12 13

To Braithwaite

Coledale Beck

High Force Workings

Birkthwaite Beck

Pudding Beck

To Scar Crags

Coledale Beck

0 50 100 200 metres

Key

Extraction

- Levels
- M = Milkhouse Level
- S = The Old Shaft
- Surface extraction
- E Explosives stores
- Roadstone quarrying

Transporting the ore

- Tracks
- Tramways (inferred)
- Slushing channel (inferred)
- Aerial ropeway

Water management

- Cisterns
- Dams (inferred)
- Leats (inferred)

Processing the ore

- Hand-dressing floors
- Extant mill
- Early mills
- Miscellaneous buildings

Waste disposal

- Tips
- Settling ponds

Miscellaneous

- Cairnfield
- Huts
- Sheepfold
- Sculpture

ENGLISH HERITAGE