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FORCE CRAG MINE, ABOVE DERWENT, CUMBRIA
ARCHAEOLOGICAL SURVEY OF THE HIGH FORCE WORKINGS

SURVEY REPORT

Al Oswald, Phil Newman, Dave Went and Catherine Grindey

ARCHAEOLOGICAL
SURVEY AND INVESTIGATION

ENGLISH HERITAGE

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SUMMARY

Force Crag Mine, which was until 1991 the last working metal mine in Cumbria, is now owned by the National Trust; the 75-hectare (185-acre) site is accessible to walkers throughout the year and the extant processing mill is open to visitors on a number of advertised days during the summer. Following an archaeological survey of the surface remains of the Low Force Workings in 1999, which contributed to an award-winning series of conservation measures undertaken subsequently by the National Trust, in 2007 English Heritage undertook further analytical survey of the adits, buildings, tracks and other remains relating to the more inaccessible High Force Workings. Although mining for barytes in the High Force Workings spanned the hundred years between 1867 and 1967, it comprised five separate phases with a total duration of only 36 years and with one hiatus lasting nearly half a century, between 1881 and 1929. Underground, this part of the mine was the setting in 1949-52 of what has been called "one of the most ambitious mining operations in the Lake District", but most of the surface remains relate to work undertaken, arguably on an equally ambitious scale, during the 1930s and '40s.

CONTRIBUTORS

The field investigation was carried out by Alastair Oswald, Phil Newman and Dave Went of English Heritage Research Department's Archaeological Survey and Investigation team. Catherine Grindey and Adele Burnett participated in the project as trainees, respectively as part of the EPPIC (English Heritage Professional Placements in Conservation) scheme and as a one-month placement from Bangor University's MA course in conservation studies. The photographic recording on the ground was carried out by James Davies of English Heritage's Imaging, Graphics and Survey team, and the aerial photographs were taken in 1999 by Peter Horne of the Aerial Survey Team.

The text was produced by Al Oswald, and the illustrations by Phil Sinton, Cat Grindey and Al Oswald. The report was edited by Dave Went and brought to publication by Abby Hunt.

ACKNOWLEDGEMENTS

English Heritage would like to thank Jamie Lund, Archaeologist for the National Trust's North-West Region, for initiating the field investigation and, along with John Malley, Property Manager for Borrowdale, for facilitating the project throughout. Thanks are also due to Mrs J M Firth for giving permission to make use of the archive material collected by her late father the local mining engineer Mr W T Shaw; to the staff of the Cumbria County Record Office in Carlisle for their assistance; and to local mining experts Ian Tyler and John Crompton for information and comments.

ARCHIVE LOCATION

NMR Swindon. NMR number NY 12 SE 11

DATE OF SURVEY

May - June 2007

CONTACT DETAILS

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1. INTRODUCTION

In 1999, English Heritage undertook an analytical field investigation to identify, interpret and record the surface remains of the Low Force Workings and ore processing mills of Force Crag Mine in Cumbria (Oswald and Pearson 1999). The archaeological and architectural survey was initiated and jointly funded by the National Trust, which now owns the property, and was intended to inform emergency conservation works and longer term management and presentation of the site. In 2007, the National Trust embarked on further conservation measures intended to alleviate the worsening problem of flooding in the mine's lower workings and resultant contamination, measures which are (at the time of writing) expected to include construction of a new drain, exiting through one of the lowest mine levels, and perhaps new settling tanks on the valley floor. In advance of this, the National Trust asked and again jointly funded the same team to investigate and record the High Force Workings, which had been subject only to rapid examination in 1999. The surface remains of the mining complex as a whole cover an area of approximately 75 hectares (185 acres), the majority of which was investigated in 1999; the 2007 survey was limited to an area of 15 hectares (37 acres). The High Force Cross-Cut, which was historically the most important of the five main tunnels that provided access to the High Force Workings, is associated with three ruined buildings and other structures. The entrance to the tunnel lies at National Grid Reference NY 1924 2147 and at an altitude of 521m above Ordnance Datum (AOD).

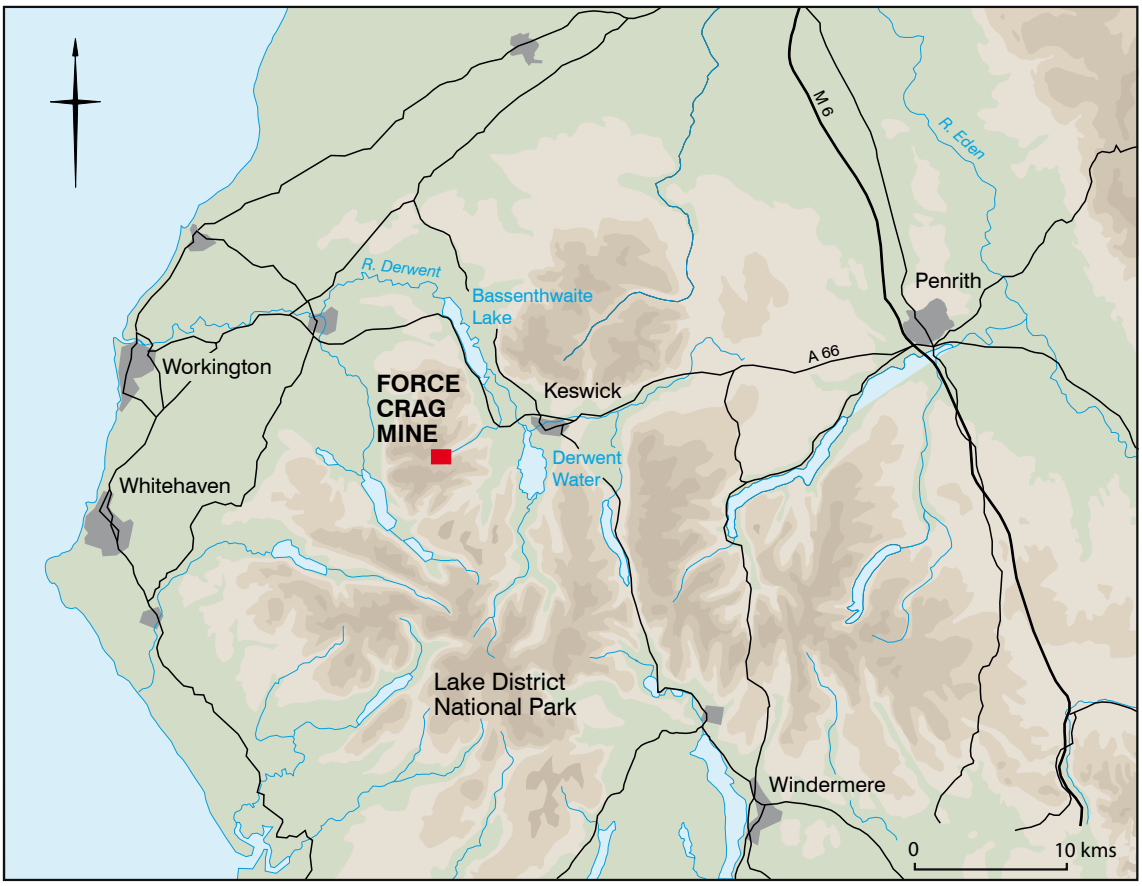

Figure 1. Location map

The High Force Workings take their name from a waterfall ('force' in local dialect) which occurs where the Pudding Beck, a tributary of the Coledale Beck, descends a sheer rock face on the northern side of the Coledale Valley, some 70m higher than the more imposing glaciated cliff known as Force Crag. The geological context of the mine is summarized at length in the 1999 report, as well as in various other more authoritative sources (Eastwood 1921; Young and Cooper 1988; Institute of Geological Science 1971; see http://www.english-nature.org.uk/citation/citation_photo/2000241.pdf). Lead, zinc, silver and a number of other minerals are present, but the barytes (barium sulphate) deposits are most exceptional in quantity and quality, and it was this mineral in particular that the High Force Workings targeted. 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 2005, 3-4).

The investigations of the mine addressed many of the themes of English Heritage's own research agenda (English Heritage 2006). As a whole, Force Crag Mine is one of the best-preserved and most long-lived metal mining complexes in the region and therefore represents an important exemplar. Below ground, the High Force Workings were the scene in the early 1950s of what has been called 'one of the most ambitious mining operations in the Lake District' (Tyler 2005, 64-5). However, most of the immediately apparent surface remains are of early and mid 20th-century origin, associated with an operation that was arguably just as impressive. The significance of the historic remains was officially recognized in 2001, in the wake of the 1999 survey, when the whole complex was afforded legal protection as a Scheduled Ancient Monument. Force Crag lies within the Buttermere Fells Site of Special Scientific Interest (SSSI); in 1999, English Nature extended additional protection to the environs of the mine on the grounds of geological importance. Since it also lies within the Lake District National Park, the 2007 investigation contributes indirectly to the joint accord signed in 2004 between English Heritage and England's National Park Authorities. Virtually continuously since 1999, the National Trust has taken steps to conserve the main processing mill building and its contents (the project winning a conservation award in 2005), in parallel with measures to increase public access to the mill and interpretation of the wider historic environment through provision of guided tours and signage. Force Crag is thus an important vehicle for communicating the importance of the Lake District's industrial heritage to the general public.

This report, to avoid duplication of the one produced in 1999, confines itself to the history and physical remains of the High Force Workings. Given the considerable historical research already undertaken into the site (notably published in Ian Tyler's 1995 book *Force Crag: the History of a Lakeland Mine* (amended and reprinted in 2001 and 2005), the documentary research undertaken in support of the 2007 fieldwork was not exhaustive, in line with the methodology adopted for the 1999 investigation. The analytical field survey, however, was carried out in detail to the same standard (Level 3, as defined in Ainsworth, Bowden and McOmish 2007, 23-4) and at the same scale (1:1,000), though predominantly using more sophisticated survey equipment. Due to safety considerations, the mines below ground were not investigated at all. Some of the potentially unstable shafts and other openings were not examined closely on the ground, but their extents were plotted from vertical aerial photographs. This report deals principally with the

surface remains of a series of 'levels' or 'adits' (tunnels), 'stopes' (voids left where the mineral vein has been entirely quarried away) and trial pits located on the valley side at altitudes between 470m and 645m, together with three associated buildings, now in various states of ruination. However, it should be borne in mind that throughout the operation of the High Force Workings, the management of the mine and most of the mineral processing took place at the extant mill building at the Low Force Workings (termed Mill 3 in the 1999 report); these aspects of the operation were therefore discussed as part of the earlier report. Mill 3, which is recorded in the Sites and Monuments Record for Cumbria as 11693, and in the National Monuments Record as NY 12 SE 11, serves as a parent record for the other remains, the references for which are listed in Appendix 1.

The remains are all on Access Land, formerly part of the Leconfield Estate but now owned by the National Trust, and can be reached on foot by various paths. However, unauthorised entry into the workings themselves is illegal and potentially dangerous, and is therefore strictly prohibited. Disturbance of, or damage to, the historic remains, including the removal of artifacts, is illegal. Damage to, or removal of, minerals is also illegal.

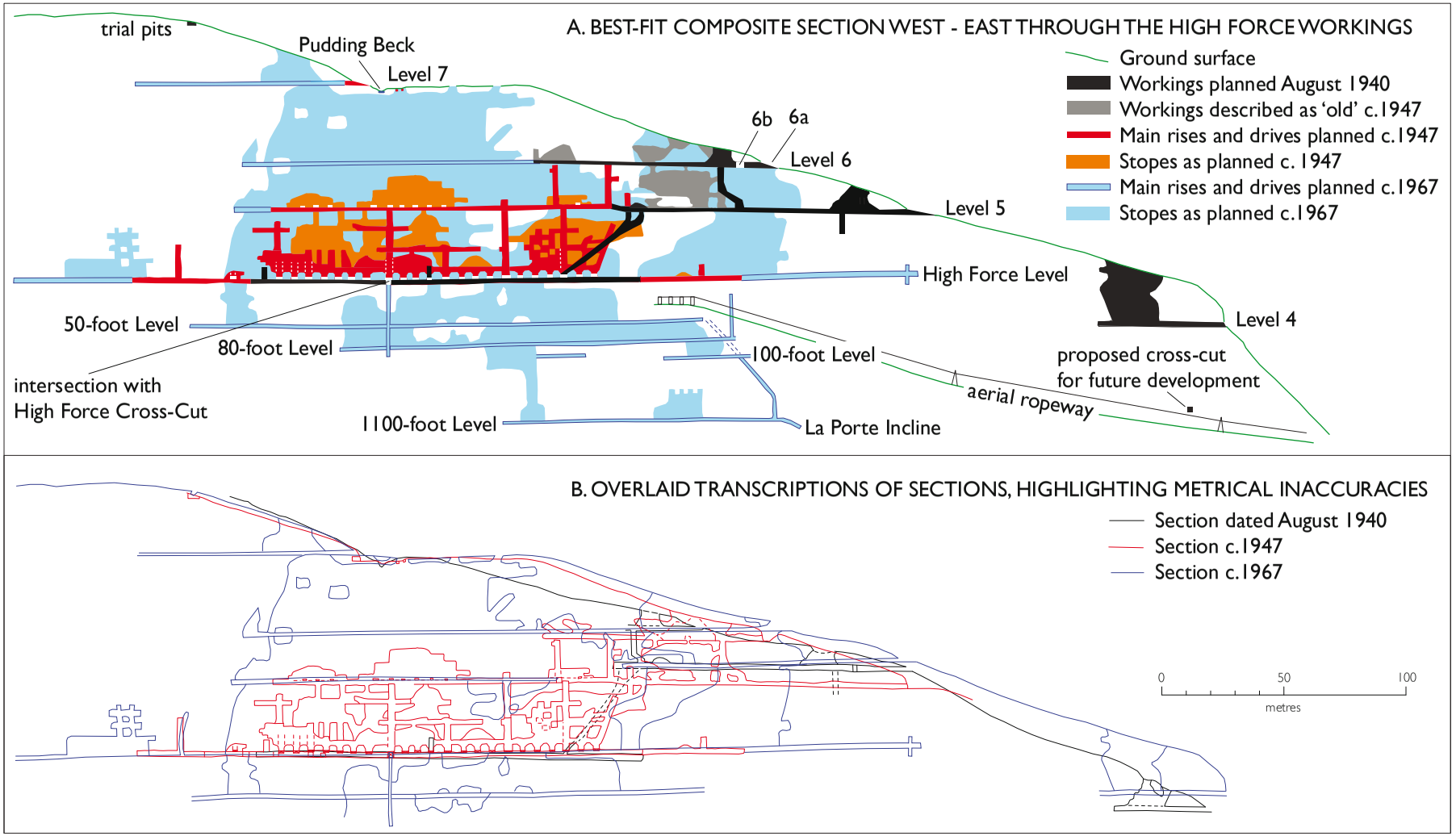

Figure 2. Section drawings showing the underground extent of the High Force Workings by 1940, c1947 and c1967 (transcribed from drawings held in Cumbria Records Office and reproduced at approximately 1:2500 scale)

2. THE DOCUMENTED HISTORY OF THE HIGH FORCE WORKINGS

The report on the 1999 archaeological investigation (Oswald and Pearson 1999) includes a lengthy summary of the documented history of the whole mine, which draws heavily on the account published by Ian Tyler (1999; 2005) and need not be repeated here. This report confines itself to the High Force Workings, and to the period during which they were in active use. Although activity at the Workings spanned the hundred years between 1867 and 1967, it comprised five separate phases with a total duration of only 36 years and with one hiatus lasting nearly half a century, between 1881 and 1929. These phases were:

1867 – 1881, primarily under The New Force Crag Mining Company Ltd;

1929 – 1933, under The Derwent Fells Mining Company Ltd;

1939 – 1946, under Tampimex Oil Products Ltd;

1949 – 1952, under La Porte Chemical Company Ltd;

1960 – 1967, under McKechnie Brothers Ltd

Historic Ordnance Survey maps constitute a useful source of information for the development of the Low Force Workings, but the 6-inch scale (1:10,560) revisions surveyed in 1898 and 1947-8 did not depict any of the contemporary or recently abandoned features associated with the High Force Workings (Ordnance Survey 1900; 1951). It is likely, given that the small scale of the map revisions and the remoteness of the workings, that the omission was accidental. In effect, therefore, historic Ordnance Survey maps can be disregarded as a source of evidence for the development of the High Force Workings. The earliest aerial photographs showing the High Force Workings were taken on 19 January 1947 (RAF 1947), two days before the start of the severe cold spell that lasted six weeks, forcing Tampimex Oil Products Ltd to abandon their lease at Force Crag and marking the end of intensive work at the High Force Cross-Cut. As a result, while the photographs represent a useful record of the state of the High Force Workings at the end of their development, they contribute little to the understanding of the developmental process itself.

Figure 2 is derived from unpublished section drawings held in the archive compiled by the former mining engineer W T Shaw (Cumbria CRO). One of these is dated 1940, and the others can be dated by inference to 1947 and 1967. When compared, it becomes apparent that the three sections contain slight metrical inaccuracies, which cannot be resolved without detailed underground survey; they are therefore reproduced here as straightforward copies of the originals, but reduced to the same scale as far as possible. The sections clearly show the dramatic increase in scale of the underground workings over the three decades or so that they span. Small-scale schematic drawings of the workings below ground have been published previously (Adams 1988, figure on page 44; Tyler 2005, figures on pages 18, 50, 55 and 110 respectively).

1867 – 1881: The New Force Crag Mining Company Ltd

In 1867, the lease of the mine was taken up by Messrs. Hall and Straughton, initially with the intention of exploiting the barytes deposits alone, although in the event lead and some zinc ore were still extracted from the Low Force Workings as a by-product (Tyler 2005, 17ff). In April, while mining continued in Level 1, work began on the first of the High Force Workings: Level 4 (also known as Postlethwaite's Level, after one of the Directors) and Level 5 (subsequently known as the Barytes Level). Evidence form the 2007 archaeological survey confirms, as previously suspected, that the supply of these workings with materials and heavy tools necessitated the construction for the first time of the circuitous track for pack-ponies that ascends the southern side of the Coledale Valley, referred to in English Heritage's 1999 report as Track 12. By 1869, the vein in Level 4 had thinned to the point where work was abandoned, but in that same year Level 5 reached a length of 100 yards along the line of the vein. A series of trial pits was also dug on the south-eastern slope of Sand Hill, at an altitude of 645m, these being the highest and most westerly workings at the site (Tyler 2005, 19-20). In 1870, 442 tons of barytes from Level 5 were milled and sold; a bleaching plant was installed as part of the main mill at the Low Force Workings, to achieve a purer product that would command a higher price.

Prospects were sufficiently good that in August 1872 the operation was floated as a public company under the name of The New Force Crag Mining Company Limited. In August of the same year, Level 5 hit a 10ft wide vein of barytes, prompting the construction of the horse-drawn tramway to Braithwaite, which was completed in a single year from 1873, and the rental of a derelict flour mill in the village for processing and storing the mineral (Tyler 2005, 23). Level 6 was begun early in 1873; over subsequent years it was driven forward and a shaft in its floor reached Level 5, some 15m beneath (Tyler 2005, 28). The means by which the barytes ore was transported down from the High Force Workings is not mentioned in the documentary sources, but the physical remains, described in Section 3, suggest that the method may have been modified from slushing to pack-pony as the extent and location of the workings changed. Production peaked in 1875 at 700 tons and remained high until 1877, when 568 tons were produced, but in that year the price of barytes began to fall. The market collapsed further in the following year and production fell to 188 tons. With unfortunate timing for the mining company, the Leconfield Estate Office remembered that the Company should have been charged a £25 per annum rent and back-dated this to 1872. After a severe winter in 1878-9, the Company limped on for another two years, but apparently without producing any further ore. It finally went out of business in January 1881, by which date a total of about 5,400 tons (5315 metric tonnes) of barytes ore had been extracted.

As was normal practice, the mine was 'asset-stripped' almost exactly a year later, in January 1882 (Tyler 2005, 28-30). While mining resumed in the Low Force Workings in 1906, the High Force Workings were to remain derelict for almost half a century. A report of 1885 painted a gloomy picture, recording that the entrances to Levels 5 and 6 were full of scree and that the entrance of Level 4 could not even be located (Tyler 2005, 31). A 1923 report noted that Level 6 was still open (Tyler 2005, 48), but it is possible that access was gained through a different entrance from that examined in 1885, as described below.

1929 – 1933: The Derwent Fells Mining Company Ltd

The Derwent Fells Mining Company was formed in March 1928 by optimistic newcomers W T Donovan and Maurice Newbould. In 1929, after explorations in Levels 4, 5 and 6, work began on the High Force Cross-Cut, some 37m lower than Level 5. Technically, the 'cross-cut' is the tunnel driven approximately perpendicular to the mineral vein, while the workings along the line of the vein are the 'High Force Level'; both names are used on contemporary documents, but in this report the former is sometimes used as a convenient shorthand for the workings as a whole (following Tyler). The Cross-Cut progressed 146m before a small thread of barytes was encountered, but calculations suggested that this was not the main vein, so it was driven forwards a further 14m to a point where, in 1930, a large seam of barites was exposed (Tyler 2005, 49). In that year, 1,750 tons of barytes were extracted, and the figure reached nearly 3,000 tons in 1932-3. As with the 19th-century operation of Levels 5 and 6, documentary sources shed no light on how the ore was transported down from the High Force Workings. Tyler (2005, 51) concludes that lorries were probably used, but the physical remains, described in Section 3, suggest that pack-ponies may still have been employed at this stage. In 1931, work commenced on the Newbould Cross-Cut, but it was never extended more than a few yards (Tyler 2005, 51). In 1933, however, possibly because of the imposition of a new 10% duty on barytes, production abruptly ceased, by which date about 5000 tons (4921.0 metric tonnes) had been extracted. A longitudinal section through the mine, produced for the subsequent leaseholders around August 1940 and retained by W T Shaw, shows the extent of the underground workings by the time the Derwent Fells Mining Company surrendered the lease (Cumbria CRO: D/Sh/Plans/40; see also Figure 2).

1939 – 1947: Tampimex Oil Products Ltd

Tampimex Oil Products Ltd took on the lease in 1939. Tyler (2005, 52) infers that Tampimex may have had financial backing from the Ministry of Munitions, since barytes was in dramatically greater demand as a fluxing agent in the munitions industry and the company's initial investment in the infrastructure was uncharacteristically lavish. According to an estimate apparently dating to 1940, the total cost was initially expected to be in excess of £20,000, including around £10,000 for an aerial ropeway to carry ore from the High Force Cross-Cut to a proposed new processing area at Braithwaite Station (Cumbria CRO: D/Sh/1/12/Plans(i)). However, a longitudinal section drawing of August 1940 suggests that these ambitious plans were soon revised, for it shows the proposed ropeway descending steeply from the edge of Force Crag directly to the extant processing mill on the valley floor (Cumbria CRO: D/Sh/Plans/40). The drawing also shows a 'proposed cross-cut for future development' at an altitude of 1540 feet (469m AOD). The aerial ropeway was completed soon after April 1941 (according to a date scratched into one of the pylon bases, found in 1999), but was not constructed as initially envisaged on either the written estimate or the later section drawing. Instead, presumably because the steep angle of the direct descent to the mill proved impractical, the ropeway was built with a more gentle gradient and an acute angle change at a mid-way station on the valley side east of the extant mill, then returning westwards to deliver the ore. There is also some physical evidence at the mid-way station that Tampimex still wished to retain the possibility of an eventual extension of the ropeway to Braithwaite. Subsequently, according to Tyler, severe winter weather occasionally necessitated the resumption of

transport by lorry. Track 12 had been broadened by blasting near its upper reaches to create a route suitable for lorries, presumably early in the preparatory work, while two new buildings were constructed on the artificial shelf that gives access to the High Force Cross-Cut.

Production rose dramatically as the Second World War peaked and the general demand for minerals increased, but also reflecting the successful, if intermittent, operation of the aerial ropeway. In 1941, 283 tons were milled and sold; in 1942, 3,611 tons; in 1943, 9,213 tons; in 1944, 11,154 tons; in 1945 7,300 tons, diminishing again to 3,000 tons in 1946 (Tyler 2005, 53; 66). By 1944 High Force Level had been driven, from the intersection of the Cross-Cut with the vein, 107m westward and 198m eastward (Tyler 2005, 53). A large-scale plan and longitudinal section, apparently made by Tampimex about 1944, or possibly in 1949 by the La Porte Chemical Company at the start of their work, shows the progress of Tampimex's work (Cumbria CRO: D/Sh/Plans/45; see also Figure 2). By 1944, Level 7 had been driven 82m westward along the line of the vein.

However, the notoriously harsh winter weather which lasted between January and March 1947 put the mine out of action for six weeks and caused severe flooding, particularly in the Low Force Workings. This, together with the drop in demand for barytes that had accompanied the end of the war, forced Tampimex to surrender their lease at the beginning of 1948, despite the massive investment they had made in the infrastructure of the mine. As it turned out, this marked the final cessation of intensive activity above ground at the High Force Workings. Aerial photographs taken by the RAF on 19 January 1947, although taken from high altitude and with the High Force Cross-Cut in deep shade, indicate that there were no major additions to the surface infrastructure up to the present day (RAF 1947).

1949 – 1952: La Porte Chemical Company Ltd

The La Porte Chemical Company Ltd applied for planning permission to take on the lease at Force Crag in November 1948, and were granted permission at the start of June 1949, on condition that no further adits were embarked upon (Cumbria CRO: D/Sh/1/12). Doubtless La Porte intended to capitalize on the investments in the mine made by Tampimex, yet in the event their own infrastructural investment was almost equal to that made by their predecessors.

A 335m-long underground incline was begun by La Porte, which was intended to rise steadily from Level 3 to connect with the High Force Level; this ultimately cost around £20,000 to construct (Tyler 2005, 64-5). The incline was intended to create a more direct and weather-proof continuous descent from the High Force Workings to the top of the Track 8, which had provided relatively easy access to Level 3 since the 19th century and was now broadened to be passable for lorries. After three years of continuous work on the project without any ore being processed, the incline was abandoned just short of completion in 1952 (Tyler 2005, 64-5). Although it was to prove an expensive failure for La Porte, the incline was to play an important role in the subsequent development of the mining operation.

1960 – 1967: McKechnie Brothers Ltd

McKechnie Brothers signed a 25 year lease on 13 October 1960 (Tyler 2005, 67). By the end of 1960, Force Crag employed 15 miners, 16 millmen, 4 labourers, 2 office staff and 1 foreman. Predictably, McKechnie Brothers began by capitalizing on La Porte's massive infrastructural investment and engineered a connection from the lowest level beneath the High Force Level to a cross-cut drive begun by La Porte, which connected to the upper end of their long incline. This route was awkward and inefficient, requiring four handling stages. In 1962, Her Majesty's Inspector of Mines classified the La Porte incline as unsafe, forcing McKechnie Brothers to widen it and install steps alongside the floor which was intended to act as a slushing channel. At around the same date, Track 12 was improved again, allowing materials and workers to be transported up the mountain and lowered to the various working areas. In late 1963, Big Rise was completed, linking the High Force Level more directly with the La Porte Incline and in 1964, extraction of barytes began again, on a modest scale by comparison with Tampimex (Tyler 2005, 72-4). Tyler understandably expresses mystification as to why, on the verge of successful operation, McKechnie Brothers seem to have turned their attentions once more to exploratory work in Levels 0 and 1. The quantities of barytes extracted from the High Force Workings were never sufficient to make big profits, and McKechnie Brothers eventually abandoned the operation early in 1967 and auctioned off the equipment in March of that year (Tyler 2005, 86-7). Although the Low Force Workings saw subsequent attempts to revitalize the mine, the exploitation of the High Force Workings was effectively over.

The only footnote to the site's industrial history was the brief period in the late 1960s or early 1970s during which a hippy lived in the Office on the shelf outside the entrance to the High Force Cross-Cut (Tyler 2005, 96).

Figure 3. English Heritage aerial photograph of Force Crag Mine from the south-east, taken 17 June 1999. © Crown Copyright NMR, reference 17266/20

3. DESCRIPTION AND INTERPRETATION OF THE REMAINS

3.1 The workings and related features

English Heritage's 1999 report categorized the historic remains according to the sequence of the process from extraction to refining, in order to clarify the complex and changing interplay, which in some cases remains imperfectly understood, between different features at different stages in the development of the complex (Oswald and Pearson 1999). The features associated with the High Force Workings, which developed in a more straightforward fashion and over a shorter period, are grouped in this report according to their relation to the individual workings, and in chronological order. However, the numbering sequence for tracks used in the 1999 report has been retained. The principal components of the complex have been allocated individual National Monuments Record numbers, as listed in Appendix 1.

Figure 4. English Heritage aerial photograph of the High Force Workings from the south-west, taken 17 June 1999. © Crown Copyright NMR, reference 17273/12

The 1999 survey recorded Level 4, although it is generally treated as part of the High Force Workings, primarily because it lies just below the obvious topographical boundary represented by the upper edge of Force Crag (Figure 3). Given the Level's close affinities with, and chronological relationship to, the other High Force Workings, the 1999 account is reproduced here, slightly amended.

Level 4 (Postlethwaite's Level) NY 19476 21637; 501m (1644 feet) AOD.

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 2005, 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. A report on the condition of the mines in 1882 seems to indicate that the entrance was blocked at that date, since the author was unable even to locate the level (Tyler 2005, 30). In 1928 the newly formed Derwent Fells Mining Company is known to have carried out explorations in the level prior to starting work on the High Force Cross-Cut (Tyler 2005, 49), but access may have been gained via the open stope just upslope from the original entrance. A report of 1939 was again reportedly unable to locate the entrance (Tyler 2005, 51).

Description (Figure 5)

Although Level 4 is accessible on foot, with considerable effort, up the natural gulley which runs steeply upwards from Level 3, the supply of materials and heavy tools to the working must have been intolerably difficult from the outset. As Tyler (2005, 17) notes, this may well have prompted the construction of the first incarnation of the circuitous track that ascends the southern side of the Coledale Valley, referred to in the 1999 report as Track 12. Track 15, which gives access to Level 4 from above and probably represents a virtually unmodified section of the original track, is little better defined than a sheep-track, consistent with the occasional use of pack-ponies to bring up heavy items over the three-year period that the level was worked. However, the fact that the track is traceable across the outwash gulley from Level 5 indicates that it remained in occasional use after the abandonment of Level 4 and well into the 20th century, presumably as short-cut to the High Force Cross-Cut for miners who ascended the natural gulley on foot.

The entrance to Level 4 is blasted 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 an opening 1.0m wide and 0.4m high has been made at the top of the original arch-shaped portal, probably by mining enthusiasts 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 natural gulley below, along which ore extracted from the level could have been swept downslope by water.

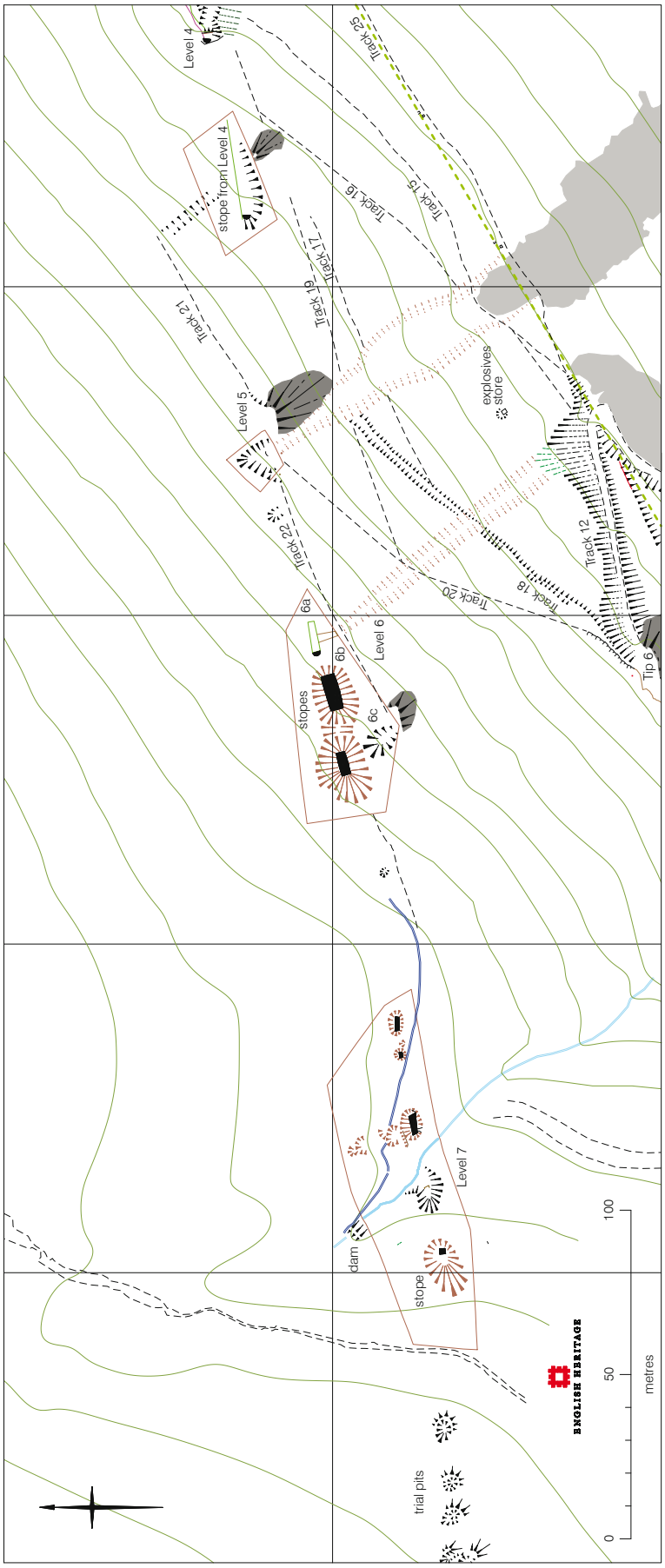

Figure 5. Extract from English Heritage plan showing Levels 4, 5, 6 and 7 (reduced to 1:2000 from original survey at 1:500)

To the east of the entrance of the level, a narrow ledge varying from 0.9m to 1.8m in width has been blasted into the steep face of the natural outcrop, apparently primarily to extract the mineral vein exposed on the surface. The surface of the ledge is now somewhat uneven, but its width suggests that it may have carried a short length of the tramway serving the level. Several sparse patches of 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 from this ledge.

Upslope from the entrance on the line of the vein, a 30m-long cutting up to 4m deep, partly filled with rubble but still open at its west end, represents the blocked mouth of a stope driven up from Level 4. A small spoil heap mid-way along the side of the cutting suggests that some work was done on the surface before the stope was completed. Indeed, the constant gradient of Track 16, which appears to be connected with this minor working, suggests that some ore may have been taken out at this point and removed via Tracks 16 and 12, presumably early in the three-year period that the main Level was worked.

Level 5 (The Barytes Level) NY 19349 21619; 559m (1833 feet) AOD

History

Level 5 was begun in 1867 and by 1869 had been driven to a depth of 100 yards. In 1870, 442 tons of barytes from Level 5 were milled and sold, but in August 1872, a 10ft wide vein of barytes was struck, leading to a dramatic rise in production. However, in 1878 the price of barytes began to fall and the market collapsed further in the following year. The winter of 1878-9 was severe and there is no evidence that any barytes ore was produced between then and January 1881, when the New Force Crag Mining Company Limited went bankrupt. Any internal fittings, such as tram rails, were probably removed when the mine was asset-stripped in January 1882 (Tyler 2005, 28-31). A report on the condition of the mines in that year recorded that the entrance was blocked (Tyler 2005, 30). In 1928, the newly formed Derwent Fells Mining Company is known to have carried out explorations in this level prior to starting work on the High Force Cross-Cut (Tyler 2005, 49), but access may have been gained via a shaft rising to Level 6, since a report of 1939 was again unable to locate the entrance to Level 5 itself (Tyler 2005, 51). During the Second World War, under Tampimex Oil Products Ltd, stopes driven up from the High Force Cross-Cut intersected with Levels 5 and 6, making the entrances to both these levels redundant (Tyler 2005, 55).

Description (Figure 5)

Since a minimal quantity of overburden had to be removed before solid rock was reached, the entrance of Level 5 is relatively inconspicuous and associated with a fairly modest tip of spoil. Only the upper edge of the mouth of the tunnel is now exposed, the remainder being choked with rubble. The identification of this as the entrance is confirmed by comparison of the field remains with the setions through the underground workings (see Figure 2). Much more conspicuous is a broad outwash channel, eroded to a maximum depth of 0.6m, which extends downslope from the mouth of the level. This appears to have been created by regular deluges of water, presumably brought about

by surface run-off flowing into the open stopes rising from Level 6 and descending into Level 5 via the shaft that had connected the two levels by1877. The fact that the water did not flow out through one of the lower levels implies that the erosion must have taken place before the Second World War, when stopes driven up from the High Force Cross-Cut intersected with Levels 5 and 6, which would have allowed water to descend to lower levels. This is confirmed by aerial photographs of January 1947, which show that the outwash channel had reached its present extent by that date (RAF 1947).

Tyler (2005, 22-3) suggests that the slushing channel that undoubtedly served Level 4 was extended further up the slope to serve Levels 5 and 6, using 'flumes' (wooden channels). The absence of any convincing physical trace of this arrangement could perhaps be explained away if the flumes rested lightly on the surface, as they almost certainly would have done, but there are three more convincing possibilities. First, and most obviously, ore may have been taken down Track 20, which gave direct access to the entrance of Level 5 (as well as to Level 6 via Track 22), presumably using pack-ponies to carry the ore. Track 20 is fairly worn, but possibly partly because it gave access to Level 6. A second possibility is that ore may have been sent down a chute along the line of the outwash channel to be collected at the upper end of Track 18, which does not continue east of the outwash channel and must therefore have terminated directly downslope from the mouth of Level 5 (it also intersected at this point with a minor path Track 19, presumably used only for ascent on foot). Tipping downslope would have had the advantage over the more direct route represented by Track 20 of reducing the effort involved in loading the panniers by harnessing gravity. Track 18 is the most worn of all the tracks that served Level 5, strongly suggesting that it was the primary route used for descent. The third possibility is represented by Track 21, which leads gently down from Level 5 apparently to a terminus directly above the open stope above Level 4. Indeed, the gradient is gentle enough that it could have been intended as a continuation of the tramway within Level 5 and the track is slightly wider than minor footpaths such as Tracks 17 and 19, suggesting that it could have been used as a tramway. Such an extension of the tramway within Level 5 would have allowed ore to be tipped down a chute at the end of Track 21 into bogies waiting beneath in Level 4 and then moved into the Slushing Channel along with ore brought out from Level 4 itself. A slight depression may mark the line of such a chute, although it could conceivably be of natural origin; equally, the evidence that Track 21 was used as more than a footpath is not overwhelming.

At face value, the simultaneous use of three different transportation mechanisms seems highly unlikely, but, taken as a whole, the physical evidence is consistent with the documented history of Level 4, 5 and 6. It seems plausible that Track 20 or the route formed by Track 21, Level 4 and the Slushing Channel may initially (after 1867) have provided the means of transporting the ore to the valley floor, but that this might have proved too inefficient after Level 4 ceased to produce ore in about 1870, or after Level 6 began to produce ore in 1873. The completion of the shaft connecting Level 5 with Level 6 in the mid-1870s would have introduced additional handling stages into an already extended chain, so by this time, if not before, it would certainly have been more efficient to use pack-ponies descending from Level 5 via Track 18 and Track 12: a longer route but one with fewer transfers.

Trial pits on Sand Hill (Figure 5)

The westernmost of a series of five closely-spaced trial pits on the south-eastern slope of Sand Hill lies at NY 19012 21559, at an altitude of 644m (2050 feet) AOD. These were dug along the line of the vein in 1869 or shortly after (Tyler 2005, 20). They extend to within 150m of the parish boundary, which corresponded to the edge of the mining 'sett'. A few other minor trials were dug at irregular intervals between Levels 5 and 7, probably also in the 1860s.

Level 6 NY 19298 21607; 574m (1883 feet) AOD

History

Level 6 was begun early in 1873 and seems to have continued in use until at least 1877, by which date a shaft in its floor had reached Level 5, some 15m beneath (Tyler 2005, 28). It may have continued in use to some degree until January 1881, when The New Force Crag Mining Company finally went bankrupt. A report on the condition of the mines in 1882 recorded that the entrance was blocked at that date (Tyler 2005, 30). In 1928 the newly formed Derwent Fells Mining Company is known to have carried out explorations in the level prior to starting work on the High Force Cross-Cut (Tyler 2005, 49), but it is possible that access was gained through the open stope upslope from the entrance. A report of 1939 recorded that Level 6 extended east and west (Tyler 2005, 51), which perhaps indicates that the author had confused it with the High Force Cross-Cut. During the Second World War, under Tampimex Oil Products Ltd, stopes driven up from the High Force Cross-Cut intersected with Levels 5 and 6, making their entrances entirely redundant (Tyler 2005, 55).

Description (Figure 5)

The original entrance to Level 6 was presumably the rock-cut passage on the line of the vein (labeled Level 6a on Figure 4), since this would have been the simplest and most efficient approach. This entrance seems to have been supplemented almost immediately by two short cross-cut adits (6b and 6c). Level 6b is a narrow, roofless passage 6m long, cut into solid rock to reach the line of the main adit, with a negligible quantity of associated spoil. A pronounced outwash gulley, similar to but smaller than that associated with Level 5, has formed downslope. As with Level 5, aerial photographs of January 1947 show that the outwash channel had reached its present extent by that date (RAF 1947). Level 6c was driven for approximately 20m through loose overburden (which has subsequently collapsed and completely choked the cutting), producing a moderately large spoil tip. Track 22, which connected the original entrance 6a to Level 5, and was evidently later extended westwards to serve 6c, is very slightly worn (much less than Track 20), suggesting that it was not used intensively for the removal of ore. After the completion of the shaft descending from Level 6 into Level 5, ore could have been removed most efficiently by tipping the ore down the shaft into bogies waiting below, so that the output of Levels 5 and 6 was combined. This could well explain the angle change at the base of the shaft (recorded on section drawings through the underground workings; see Figure 2), which would have broken the descent of the tipped material before it fell into the bogies. However, the shaft was not completed until some years after Level 6 was

begun, begging the question as to how ore was removed prior to that date, if not along Track 22. Perhaps the most plausible theory is that the two short cross-cuts (Levels 6b and c), whose purpose is otherwise difficult to explain, were dug to bring the ore out perpendicular to the slope and then tip it down chutes to be collected on Track 20. It could be argued against this that the descent from Level 6c would have been excessively long for this to have been effective; and neither of the putative chutes has left any surface trace, but this is not necessarily surprising if each was made of timber and used only briefly.

The open stope enclosed within the same fence as Levels 6a, b and c may well have reached the surface in the 1870s, since similar stoping was certainly completed at that time in Level 4. The section drawing made in August 1940 shows that it was in existence by the time Tampimex began work, but it was enlarged during the Second World War, as both the undated section drawing made by Tampimex and aerial photographs of January 1947 show. The section drawing made by McKechnie Brothers in about 1967 suggests that the stope had been massively enlarged again by that date, but the surface remains suggest that the Tampimex drawing is a more accurate reflection. This probably reflects the fact that McKechnie Brothers were more concerned with the workings below the High Force Cross-Cut. A series of open stopes further west along the line of the vein towards Level 7 result from the work undertaken by Tampimex during the Second World War (Figure 6).

Figure 6. View from the west of open stopes east of Level 7, rising from Level 6 and deeper.
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The High Force Cross-Cut NY 19237 21475; 521m (1710 feet) AOD

History

Surface activity at the High Force Cross-Cut falls into two main phases. In 1929, after explorations in Levels 4, 5 and 6, the newly formed Derwent Fells Mining Company began to drive the level approximately perpendicular to the vein (hence the term 'cross-cut') to intersect with it deep underground. The cross-cut progressed 146m before a small thread of barytes was encountered, but calculations suggested that this was not the main vein, so it was driven forwards a further 14m to a point where, in 1930, a wide seam of barytes was exposed (Tyler 2005, 49). In 1930, 1,750 tons of barytes were extracted, and the figure reached nearly 3,000 tons in 1932-3. In 1933, however, possibly because of the imposition of a new 10% duty on barytes, production abruptly ceased, by which date about 5000 tons (4921 metric tonnes) had been extracted.

The second phase began six years later, in 1939. Under Tampimex Oil Products, extraction again focused on the High Force Level, and by 1946 in excess of 30,000 tones of ore had been extracted. The aerial ropeway, completed in 1941, must have been a key factor in achieving such impressive production (see Section 4), but lorries were used when the ropeway was not working properly, particularly during winter months. However, the harsh winter of 1947 put the mine out of action for six weeks and caused severe flooding, particularly in the Low Force Workings. This, together with the drop in demand for barytes that had accompanied the end of the War, forced Tampimex to surrender their lease at the start of 1948, despite the huge infrastructural investments they had made. With this, regular activity above ground at the High Force Workings ended.

Figure 7. View from the south of the setting of the entrance to the High Force Cross-Cut.
© English Heritage 2007, NMR reference DP054868.

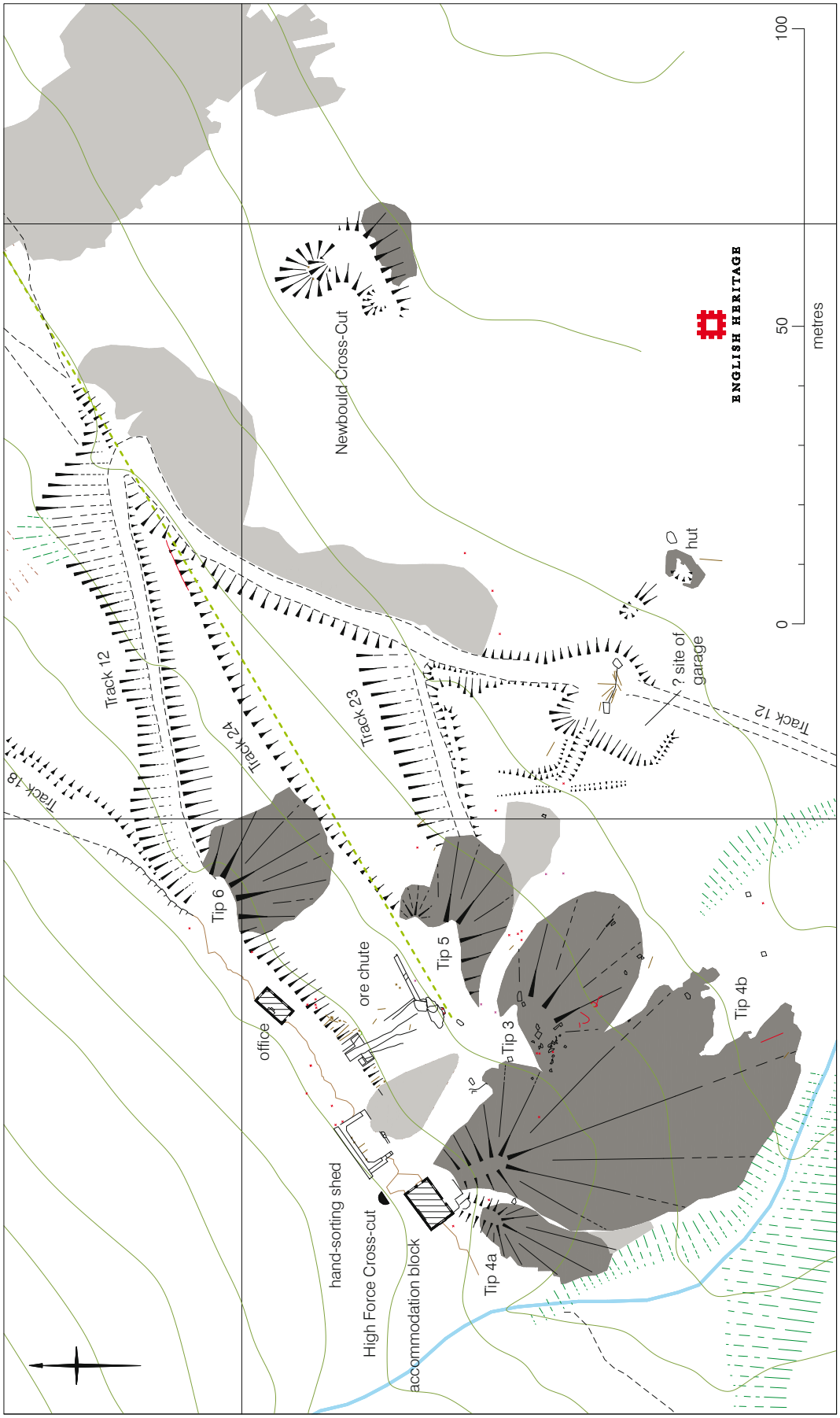

Figure 8. Extract from English Heritage plan showing High Force Cross-Cut and associated features (reduced to 1:1000 from original survey at 1:500)

Description (Figures 7 and 8)

The entrance to the High Force Cross-Cut is cut into solid rock, the mouth of the tunnel measuring 2.0m square. On abandonment, it was blocked 8m underground by a gate that has been deliberately broken, probably in recent years by mining enthusiasts. The spoil produced from the 160m-long drive required to reach the mineral vein was tipped immediately to the south of the mouth of the level to form two large 'finger-dumps', labeled Tips '4a' and '4b' on Figure 7. Both tips stratigraphically predate the construction of a building interpreted as an accommodation block (see below), supporting the inference that this was built as part of the later phase of activity. The rails of the tramway that served the level from its inception in 1929 until at least 1946 have been removed, at an unknown date. However, a few bent rails are still scattered across the tip downslope, suggesting that the other rails may have been taken for re-use elsewhere, rather than for scrap. In the second phase of its use, between 1939 and 1947, the tramway evidently curved north-eastwards from the entrance of the level, first running across the frontage of the hand-sorting shed, then over a hopper at the head of an ore chute that supplied the loading station of the aerial ropeway, and then for at least 35m further north-eastwards to a spoil tip (Tip 6).

Predictably, the arrangement in the earlier phase of activity is much less easy to interpret. Tyler (2005, 51) confesses uncertainty as to how ore was initially transported down to the main mill at the Low Force Workings, concluding that it was probably by lorry. While Track 12 must have made up the majority of the route taken, it seems doubtful that the lorries available around 1929 could have managed the numerous steep ascents and descents required to transport the 5,000 tons of ore known to have been extracted. Track 23, on the evidence of its form and stratigraphy, must have been one of the earliest routes associated with the Cross-Cut; it is partially buried beneath Tip 5, which is apparently associated with the construction of the aerial ropeway terminus, which took place in about April 1941. Track 24 may have been the route along which ore was actually removed, but the form of this track was certainly modified during the Second World War to allow its use by lorries. Track 23, which did not undergo any later modification, is relatively narrow and steep, suggesting that pack ponies are more likely than lorries to have been used in the early 1930s. The existence of Tracks 18 and 20 indicates that the entrance to the Cross-Cut could have been reached from a higher point on Track 12; indeed, it is almost certain that the shelf which now provides access was blasted in 1929. However, this route is unlikely to have been used for the removal of ore because it would have been necessary to raise the material from the floor of the hand-sorting shed – an inefficient handling stage - regardless of whether ponies or vehicles were used.

Tracks 23 and 24 never ascended to the same height as the Level itself, but appear to have terminated, as far as can be discerned, more-or-less directly downslope from the hand-sorting shed. It therefore seems likely that a chute, similar in essence to the extant one, was used to move ore down to a loading area with the assistance of gravity. Tip 3, which is markedly more overgrown than Tips 4, 5 and 6, appears to be contemporary in origin with Track 20 and to result from the construction of a level area at the top of the track. The only possible surviving remains of the supposed chute are a short length of curving drystone wall, almost entirely buried in scree, topped by fragments of a steeply pitched roof-like structure, formed by a thin layer of concrete (Figure 9). The curving wall

Figure 9. View from the south-east of the fragments of the possible early chute.
© English Heritage 2007

is reminiscent of an ore bin, while the fragmentary roof-like structure could represent the lower end of the chute itself, descending from the south-western end of the hand-sorting shed. The height of the lower end of the chute could have allowed ore to be funneled directly into panniers carried by pack-ponies. Alternatively, or perhaps in addition at a different date, a similar chute may have occupied the eroded gulley below the north-eastern end of the hand-sorting shed, whose existence is otherwise somewhat difficult to account for.

Hand-sorting shed NY 19246 21479; 521m AOD (Figures 10 and 11)

An open fronted building interpreted as a hand-sorting shed appears to have been built around 1929, as part of the earlier phase of activity at the High Force Cross-Cut, mid-way along the shelf blasted into the steep hillside. The fact that the building was constructed as a lean-to against the blasted rock face indicates that this part of the shelf, at least, was created in 1929 and there is no evidence to support the theory that it was extended by later blasting. Unlike the two buildings which flank it, the walls of the hand-sorting shed are built in stone rubble with brick coigns (a few of the bricks evidently re-used from the 1909 mill buildings at the Low Force Workings). Internally, it measures 7.90m long by at least 4.6m wide, but the form of the timber roof supports suggests that the south-east side of the building was always open. The roof pitched forwards away from the blasted rock face and probably projected over the tramway. Three timber braces which would have supported the pitched roof joists still survive in situ

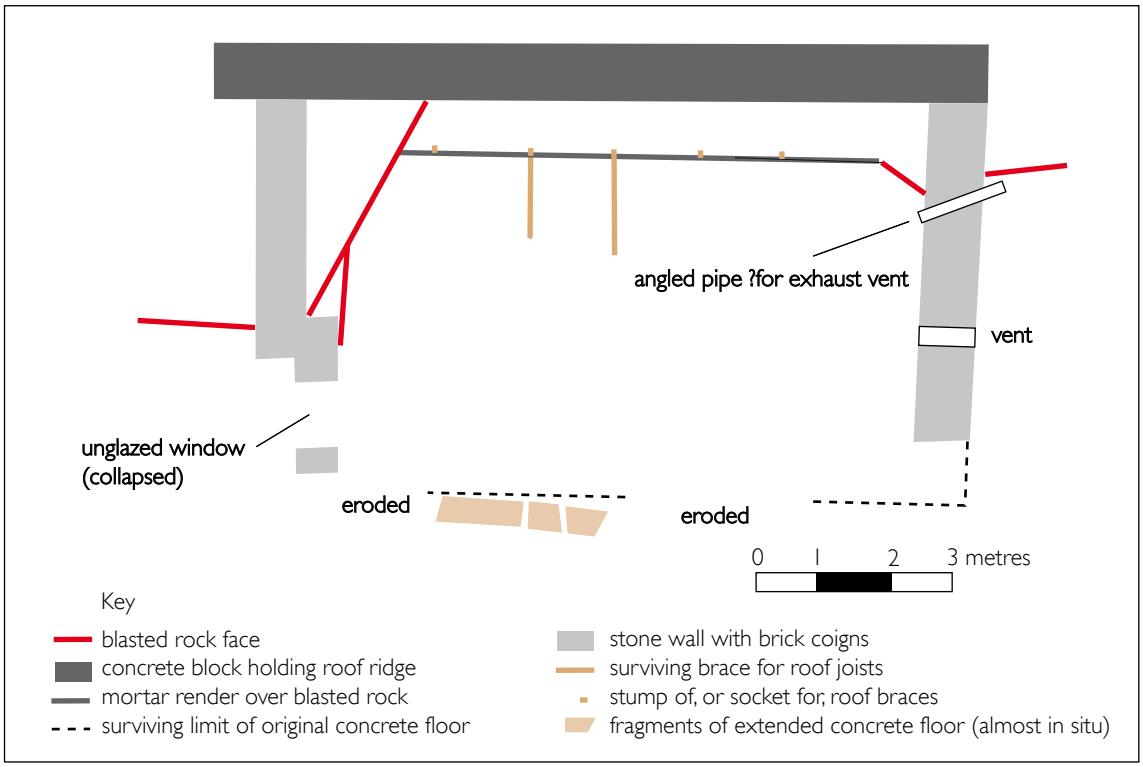

Figure 10. Plan of the hand-sorting shed at 1:100 scale

Figure 11. View from the south of the hand-sorting shed. © English Heritage 2007, NMR reference DP054874.

(the others having rotted away), while fragments of the lightweight roof covering, formed by mortar poured over steel duck-boards (possibly a replacement of the original roof), are scattered throughout the interior. In the south-western wall, an unglazed window looked towards the mouth of the level. In the earliest phase of its use, the shed may have housed a petrol-driven compressor for pneumatic rock drills in use in the Cross-Cut (Tyler 2005, 49), for an angled pipe outlet high in the north-eastern wall seems to represent the exhaust from a generator or similar. However, the shed seems to have been designed as a covered floor for sorting and perhaps dressing the ore by hand and possibly as a dry store for periods when ore was being extracted faster than it could be transported down to the Mill 3.

The building was evidently retained into the second, Wartime phase of activity at the Cross-Cut; the start of the later operation may have coincided with the extension of the floor of the building, evidenced by a floor panel of a different mix of concrete, most of which has crumbled away.

Ore hopper and chute NY 19261 21480; 520m AOD (Figure 12)

In its eventual form in the 1940s, the tramway continued north-eastwards from the hand-sorting shed across a series of timber trestles along the edge of the tip to pass over a hopper at the head of a concrete chute which delivered the ore to the loading station of the aerial ropeway. Tyler (2005, 53) states that the tramway bogies were of the end-tipping type (made by Hudsons of Leeds). Beyond the hopper, the tramway continued to Tip 6, which is fairly small, considering the documented scale of the extraction, probably reflecting the well-attested purity of the mineral seam.

Figure 12. View from the south of the ore hopper and chute. © English Heritage 2007, NMR reference DP054892.

Several of the tramway trestles, made from full rounds of young pine trees bolted together, survive *in situ* and more or less intact, while others have partially rotted or fallen. The hopper at the head of the chute, constructed of rubble and brick rendered in concrete, is largely intact, but its outer side is open. A curving steel clamp at one side of the flanking brick structure seems to have held a horizontal round timber. It is possible that this may have held the top edge of a light-weight barrier, such as metal sheet, forming the fourth side. From the hopper, the ore moved down the chute under gravity to the loading station of the aerial ropeway, which was completed at some point after April 1940. The lower end of the chute, where it rested on a 3.5m-high retaining wall 0.6m thick, built in stone and brick with a mortar render, has collapsed forward under pressure from the accumulated material upslope. However, a block holding two bolts, possibly part of a sluice-like mechanism at the mouth of the chute, is still visible, though not *in situ*. The brickwork at the north-eastern end of the retaining wall has been left toothed, apparently to allow the extension of the wall if further accumulation of spoil threatened to block the track. Presumably, the chute would have delivered ore directly into the ropeway buckets without the need for intermediate handling, and the large capacity at its lower end would have allowed it to act as a temporary store from which ore could be released at need.

The documented resumption of the use of lorries at times when the aerial ropeway was frozen up may be evidenced by what appears to be an unplanned and rather crudely executed modification of the earlier arrangement. A pair of shallow slots, roughly chiseled into the concrete cap of the retaining wall, and a pair of timber stumps the same distance apart just upslope, seem to represent the fixings for lower end of some form of relatively narrow chute, angled obliquely across the tip of spoil towards the head of the extant concrete chute. This perhaps temporarily allowed lorries to be filled without the need to dismantle the terminus of the ropeway.

The aerial ropeway

The ropeway was completed soon after April 1941 by Tampimex Oil Products and the lower part of its course was described as part of the 1999 report. From the loading station at NY 19268 21466, the ropeway descended to the head of the gulley above Level 4, passing over three pylons before falling more steeply to a mid-way station. There, it turned an acute angle and descended through the upper wing of the extant mill (Mill 3), where the buckets were emptied automatically, and on to a lower terminus. The total length of the ropeway was around 1500m (nearly 1 mile). A photograph taken at some point between 1940 and 1946 shows the loading station, which appears to consist of a low timber platform supported on trestles (Tyler 2005, 54). This concurs with the small-scale depiction on the profile drawing made about 16 August 1940 (D/Sh/Plans/40), but its exact form is nevertheless difficult to reconstruct. A number of large fragments of a concrete block downslope from the terminus seem to represent the remains of the substantial foundations that would have been required to support the winding gear and, by analogy with the lower terminus and mid-way station, an 'anchor' for the final pylon structure. These fragments are widely scattered across the slope below, suggesting that the terminus was destroyed by blasting and possibly deliberately rolled down the slope of the tip. In passing, it is worth noting that the lower terminus was destroyed in

Figure 13. View of one of the aerial ropeway pylon bases. © English Heritage 2007.

Figure 14. View of a collection of aerial ropeway cradle fragments, evidently arranged to simulate a whole unit. © English Heritage 2007.

a similar fashion; this may have been necessary in both cases to remove the salvageable equipment. A photograph taken in the late 1960s or early 1970s shows the ropeway pylons intact, as does a plan of 1972 (Tyler 2005, 96; Cumbria CRO k). They were eventually sawn down and sold for scrap, leaving only the concrete foundation blocks and in some cases the triangular steel bases of the pylons (Figure 13). A minor footpath (Track 25) approximately follows the course of the ropeway, presumably to facilitate construction and subsequent maintenance. Several fragments of the wheeled cradles from which the buckets were suspended also lie scattered downslope; two of these have been deliberately placed alongside each other so that together they represent the form of the original whole component (Figure 14). 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. Close to the edge of Force Crag, the position of one of the pylons seems to have been adjusted twice, apparently because the ground was too soft to hold the foundation blocks.

The Newbould Cross-Cut NY 19393 21486; 472m (1550 feet) AOD.

The Newbould Cross-Cut, begun in 1931, was never extended more than a few yards (Tyler 2005, 51). This may be due to the soft ground encountered at the entrance, which is now marked by a fairly amorphous scree-filled hollow. The spoil from the hollow has been pulled downslope to create a terrace extending to the west, on which, immediately to the mouth of the level, a slight scoop probably represents the point where the miners took shelter when blasting.

Level 7 NY 19126 21572; 608m (1995 feet) AOD

History

Level 7 was begun by Tampimex in about 1944 and by 1947 had been driven 82m westward along the line of the vein (Tyler 2005, 53). By that date, one stope driven upwards from the High Force Cross-Cut had intersected with the level just west of its entrance, effectively making the level redundant, both for the removal of ore and as a means of ventilation and escape. Indeed, Level 7 is undoubtedly the most inaccessible at Force Crag and there is no clear evidence that ore was ever brought to the surface through its entrance. Its main function may have been to test the upper part of the vein, for the section drawing produced by McKechnie Brothers in 1967 does not depict any workings off the level west of the stope rising from the High Force Level.

Description

The entrance to Level 7 is driven into the western side of the shallow valley carved by the Pudding Beck. The cutting is largely filled by scree, but the timber boards that reveted both sides of the lower end of the passage are partially exposed. The open stope immediately upslope and to the west of the entrance rises from the High Force Level and cuts through Level 7. Aerial photographs taken on 19 January 1947 indicate that the deep erosion cone around the mouth of the stope has broadened considerably since that date; it seems to be closer to today's dimensions a decade later (RAF 1947; 1957).

This may indicate that much of the erosion was a direct consequence of the six weeks of severe winter conditions that began on 21 January 1947, at which time the mouth of the stope would have been freshly cut and therefore most susceptible to rapid erosion.

Some 20m north of Level 7, a low earthen dam seems to have been intended to divert the entire flow of Pudding Beck, which at this point is a tiny stream for most of the year, into a leat and carry it eastwards for at least 100m to an indeterminate point. The principal purpose of the leat may have been to carry water away from the mouth of Level 7 and the open stopes to the east, for Tyler (2005, 54) notes that after rainfall, water streaming through the workings was a constant problem.

Accommodation block NY 19235 21468 (Figures 15 - 17)

Immediately to the west of the entrance to the High Force Cross-Cut is a single-room flat-roofed building, 4.20m by 7.00m internally, constructed entirely in reinforced concrete, using steel tramway rails and various other scrap as reinforcing rods. The south-western end of the roof has partly collapsed and its condition looks set to deteriorate further, primarily due to the rusting of the reinforcing rods within the concrete. The yellowish tinge of the concrete is similar to that of the material on Tip 4b, probably indicating that crushed waste material from the tunnel was used to make the concrete. Tyler (2005, 52) interprets this as a 'compressor house', containing a generator and compressor for pneumatic rock-drills in use in the mine. This interpretation is not consistent with the form of the building, which strongly suggests an accommodation block, although admittedly without any evidence for artificial lighting, or for toilet and washing facilities. The building has two doors, one facing east towards the mouth of the level and the other facing south onto a broad concreted 'terrace', which runs the length of the building. There are two large windows in the south-east wall and one in each end wall, all of which were originally glazed; the provision of these is strong evidence

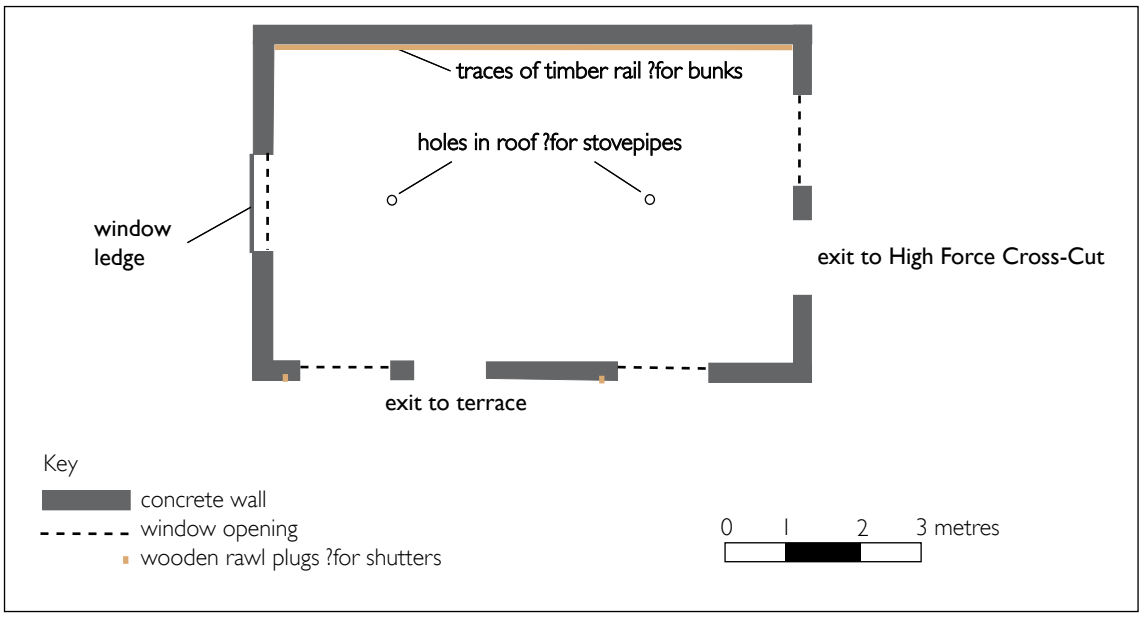

Figure 15. Plan of the probable accommodation block at 1:100 scale.

Figure 16. View from the east of the exterior of the probable accomodation block.
© English Heritage 2007, NMR reference DP054873.

Figure 17. View from the east of the interior of the probable accomodation block.
© English Heritage 2007, NMR reference DP054872.

that the room was intended to provide accommodation. The two south-east facing windows may have had external shutters, for there are two wooden rawl plugs to the left of each window opening. The building is poorly insulated, but the absence of heating, which might argue against its interpretation as an accommodation block, may be more apparent than real. Two holes in the roof, placed centrally and symmetrically towards each end of the room, may have allowed stove pipes to exit. Fragments of coal cinders were noted on the tip nearby. The walls of the building were white-washed internally, which is further evidence that the room was less utilitarian in nature. Although it is clear that timbers were fastened to all the internal walls of the buildings, most of the traces are not diagnostic of particular fittings. A timber rail 1.8m above floor level evidently ran the length of the rear wall, its existence now marked by a line of wooden rawl plugs and a strip of wall without white-wash; this may have held the upper frame of bunk beds.

Office NY 19268 21494 (Figures 18 - 20)

Towards the north-eastern end of the shelf blasted for the High Force Cross-Cut is a well-preserved single-room building with a flat roof, constructed out of identical concrete to the accommodation block described above. According to Tyler (2005, 51-2), the miners used this as 'a place to eat their bait', but the form of the building suggests that the building served primarily as a Foreman's office for the High Force Workings. The single room was only 5.40m by 2.45m internally, with doors in both end walls facing east and west. The walls were whitewashed internally; there were wooden fixtures (including shelves) on the walls, and the room was heated by a home-made range stove on the rear wall. Two large windows in the south facing front wall were originally glazed. A portion of a painted steel door, whose size does not correspond to any of the surviving openings, has been used as a shutter to block one of the windows, presumably in around 1967. A line of small holes drilled through the east wall above the door suggest that the building may have had electricity and perhaps may have been served by a telephone, presumably allowing communication with the main Office at the Low Force Workings.

A photograph of the late 1960s or early 1970s shows a hippy who lived briefly in the building. presumably over the summer months (Tyler 2005, 96). The northern wall still bears traces of faded patches of red and green paint, possibly depicting a suburst.

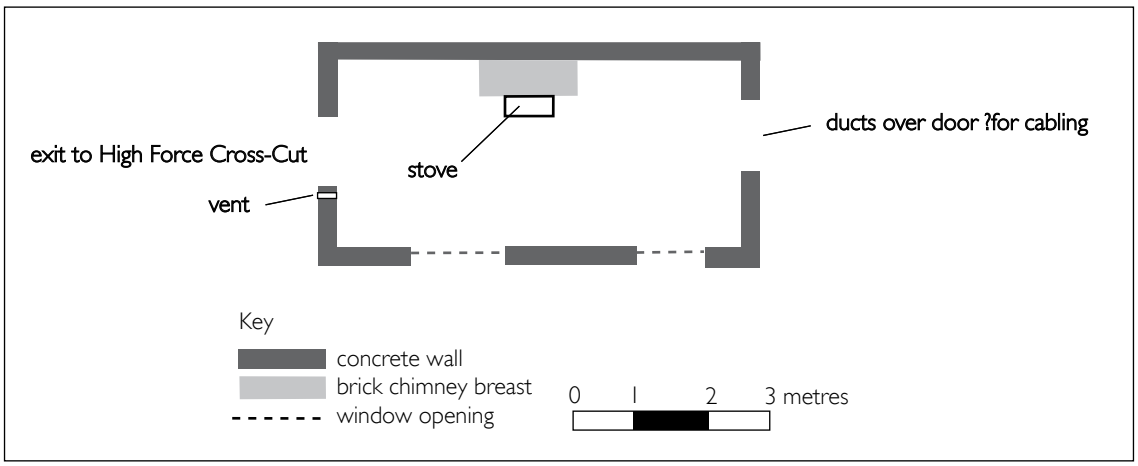

Figure 18. Plan of the probable office at 1:100 scale.

Figure 19. View from the east of the exterior of the probable office.
© English Heritage 2007, NMR reference DP054878.

Figure 20. View from the west of the interior of the probable office.
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Explosives Store NY 19362 21548 (Figure 21)

On the fell side, some 150m north-east of the entrance to the High Force Cross-Cut, stands a small chamber built of brick with a cast concrete roof, measuring 1.0m long by 0.7m wide by 0.8m internally. The chamber is now open on the downslope side, but appears to have had a wooden door. It is typical of a store for gelignite, both in terms of its form and its remoteness from the main areas of activity. Thick roofs, which were not a characteristic of dynamite stores, were necessary to maintain a more constant temperature, since temperature fluctuations caused gelignite to become unstable.

Possible garage NY 19317 21437

A level platform cut into the slope adjacent to Track 12 seems to be the site of a building some 15m long by 6m wide. Though the platform itself is clear on aerial photographs taken in June 1957, no building was standing at that date; nothing can be discerned on 1947 images because the area lay in heavy shadow (RAF 1947; 1957). The fact that nothing survives of the building suggests that it was lightly constructed, such as an open-sided shed serving as a garage or a store. A number of long pine posts lie nearby, where they have evidently been re-used in recent years, in conjunction with a tumbled fragment of the aerial ropeway terminus, to construct a framework for a temporary shelter. These timbers may originally have supported the walls or roof of Building 7, although they are also similar in form and size to those used to construct the trestles that carried the tramway serving the High Force Cross-Cut. A narrow gulley leads into the rear of the platform from upslope; this may be a pipe trench although its exact function is unclear.

Figure 21. View from the east of the explosives store © English Heritage 2007

3.2 Other remains

Peat extraction

Track 12 post-dates a large peat cutting in the low-lying ground west of Force Crag. The English Heritage survey in 1999 identified peat cutting further south in close proximity to a large dam (Dam 1) across the Coledale Beck; while some of the turfs had evidently been used in the construction of the dam in about 1839, the suspicion remained that some of the peat cutting might be earlier. In upland regions where timber was sparse, peat was used as fuel for smelting lead up until the 19th century, so it is possible that the extraction relates to the mining operation, but it is also possible that it was cut for use as domestic fuel. As noted in the 1999 report, the peat deposits in this area appear to represent a potentially important palaeo-environmental resource, since large fragments of waterlogged organic material are exposed in many places around the edges of the cutting.

Stone quarrying

A short, poorly defined, narrow track branching off Track 12 seems to have been intended solely to give access to rock outcrops which have been superficially quarried. Given the abundance of stone elsewhere, it is most likely that the stone was intended for use nearby and probably downslope. The enlargement and extension of Dam 1, which may have been begun in about 1912, offers one plausible context. However, since the track associated with the quarry seems to have been used by lorries, which do not seem to have been used to reach the High Force Workings until the 1940s, it is more likely that the quarry was the source of the stone used to construct drainage conduits and revetments for Track 12, particularly where it passes through the waterlogged peat cuttings described above.

Shielings

A small shieling, comprising a possible temporary dwelling with an adjoining sheepfold, all formed by crudely built dry-stone walls, stands at the foot of the steep slope to the west of the High Force Workings at NY 19314 21292. The First Edition Ordnance Survey map shows that it was constructed before 1861 and it may be of considerably earlier origin (Ordnance Survey 1862). It is one of several sheepfolds scattered around the head of the Coledale Valley and its proximity to the mine is not significant.

The footings of a small drystone bothy, overgrown and not easy to discern, lie immediately downslope form the High Force Workings at NY 19342 21426. The condition of this structure suggests considerable antiquity, but its form is not diagnostic of any particular period. Its isolation suggests that it may have been a shepherd's hut, but similar structures are increasingly recognized as being characteristic of the temporary dwellings of early miners.

4. CONCLUSIONS

Although activity at the High Force Workings continued sporadically until 1967, the origins of most of the surface remains relate to three distinct campaigns of work earlier in the life of the mine. These are:

1867 – 1881, under The New Force Crag Mining Company Ltd;

1929 – 1933, under The Derwent Fells Mining Company Ltd;

1939 – 1946, under Tampimex Oil Products Ltd;

The remains relating to the 19th century activity are more remarkable for their inaccessibility than for their scale or quality; the principal point of interest is the means by which ore was transported down to the mill on the valley floor. Although the evidence is not clear-cut, it would seem that the sequence of handling stages originally envisaged by the New Force Crag Mining Company was quickly thwarted by the disappointing three-year duration of production in Level 4. After 1870, the Company seems to have retained the approach of tipping downslope for more efficient loading at the lower end, which had at first served for the delivery of ore from Level 5 into Level 4, but with pack ponies replacing the sequence of tramway and slushing channel. This less elaborate solution must have been both more reliable and less costly in terms of labour, since the job of leading the ponies would not have required the involvement of a skilled adult worker.

The remains dating to the mid-20th century, though individually unexceptional, are more significant as a group. Tyler has characterized the underground incline begun by La Porte in 1949 as 'one of the most ambitious mining operations in the Lake District' (Tyler 2005, 64-5). While this is undoubtedly true, the statement perhaps underplays the sheer scale of the investment in surface infrastructure put in place by Tampimex Oil Products Ltd during the Second World War. The aerial ropeway completed soon after April 1941 has been implicitly characterized as a 'white elephant', with attention focusing on its failure to operate during freezing conditions. While this unanticipated difficulty seems to have forced some makeshift modifications on the arrangements for loading ore at the High Force Workings, the importance of the ropeway's contribution to the processing of nearly 35,000 tons of barytes over a six-year period should not be underestimated. The original plan to extend the ropeway to Braithwaite railway station (Tyler 2005, 53), which was contemplated sufficiently seriously for preparatory work to be undertaken at the ropeway's mid-way station, would have been an even more extraordinary achievement. A ropeway of this period survives in operation at Claughton, in Lancashire. Furthermore, the 'proposed cross-cut for future development', shown on the section drawing of August 1940, was effectively a more ambitious forerunner of the La Porte incline, indicating the grandeur of Tampimex's early aspirations.

5. METHODOLOGY

The measured survey was carried out principally using Trimble differential survey-grade GPS, capturing a level of detail suitable for reproduction at scales up to 1:500. The buildings and some of the other remains in the lee of the blasted rock face were surveyed using a Trimble 'Total Station' Theodolite, from two stations established on high ground to the south. The remaining details of the buildings were supplied with tape measures using standard graphical techniques. The resulting plan was plotted at 1:1,000 scale, with windows at 1:200, via Geosite and AutoCAD software.

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APPENDIX 1. NMR NUMBERS ATTACHED TO THE SURVEY

Level 4 NY 19476 21637 NY 12 SE 19

Aerial ropeway NY 1992 2157 NY 12 SE 22

Level 5 NY 19349 21619 NY 12 SE 36

Level 6 NY 19298 21607 NY 12 SE 37

Trials on Sand Hill NY 19012 21559 NY 12 SE 38

High Force Cross-Cut NY 19237 21475 NY 12 SE 39

Newbould Cross-Cut19393 21486 NY 12 SE 40

Level 7 NY 19126 21572 NY 12 SE 41

Hand-sorting shed NY19246 21479 NY 12 SE 42

Ore hopper and chute NY 19261 21480 NY 12 SE 43

Accommodation block NY 19235 21468 NY 12 SE 44

Office NY 19268 21494 NY 12 SE 45

Explosives store NY 19362 21548 NY 12 SE 46

Possible garage NY 19317 21437 NY 12 SE 47

Sheepfold NY 19314 21292 NY 12 SE 48

Sheepfold NY 19342 21426 NY 12 SE 49

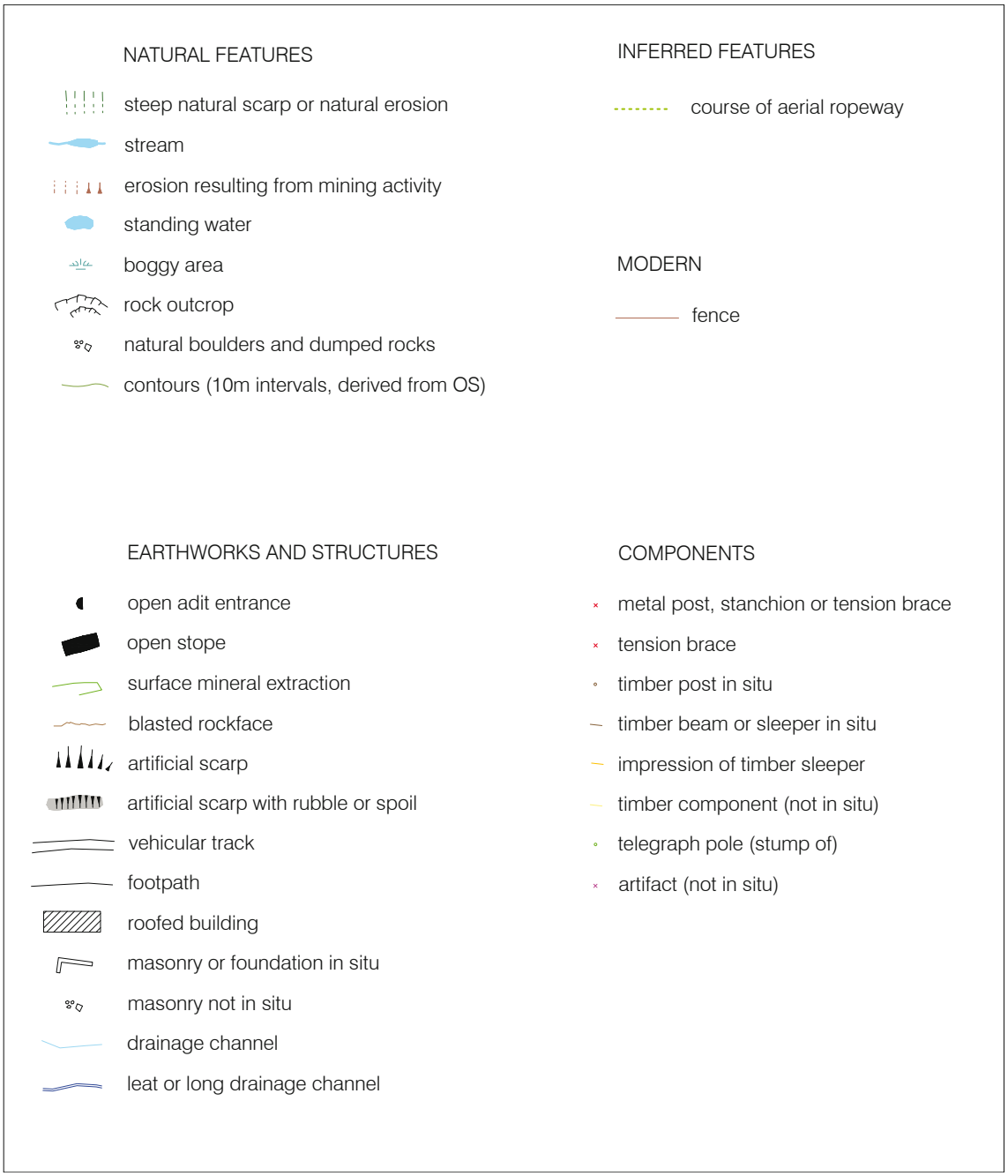

Figure 22. Key to English Heritage plans of Force Crag Mine

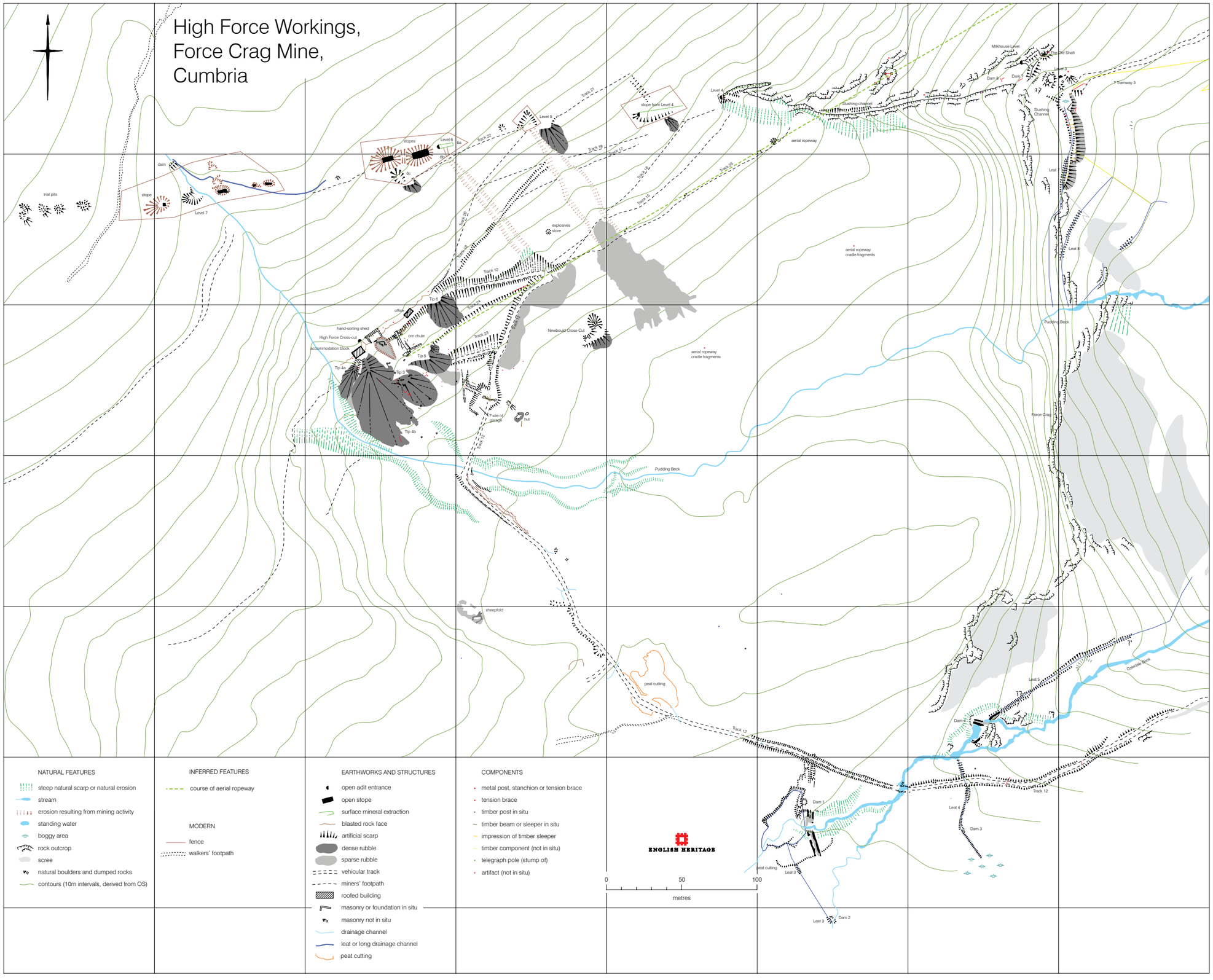

Figure 23: English Heritage plan of the High Force Workings






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