NAA

ARCHAEOLOGICAL SURVEY

NENTHEAD MINES,

NENTHEAD,

ALSTON, CUMBRIA

on behalf of

Cumbria County Council

NAA 13/130
February 2014

NAA

ARCHAEOLOGICAL SURVEY

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NENTHEAD MINES, NENTHEAD,

CUMBRIA

ARCHAEOLOGICAL SURVEY AND MANAGEMENT PLAN

Summary

Northern Archaeological Associates Ltd (NAA) was commissioned by Cumbria County Council, with the support of Natural England, to undertake an archaeological survey of land at Nenthead Mines, Nenthead, Cumbria (NGR NY 7865 4325). The survey was undertaken to inform a management plan for the site, which looked at threats to the identified archaeological resource and established mitigation measures for its preservation (Countryside Consultants 2013). The project area comprises a lead mining area and Scheduled Monument covering 48 hectares.

Mining at Nenthead is likely to date from the 17th century or earlier, but there are no surviving records of specific mines in this area at this time. The first systematic exploitation of Alston Moor commenced in the early 17th century, when the estate passed to Sir Francis Radcliffe, Earl of Derwentwater, in 1618. The mines were reported as exhausted, and the Radcliffes encouraged the systematic development of the mines, with an increase in production from the late 17th century; the first vein known to have been exploited at Nenthead was the Rampgill Vein, from 1692.

In 1716, Sir James Radcliffe was beheaded for his part in the Jacobite uprising in the previous year, and the estate passed to the Crown. In 1735 the Alston Moor estate was granted to the Royal Hospital for Seamen at Greenwich in London. Greenwich Hospital leased out mines on the moor, with one of the major lease-holders being George Liddle, who began working at Nenthead from 1736, and built the first smelt mill. Liddle was not successful, and in 1745, the leases were taken on by the London Lead Company (as it was known colloquially). The company successfully developed and modernised the mines, becoming the largest employer in the area, and also built social and welfare facilities for the miners and their families. The greatest period of production was between 1780 and 1820, but by the early 19th century, cheaper foreign imports began to damage the industry, leading to the ultimate end of lead mining by the early 20th century.

The London Lead Company gave up its leases in 1882. Between 1882 and 1896, the mines were run by the Nenthead and Tynedale Lead and Zinc Company, who struggled in an increasingly volatile market. From 1896, Vielle Montagne Zinc Company of Belgium took up the Nenthead leases for 42 years, concentrating on producing concentrates of zinc and lead from both mined ore and the reprocessing of spoil dumps. The company were very successful, and modernised the mines, using traction engines and locomotives for haulage, and modernising the washing floors. The miners used rock-drilling powered by hydraulic compressors, and acetylene torches replaced candles. In the Second World War, the mines were cut off from their head office by the Nazi occupation of Belgium, and the works were requisitioned by the Ministry of Supply. Following the war, the mines were worked by the Anglo-Austral Mining company (from 1949), and then by a series of small

concerns, who were mainly interested in the reprocessing of spoil heaps rather than undertaking further mining. By the 1970s, activity at the site had largely ceased, and the smelt mill and other buildings were systematically destroyed.

Within the project area, eight separate areas were identified for detailed research and survey. These comprised the smelt mill, and its associated flue and chimney, as well as the Stagg Condenser, which lies just north of the mill. Features related to two separate dressing floors at Rampgill and Smallcleugh mines were also examined (as well as the portal entrance of Rampgill mine itself). The culvert at Rampgill Burn was also examined; a second culvert at Smallcleugh was also added after the project had begun.

This report presents the results of this study and the significance of archaeology within the different areas examined, as well as limited recommendations for future survey and excavation work.

Acknowledgements

Northern Archaeological Associates would like to thank: David Rawle, Cumbria County Council; Tom Gledhill and Frances Fewster, Natural England; Peter Jackson and Sheila Barker, Nenthead Mines Conservation Society; Peter Kempsey and Tracy Perfect-Reid, Countryside Consultants; Andrew Davison, Caron Newman and Dave Went, English Heritage. Dr. Brian Young provided the section on geology and I am grateful for his time in providing this.

Project No: 1157
Report Author: Matthew Town
Mapping/Illustration: Cath Chisman
Editing: Richard Fraser and Tania Simpson

NENTHEAD MINES, NENTHEAD,

CUMBRIA

ARCHAEOLOGICAL SURVEY

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1.0 INTRODUCTION

1.1 Northern Archaeological Associates Ltd (NAA) was commissioned by Cumbria County Council, with the support of Natural England, to undertake an archaeological survey of land at Nenthead Mines, Nenthead, Cumbria (NGR NY 7865 4325). This work comprised a desk-based study, and a detailed topographic and buildings survey, aimed at identifying and preserving the heritage significance of the site through archaeological record. The work was undertaken in accordance with specifications supplied by Natural England (Gledhill 2013) and English Heritage (Andrews 2013), and a methods statement prepared by NAA (NAA 2013). The aim of the archaeological survey was to help inform a wider Management Plan being undertaken by Countryside Consultants (2013), which includes a structural assessment, wildlife habitat survey and a general conditions assessment, and is intended to inform the development of a long-term management strategy for the site.

1.2 The following document focuses on the surviving archaeological evidence of the mines, placing *in-situ* features within their functional context and discussing the potential preservation of any sub-surface material. This is intended to facilitate a better understanding of the nature, form, extent and significance of the site and inform an integrated strategy for the future management of the complex. An illustrated site inventory of all archaeological features can be found at the end of this report (Section 9). The results of the survey and evaluation have been used in the preparation of the Management Plan (Countryside Consultants 2013).

Project Aims

1.3 The principal aim of the project was to produce a Management Plan for Nenthead Mines. The formulation of the Management Plan is underpinned by an archaeological survey of the site, the purpose of which was to provide an archaeological record of the site in order to mitigate against any potential future loss of understanding. In turn, this would inform an assessment of the long-term risks facing the site and the development of a phased management strategy. To achieve this, the following objectives were identified and met:

- to gather sufficient information to establish the extent, nature, character, condition, quality and date of the surviving archaeology within the project area and to provide an English Heritage Level 3 topographic and buildings survey of all extant features within the identified survey areas. This was intended to serve as a *'preservation by record'* archive of the features, as well as acting as a pre-intervention survey;

- to contribute to the detailed structural assessment of the condition of the standing remains, and to provide a series of recommendations on the proposed consolidation and repair;

- to assess the overall cultural significance of the site, and those aspects which contribute to that significance;

- to ascertain any risks and issues which currently threaten site significance or could become a

potential cause for concern in the future; and

- to contribute to an outline long-term management programme to work towards the 'ideal management' of Nenthead Mines.

Scope of Work

1.4 The project area comprises a 48 ha area defined by the Scheduled Monument (SM) site boundary as shown in Figure 2. Within the project area, eight separate areas were identified for detailed research and survey (Gledhill 2013), with a further section added after project commencement (Gledhill *pers. comm.*). The areas selected were as follows:

1. Rampgill Reservoir, Dowgang Hush
2. Rampgill Horse Level
3. Nenthead Smeltmill Complex
4. Smeltmill Flue and Chimney
5. Stagg Condenser Wheel Pit
6. Culvert, Smallcleugh Level
7. Powder House at Smallcleugh
8. Retaining walls, Smallcleugh Washing Floor and Dressing Mill
9. Culvert to Rampgill Burn

1.5 Significant consolidation work has already been undertaken to many of these features, but despite this, ongoing deterioration has continued, especially since the closure of the North Pennines Heritage Trust in 2011 (see below). The scope of the fieldwork element of the project was restricted to the examination and recording of the structural and earthwork features within each section, and the identification and recording of threatened areas of the monument. As part of the analysis of each section, all readily available documentary, cartographic and photographic sources were consulted, and interested parties were contacted for assistance. The examination of primary documentary sources was not required, but remains a potential source for additional information.

2.0 METHODOLOGY

Introduction

2.1 All aspects of the work were undertaken in accordance with specifications supplied by Natural England (Gledhill 2013) and English Heritage (Andrews 2013), and a methods statement prepared by NAA (NAA 2013). All methodologies were in line with current standards and guidance published by English Heritage (1999, 2000, 2006a, 2006b, 2007, 2008a, 2008b, 2010) and the Institute for Archaeologists (2008a, 2008b and 2009).

Documentary Survey

2.2 Research into the history of the Nenthead Mines has previously been undertaken, and therefore a broad summary of the historical development of the mines was requested, rather than a full documentary survey. All research was undertaken in accordance with IfA recommendations (IfA 2008a).

2.3 The summary comprised a review of the secondary documentary material listed in the brief (Jackson 1969; LUEAU undated; RCHME 1993; BHWB 1995; LUAU 1997; NPHT 1999) as well as other unlisted texts (e.g. Raistrick 1938; Critchley 1984; Fairbairn 1993; Robertson 1999). In addition, a review of the corpus of reporting undertaken at the site by North Pennines Archaeology Ltd between 2005 and 2010 was also undertaken, including the final reporting for the English Heritage funded Phase III works (Town 2005; Cavanagh and Town 2009a-c) and the reporting for the field school project at the mines (Sowerby 2006). During 2010 to 2011, the site had been subject to a detailed survey by NPA (now Wardell Armstrong Archaeology) as part of the English Heritage Miner Farmer Landscapes Project, a report for which has just been completed (Railton and Wooler 2012). The results of the survey were also assessed as part of the current study. Searches were also made for articles in *British Mining*, *Historical Metallurgy* and *Industrial Archaeology Review,* and extensive use was made of online resources, most particularly the websites of the Northern Mines Research Society (NMRS) and the National Association of Mining History Organisations (NAMHO), the latter of which is currently undertaking *The Research Framework for the Archaeology of the Extractive Industries in England (Mining and Quarrying).*

2.4 In addition to the secondary sources listed above, a review of available primary documentation held by the Nenthead Mines Conservation Society was also undertaken, to inform a more detailed assessment focusing on each of the nine survey areas on the site. Information consulted included: historic photographs taken during the mine operations and by mine explorers and historians particularly from the 1950s; aerial photographs; copies of maps and plans of the mine workings; original documents such as minute books for the London Lead Company; and any other relevant documents. The study also drew heavily on the knowledge and experience of mining historians, previously consulted by the author for other studies (Sheila Barker, Ray Fairbairn, Peter Jackson and Peter Wilkinson). Peter Jackson was also a constant and ready source of information and a useful

sounding block for theories on the recorded evidence.

Topographic Survey

2.5 The survey methodology within the selected areas detailed above was undertaken in accordance with codes and practices outlined by the Institute for Archaeologists (IfA 2008b) and English Heritage (2006b, 2007), and the level of survey required for each structure was undertaken in accordance with the project specifications (Andrews 2013, Gledhill 2013).

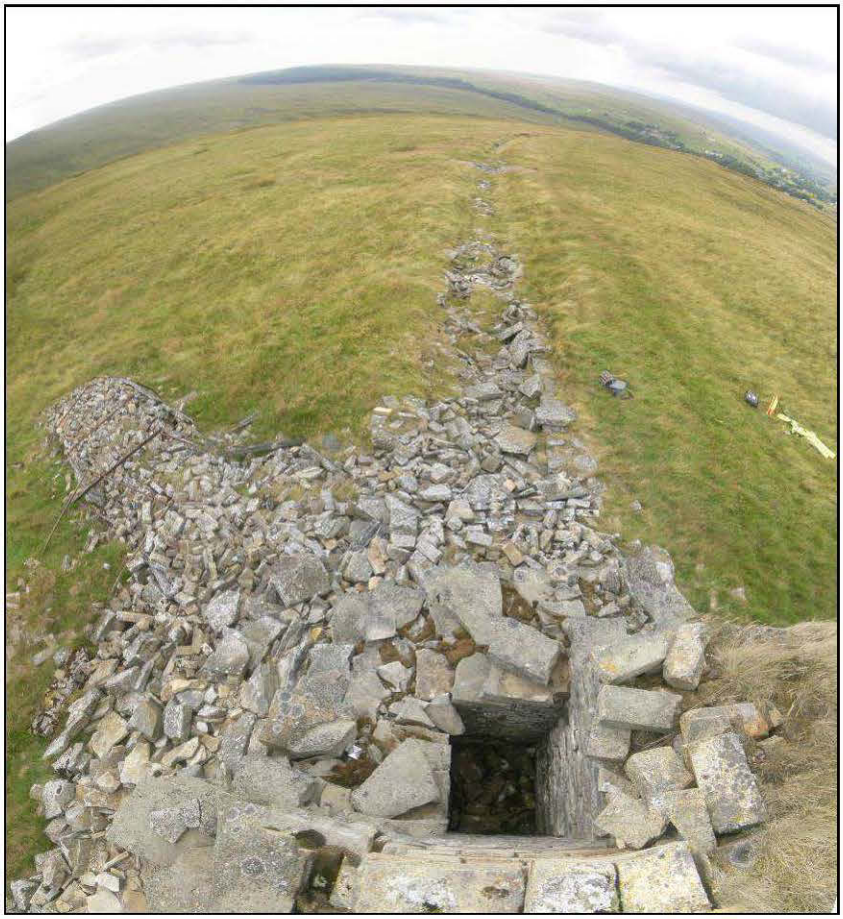

Plate 1: photo-montage of chimney and flue

2.6 All structures were subject to a written and photographic record to English Heritage Level 2 standard (English Heritage 2006b). The written record comprised an accurate detailed written description of the existing structures and identified the origins, main phases of development and use of the structures within each survey area. Each discrete feature, or group of features, was allocated a unique identification number and a structured gazetteer was made of all features identified on the site (Section 9). The position of each structural feature is depicted on the relevant figures for each section (see Figure 2 for their locations). A note on the significance, condition and recommendations for each feature was also made in order to inform future management and conservation strategies, information for which is discussed in Sections 8 and 9. A general photographic survey was also undertaken using a 10 megapixel camera. All detailed photographs contained a graduated

photographic scale.

2.7 Areas 4 (chimney only), 8 and 9 were also subject to topographic survey to English Heritage Level 3 standard, at a scale of 1:100, providing a record of all key features associated with the structures. The survey comprised a metric survey of the plan components in each area using a combination of Topcon GPS and Leica 700 series Total Station Theodolite, providing sub-centimetre accuracy. This was used to record the top and bottom of all features, producing an outline plan on the handset as the surveyor progressed across the site. An interpretative plan was produced in AutoCAD using structured layer control according to English Heritage guidelines (English Heritage 2000, 2007). The site was surveyed using the Ordnance Survey grid and all heights were tied into the OS datum.

Rectified Photography

2.8 Areas 4 (chimney only), 8 and 9 were also recorded by means of rectified photography at 1:20 scale. The control network for rectification was provided by use of a reflectorless total station survey (TST), recording sufficient elevation detail for accurate rectification of each photograph. The TST was used to survey in outlines and key features, as well as any area of damage. All survey information was tied in directly with the topographic survey control grid, ensuring consistent accuracy throughout. Rectified photographs were taken using a high resolution digital 35mm full sensor camera at a minimum resolution of 3mm per pixel. The camera was tripod mounted and flash was not required. The rectified survey was supplemented by general and oblique photographic coverage of the structures in order to pick up record shots of returns and inaccessible elevations. The rectification was based on so called 'friendly joints', key points on the structures which were used as reference points. The rectified photographs were interpolated using Kubit Photoplan rectification software.

2.9 Scaled photographs were taken of the enclosed culvert walls on Rampgill Burn together with record photographs of the ceiling; however, on-site assessment of the health and safety concerns with regards to the tunnel (in particular with relation to the Confined Spaces Regulations 1997), meant that only short sections of the tunnel immediately inside the entrances could be recorded in this way. A more complete photographic record has been completed by Peter Jackson, and has been provided to the project team (Jackson *pers. comm.*).

2.10 The collapsed chimney was recorded by a series of perpendicular or shallowly oblique adjacent images taken from ground-level, pole-mounted camera, and kite-mounted camera. Surveyed ground markers and known reference points captured within the photographs, were used to geo-reference the subject. These images were then uploaded into photogrammetric software allowing their relative positions to be computed in 3D space. The software generated a comprehensive point cloud of the photographed scene, which formed the basis of detailed DEMs (Digital Elevation Models) from which high resolution scaled orthophotos were produced. The DEMs were also output in scaled 3D PDF format digital models allowing remote detailed viewing and interrogation of the site. These will form a part of the archive.

Nomenclature

2.11 A glossary of mining terms used in this report is included in Section 10 and all the monument terms used in the report have been taken from the National Monuments Record (NMR) Thesaurus of Monument Types (http://thesaurus.english-heritage.org.uk). For the purposes of this report, the term '*level*' has been used for a tunnel driven near-horizontally into the ground for access, rather than '*adit*'. '*Shaft*' has been used for tunnels driven vertically from the surface, whether to access mineral deposits or for ventilation. '*Dressing Floors*' relate to the preliminary crushing and cleaning of lead ore in a specific area, whether by hand or by mechanical means.

3.0 BACKGROUND INFORMATION

Location

3.1 The Nenthead lead mining complex is located within the modern civil parish of Alston Moor, Cumbria. The village of Nenthead is one of the three main population centres within Alston Moor, the other two being Alston and Garrigill (Figure 1).

Plate 2: aerial photograph of the Nent Valley, facing south (© NMCS archive)

3.2 The smallest part of the complex lies immediately adjacent and south-west of the village, centred on NGR NY 7760 4310. This area is formed by the Dowgang Burn and Dowgang Hush, the latter a deep steep-sided valley formed by mining. This area was primarily used as an extraction hush, with shafts and levels visible within it. The sides of the hush have a sparse covering of grass with a small number of plantations of varying size and some woodland on either side of the Dowgang Burn. To the north-east of the hush, the lower part of the site is formed by a deep valley with steeply sloping

wooded sides; the south-east side is much higher than the north-west. The Dowgang Burn flows into the valley from the moorland to the south and flows into the Nent close to the village.

3.3 The larger part of the site lies to further to the southeast, centred on NGR NY 786 433. The River Nent, which forms its focus, lies at the base of an incised glacial valley, at approximately 440m AOD, and flows north-westwards towards the village. The river is fed by a series of meltwater channels and small streams. At the head of the valley, the Long Cleugh Burn, the Middle Cleugh Burn and Old Carr's Burn combine to form the main tributaries, with the Rampgill Burn contributing to this river in the vicinity of the smelt mill complex. It is from the sides of the tributaries and valley that levels were driven, with the floor of the Nent valley containing extensive lead mining remains, comprising ruined structures associated with ore processing, such as stamp and smelt mills, condensers, compressors, tramways and dressing floors, as well as numerous mining features such as communication routes, spoil tips, reservoirs, watercourses and lodging shops.

3.4 The valley sides, through which the water-courses cut, rise steeply on the south-west side onto a series of stepped benches formed by the outcropping limestone; the north-east side by contrast is gentler and is mantled and smoothed by glacial till. The hillsides are elevated, at approximately 580m AOD, and comprise a gently undulating partially waterlogged acidic moorland landscape, predominantly of heather moorland and rough grazing, which climbs steadily to the south, up to 680m AOD around the Priorsdale boundary. The hillsides are extensively pock-marked by shafts, particularly on the south and east sides.

Ownership

3.5 The land is owned and managed by Cumbria County Council, and forms part of the North Pennines Area of Outstanding Natural Beauty (AONB). The site was leased by the North Pennines Heritage Trust between 1987 and 2011 (see below), but since its liquidation, the lease has reverted back to Cumbria County Council. Limited outreach activity and care-taking duties are now carried out by the Nenthead Mines Conservation Society (NMCS).

Designations

3.6 Nenthead Mines was designated a Scheduled Monument in 1982 (Figure 2) under the provisions of the Ancient Monuments and Archaeological Areas Act of 1979, with additional elements being added in September 1997. Previously known as Scheduled Ancient Monuments (SAMs), these sites are monitored and identified by English Heritage but legislated by the Secretary of State for Culture, Media and Sport (DCMS). Scheduling is the highest form of legal protection applicable to archaeological sites and covers both above and below ground archaeology including any subterranean mine workings. The whole of the Scheduled Monument area covers approximately 48 hectares.

3.7 A smaller area around the Smallcleugh Level complex was designated as a Site of Special Scientific Interest (SSSI) in March 1994. English Heritage's Monuments Protection Programme (MPP) (English

Heritage 1992) has classified the lead mining site as one of national/international importance.

Previous work

3.8 The North Pennines Heritage Trust (NPHT) was set up in 1987 and became actively engaged in the conservation and interpretation of the Nenthead site. Works progressed in that period from small-scale emergency repairs with limited recording, to a full-scale conservation programme. Some of the buildings on the site, particularly those related to the later phases of activity, were in a good state of preservation and survived as roofed structures; others, such as the former mine compound buildings at Rampgill, required some repair work. Most of the mineshafts and level entrances were in a reasonable condition, although many were fenced off or gated for reasons of public safety. The first excavations at the site were undertaken by David Cranstone in 1987 and 1988, at the stamp mill to the southeast of the Rampgill complex, taking in the frame and wheel-pit of the stamp mill (Cranstone 1988a and 1998b). In 1987, Manpower Services Commission trainees under the auspices of Cumbria County Council, removed the remains of a hearth within the Assay House during renovation works and undertook a basic photographic survey (NPHT 1999).

3.9 In 1994, the first major conservation works were undertaken on the Rampgill compound, and all the buildings were investigated. An archaeological watching brief also recorded a number of structures and culverts within service trenches, some of which may form part of a wider water management system (Hedley & Cranstone 1995). In 2002, prior to the extension of the café building, an excavation was also undertaken at the compound by North Pennines Archaeology Ltd (Jones and Giecco 2002).

3.10 In 1997, the appointment of an archaeologist to the Trust's staff allowed the conservation works to progress, and parts of the Nenthead lead mining complex have been the subject of detailed archaeological investigations, which have been compiled into a number of grey literature reports (NPHT 1999; Cavanagh and Town 2009a, 2009b, 2009c). As a direct result of the conservation programme, significant data was accrued concerning the phased development of several of the standing buildings on the site. In 2005, a field school, the Nent Valley Archaeological Project, was set up at the mines. The Smallcleugh Project, which formed part of it, was undertaken in 2006 and 2007, focussing on the Smallcleugh and Middlecleugh mines. The works comprised the recording and consolidation primarily of mine shops and other buildings (the 2006 season is reported in Sowerby 2006).

3.11 The Nenthead mines have also benefited from a number of detailed surveys, commissioned either by the NPHT, the Countryside Commission, English Heritage and/or Cumbria County Council. Archaeological works began in 1985, when detailed non-intrusive ground surveys were carried out by Liverpool University's Environmental Advisory Unit (LUEAU nd) and subsequently in 1993, by the Royal Commission on the Historical Monuments of England (RCHME 1993). Both surveys mapped or planned all surface features at a variety of scales and produced a gazetteer of site components and features. The RCHME report contains basic textual descriptions of the components and collates, as

far as possible, all existing survey work. Cumbria County Council's Economic Development Unit also undertook a detailed 1:500 scale contour survey of the site in the same year. In 1995, Barton Howe Warren Blackledge (BHWB 1995) was commissioned by NPHT to produce a draft management plan for the lead mining complex at Nenthead, which also mapped the surface archaeology in detail.

3.12 The survey undertaken by BHWB was supplemented by further survey work in 1997, by the Lancaster University Archaeological Unit (LUAU 1997). This examined two defined areas of landscape (an area to the south-east of the main smelt mill complex and the Dowgang Burn and Hush) and identified a further 22 features in those areas.

3.13 Between January and May 2011 North Pennines Archaeology Ltd undertook a survey of an 18km^2 upland area (known as Block 2A), as part of the wider Miner-Farmer Landscapes Project being undertaken by English Heritage. The survey area covered the south-east part of Alston Moor, together with the settlements and historic mining complexes at Garrigill and Nenthead. A total of 2548 sites were identified during the field survey, with the vast majority of the sites being of post-medieval date and directly related to lead mining (Railton and Wooler 2012).

4.0 THE GEOLOGY OF THE SITE

Brian Young BSc, C Eng, FIMM

4.1 In order to understand fully the site's numerous mining and related archaeological features it is essential to appreciate the fundamental role of the geology, including the numerous mineral deposits, in providing the basis for that industry.

4.2 The Nenthead site lies within the Northern Pennine orefield, one of a number of rich concentrations of metalliferous mineralisation in the Pennines that coincides exactly with the structural unit known by geologists as the Alston Block. This comprises a succession of Carboniferous sedimentary rocks overlying a comparatively shallow basement of Lower Palaeozoic mudstones and volcanic rocks into which was intruded the concealed pre-Carboniferous (Devonian) Northern Pennine granitic batholith, of which the Weardale Granite forms part.

4.3 A characteristic feature of the area's Carboniferous rocks is the regularly repeated upward succession of rock types typically comprising limestone, shale, siltstone, sandstone and coal. These units, or 'cyclothems', are generally referred to as 'Yoredale cyclothems', from their most characteristic development in Wensleydale (the former name for this dale), where they were first studied in detail. Individual rock units within this succession have long been known by local names, given by the early miners and quarrymen. The rocks which crop out at the surface on the Nenthead site extend upwards from beds below the Four Fathom Limestone to beds above the Firestone Sill sandstone.

4.4 A convective flow of mineralising fluids, driven by heat from the granites of the pre-Carboniferous Northern Pennine batholith, during late Carboniferous to Permian times, deposited a variety of minerals within a conjugate system of faults within these rocks, creating the orefield's numerous veins. Where these fluids reacted with limestone wall-rocks, extensive bodies of replacement 'flat'

deposits were formed adjacent to the parent veins. Both veins and some of the orefield's largest 'flat' deposits were worked at mines on the Nenthead site.

4.5 A distinctive feature of the orefield is the zonal distribution of constituent minerals. Deposits in the centre of the field are distinguished by abundant fluorite. Surrounding these is an outer zone dominated by barium minerals including baryte and witherite. The Nenthead site lies in an intermediate zone in which fluorite and barium minerals are scarce or absent, but in which zinc mineralisation is abundant.

4.6 The principal ore minerals, which typically comprise only a small proportion of the deposits, are those of iron, lead and zinc with very minor local concentrations of copper. All have been worked in the orefield, though only lead and zinc have been extracted commercially from the Nenthead site.

4.7 Although silver is widely present in trace amounts in the lead ores (mostly up to about 250 parts per million), and was recovered from the smelted lead, it is important to recognise that, contrary to some published claims, the orefield's lead ores were typically not silver-rich. It is extremely unlikely that any of the mines could ever have been worked primarily for their meagre silver content.

4.8 Associated with the ore minerals, and usually forming the bulk of the deposits, is a variety of gangue or 'spar' minerals, notably fluorite, baryte and witherite. Although commercially worthless during the heyday of lead mining, these became important industrial raw materials during the 20th century with many mines re-worked specifically for them. Whereas all of these minerals were worked in and around Alston Moor, fluorite was the only spar mineral whose extraction was ever attempted at one mine on the Nenthead site.

4.9 The Nenthead site today includes numerous excellent surface exposures of geological importance, including some of the finest sections of Carboniferous rocks and associated replacement lead/zinc mineralisation available anywhere in Britain. The importance of these features is recognised in their designation as a geological Site of Special Scientific interest (SSSI). It is therefore essential to safeguard these interests alongside any historical or archaeological designations.

4.10 From an historical perspective it is important to recognise that the evolution of some of the earliest concepts in the emergence of geological science, including the understanding of ore deposits and their origin, together with advances in mining and smelting technology, were inextricably linked over centuries of mining here in the Northern Pennines, of which the Nenthead site forms an important part. The area continues today to contribute significantly to the continuing development of geological science.

4.11 Further details of the geology of the Nenthead site, with comments on its wider significance, are contained in Young's 2014 report on the geology of the site. The most importance published texts giving more details of these can be found in the selected bibliography contained in that report.

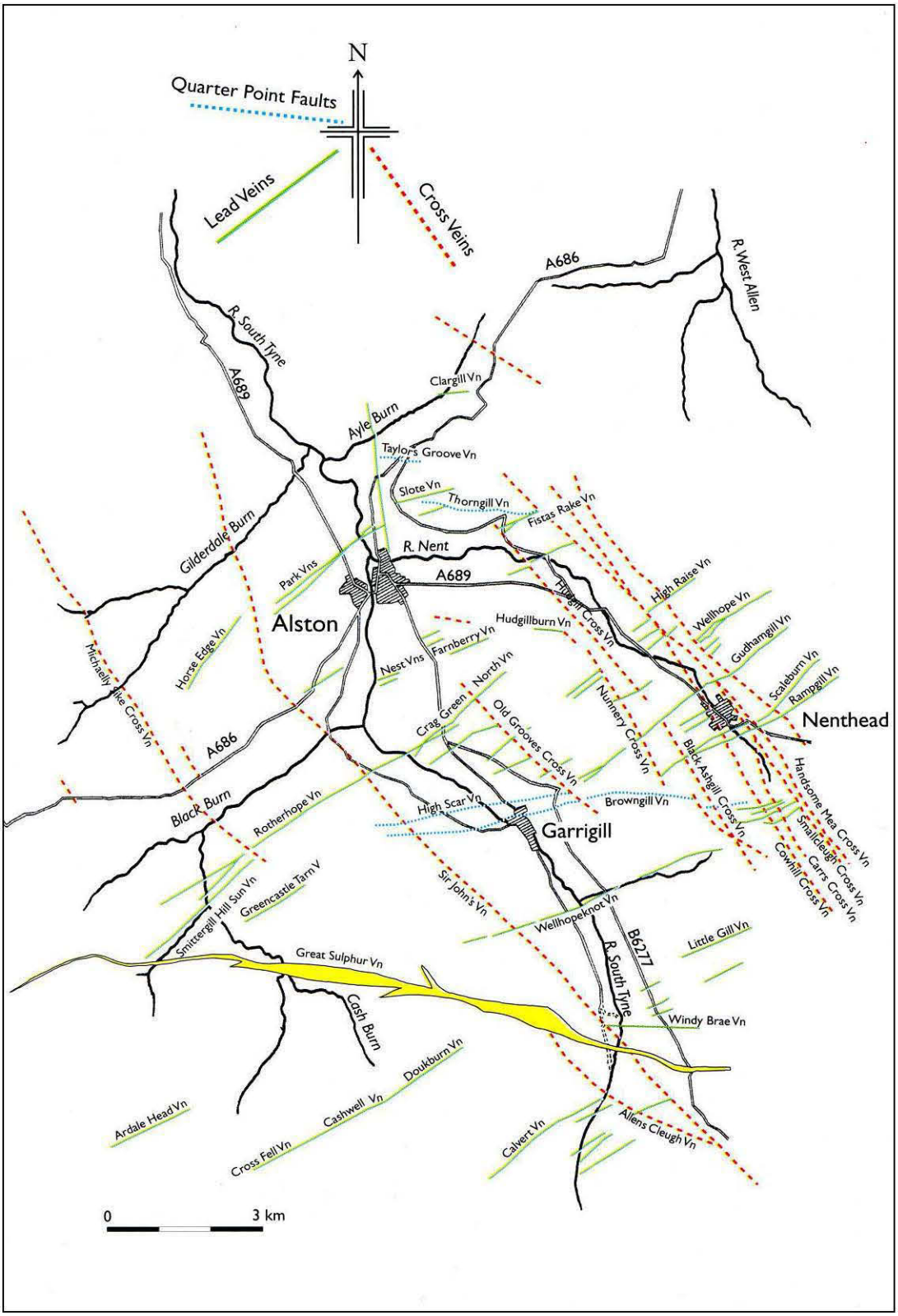

Plate 3: principal veins on Alston Moor (reproduced from Bulman 2004, 25)

5.0 THE HISTORY OF THE NENTHEAD MINES

5.1 The first documented mining activity on Alston Moor dates from the 12th century. The Pipe Roll, which was a record of royal revenues, notes the rental of a silver mine in the year 1130-31, located on Alston Moor, and recorded as the only silver mine in Cumberland. By 1135, silver from the Alston mines was being minted into coin at Carlisle (Summerson 1993, 25).

5.2 Although most of the lead smelting carried out during this period was primarily for the refining of the silver content of the lead ore, there was a growing demand for the base metal as a building material, particularly for the roofing and plumbing of religious houses and castles. In 1167, lead from Alston Moor was being taken *'to the kings houses at Windsor'* and in 1177, *'100 cartloads of lead (were) delivered to brother Simon to the work of the church of Clarevall'*, the Cistercian abbey at Clairvaux in France (Robertson 1999, 10; Walton 1945, 26).

5.3 By the 13th century, Alston Moor fell within Scottish territory and the mine came into the ownership of the Kings of Scotland. The mine lease changed hands several times and in 1290, a dispute was recorded between Henry de Whitby and his wife Joan and *'Patric of the Gill and 26 miners at Alderstone [Alston]'* (Wallace 1890, 109). Smelting disappeared from Alston Moor during the 13th century, as the number of trees available for fuel diminished (Robertson 1999, 14).

5.4 Little is known of mining activity during the 14th century. An Inquest after the death of Nicholas de Vetriponte in 1315 identified a total of 68 tenants in Alston Moor, which may have formed a population of 500 or 600 people. It was noted by Wallace, writing in 1890, that there was no way of assessing how many of this population were employed in mines (Wallace 1890, 11). The mines are reported as being leased to Tilman of Cologne in 1359 (*ibid*).

5.5 On December 20th 1468, Edward IV made agreements enabling him to receive a twelfth part of all precious metals found on Alston Moor, with a further grant made in March 1475 (Wallace 1890, 110). There is little documentary evidence for lead mining on Alston Moor between the late 15th and early 17th centuries, although it is likely that limited exploitation by surface workings and shallow pits continued throughout this period.

5.6 The Alston Moor estate was held by the Vetriponte family until the beginning of the 17th century, at which point the estate passed, by marriage, to the Hilton's of Hilton Castle, Durham (Thain 1999, 8). The mines were surveyed in 1611 and were reported as being almost exhausted (Nall 1886, 19). The estate was subsequently sold to Sir Francis Radcliffe, Earl of Derwentwater, in 1618 for £2,500. A further survey in 1629 also identified the mines as exhausted, however the Radcliffes encouraged the working of the Alston Moor mines, leading to an apparent increase in lead production by the latter half of the 17th century. In 1664, Sir Francis Radcliffe leased to George Bacon of Broadwood Hall, Allendale: *'..all the lead ore in the manor of Aldstone Moor for three years, at the sum of 37/- for every bing load of lead ore that is, or shall be gotten, within the said liberties, during the said term, being fifths or otherwise to the said Francis'* (Critchley 1984, 6). Writing at the end of the 17th century, Thomas Denton referred to William Camden's observations that Alston Moor had been

famous in the 16th century for copper mining, but by the late 17th century it was more famous for *'lead mines of incredible value, found out by Sir Francis Ratcliffe, now Earl of Derwentwater'* (Winchester 2003, 343).

5.7 Lead mining prior to 1700 was probably limited to surface workings and small underground pits. Mining rights on Alston Moor were leased by small companies and individuals, a pattern that continued into the 18th century. The first vein to be exploited to any extent at Nenthead was the Rampgill Vein, which commenced in 1690 (Critchley 1984, 6). Adventurers and investors developed their own workforces and leases regularly changed hands. From 1697, some of these individuals and small companies sold their ore to the Ryton Company based near Newcastle-Upon-Tyne (Raistrick 1938, 102). In 1692, the *'Governor and Company for Smelting Down Lead with Pit Coal and Sea Coal'*, was formed in London, being granted a very important charter for the smelting of lead with coal. In 1704, the Ryton Company and the *'Governor and Company'* merged to form a new concern, which became known as the London Lead Company (also known as the *'Quaker Company'* as many shareholders were Quakers).

5.8 On the 24th February 1716, Sir James Radcliffe (grandson of Francis), 3rd Earl of Derwentwater, was beheaded at the age of 27 for his part in the Jacobite uprising of 1715. As part of his estate, the Manor of Alston Moor was forfeited to the Crown. An inventory taken following the death of James indicated that there were only 11 working mines on Alston Moor at this date, with another four being *'Nott Wrought'* (Robertson 1999, 28).

5.9 In 1735, George II granted the estate to the Royal Hospital for Seamen at Greenwich in London. The Commissioners for Greenwich Hospital, also known as the Lords of the Admiralty or the Lords of Alston Moor, operated the mining leases from this point onwards. The first lessee of the mines on Alston Moor, is said to have been Adam Wilkinson, of Nentsbury Hall, in 1735 (Nall 1886, 16). In 1736, 31 of the remaining mining leases on Alston Moor were let to Colonel George Liddle and partners, who formed a company that began trials on the Rampgill Vein and built the first smelt mill at Nenthead in 1736 (see below). However, Liddle's operations proved to be unprofitable.

5.10 In 1745, the London Lead Company obtained the transfer of the Liddle and other leases, as well as that relating to Nenthead Mill, which had been constructed by the Colonel. The company therefore became the largest mining concern in the area, and became the major employer. By the middle of the 18th century it had developed most of the mine workings at Nenthead, and these were all in full operation by 1780. In common with many of the mines under their operation, the company increased the infrastructure needed to support their expanding mining activities, and as a result, mines were modernised and a unified system of exploration, development and mining evolved (Critchley 1984, 13). The London Lead Company were also keen to use the latest developments to increase productivity. They employed mining engineers and chemists and subsequently were able to improve smelting and metal recovery operations.

5.11 The London Lead Company, as Quakers, also looked at the social and welfare needs of the miners

and families employed at Nenthead. The company built miners cottages, shops, schools, a clock tower, a post office, a market hall and chapels for the miners and their families, along with the introduction of '*Mine Shops*' to the district. These were a sort of lodging house, located right at the portal of a mine so that miners did not have to travel distances during the working week and short harsh winter days.

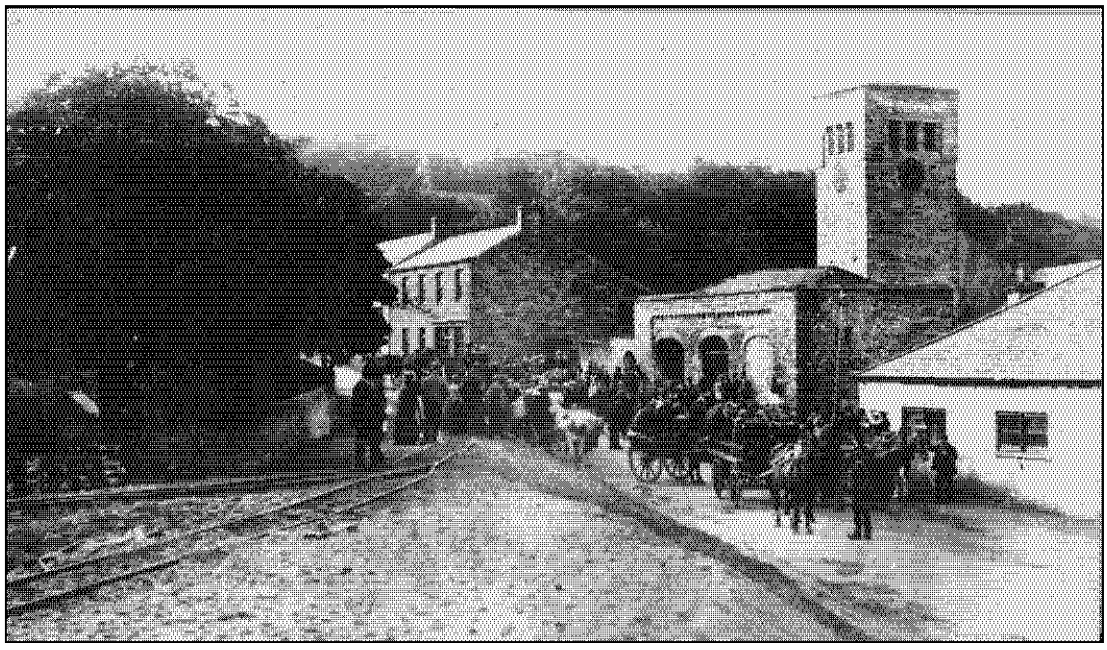

Plate 4: the clock tower, wash house, and market hall (right of picture), late 19th century (© NMCS archive)

5.12 The mines became a major source of employment for the rural populations in the North Pennines, and although the London Lead Company continued to operate at a profit until the late 19th century, its Alston Moor mines had reached their production peak in the 1820s. From this period onwards, British mines faced increased competition from imports of foreign lead, especially from Spain. The response of the owners was to centralise and mechanise labour-intensive processes such as dressing, in order to reduce production costs. Crushing, which was done by men wielding sledge hammers, was replaced by water-powered grinding rollers in specifically designed grinding mills. This lead to an increase in the fine material produced, which in turn required the improvement of other processes to maintain the flow of production. The improvements meant an increase in the yield of ore from every ton of veinstuff mined, and meant lower grade ores could be worked at a profit (Gill 2004, 53).

5.13 The London Lead Company operated at Nenthead until 1882, when the leases on the mines, which still had between fifty and sixty years to run, and the freehold of the Priorsdale estate, were sold to the Nenthead and Tynedale Lead and Zinc Company. The company had been formed by John Cameron and Joseph Wilson Swan, who also operated the spelter works at Tindale, purchased in 1868 (Almond 1977, 25). The aim of the company was to prospect for both lead and zinc, and in this way it was hoped to be able to lower marketing and mining costs. The Swans also agreed to the purchase of the lead smelting mill, which in 1884 was described as having six smelting ore hearths

(also called Scotch Furnaces), a slag hearth, two reverberatory furnaces, and two refining furnaces. The prospectus also records one de-silvering house (presumably the Rozan House, which suggests the Pattinson House was in use for other purposes at this time), and three dressing floors; the condensation system was also still in use. The total price paid was £30,562 7s 6d. The mines at this time employed 163 men in the lead mines, with a further 26 in exploratory or unproductive tasks. Work was being undertaken on 27 veins in 11 locations, with altogether 51 veins and branches known in the mines. The ore was said to be cheaply extractable due to the 43 miles of levels, which aided in the draining of the mines, of which 35 had iron rails. By October 1882, a memorandum stated that *'plates of lead with the new mark are just commencing to be made'* (Almond 1977, 25).

5.14 The company aimed to produce 5000 bings (2030 tonnes) of ore a year from the mines, which would yield 1550 tonnes of lead and 12,000 ounces of silver from the smelt mill (Almond 1977, 25). Although the company's expectations were therefore good, unfortunately the projections proved wrong. The value of lead slumped in 1889 and the value of silver slumped in 1894. The mine therefore became increasingly reliant on the production of zinc, which formed 80% of the metal sales. However, the cost of processing the zinc was much higher than that for lead and in 1895, the zinc value had also slumped (Almond 1977, 30). The combination of the disastrously low zinc, lead and silver prices were too much. In 1895, the lease on the Tindale spelter expired, and was not renewed following disputes with the landowner, the Earl of Carlisle, over the activities of the company. The works were dismantled in 1896, and the company was liquidated in the same year (Almond 1977, 32).

5.15 In 1896, the Vielle Montagne Zinc Company of Belgium took up the Nenthead leases for 42 years, paying a price of £45,000 to the Nenthead and Tynedale Lead and Zinc Company (Almond 1977, 32). The company produced concentrates of zinc and lead from both mined ore and the reprocessing of spoil dumps, though the latter was no longer the main ore. No lead smelting was undertaken on the site, the materials produced being transported out of the region, and in 1899 it is stated categorically that: *'the old smelt mills were stopped, much to the benefit of the locality'* (Newcastle Daily Chronicle 8.2.1899).

5.16 By October 1897, considerable changes were being made to the running of the mines. Under the direction of the manager, Mr C. Fernau, the company modernised the zinc and lead production. Traction engines and locomotives were used for haulage, and acetylene lamps replaced candles in the mines. The Vielle Montagne Zinc Company reworked the old London Lead Company workings for zinc and drove extensive new levels in the mines, developing the large networks served by the Rampgill and Capelcleugh levels at Nenthead, from which a considerable quantity of zinc ores as well as galena was gained. The washing floors were modernised through the construction of additional jigging machinery. Pelton Wheels, working under high pressure, replaced the water-wheels that powered the machinery. Rock-drilling machinery also began to be introduced (Newcastle Daily Chronicle 8.10.1897), and was completed by February 1899 (Newcastle Daily Chronicle 8.2.1899). A hydraulic compressor system was constructed to provide compressed air to

power mechanical drilling for mine ventilation and for pumping. Water from two reservoirs on the hills was piped by an extensive network of pipes, whose total length covered six miles, to the top of a tower over Brewery Shaft. The water then fell over 400ft through a standing pipe, pulling with it air that was drawn in through nozzles arranged at the top. This air was trapped in a large bell-shaped receiver at the base of the shaft, and the water rose through an escape pipe for 200ft, giving a back pressure of 90lb per square inch. The water was used to work a mechanical air compressor, before being reused to generate electricity, making Nenthead one of the first villages in the United Kingdom to have electric street lighting. This cheap power was a great factor in the development plan, and remained in use for half a century.

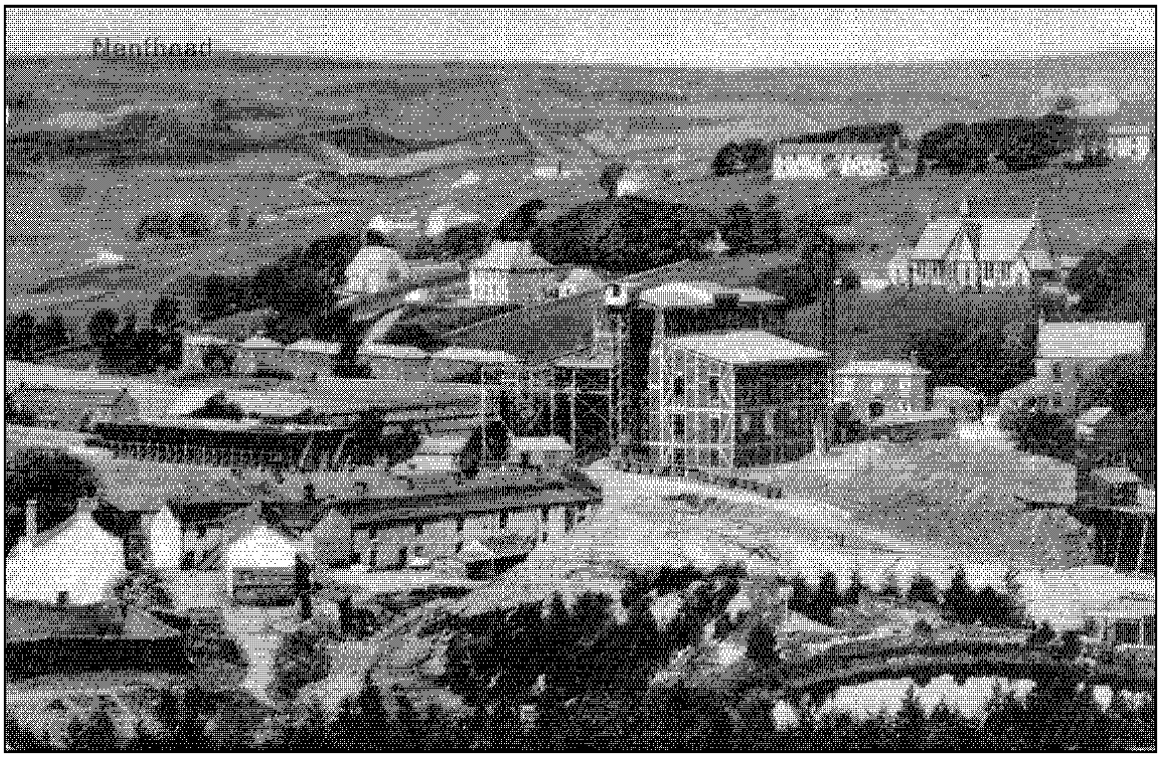

Plate 5: the Krupp Gravity Mill, in the centre of Nenthead (© NMCS archive)

5.17 In 1905 the Vielle Montagne Zinc Company commissioned a new processing plant at Nenthead. Built by the Krupp's Company from Germany, it was a gravity separation plant and was said to be the most modern in the world (Plate 5). The treated ore from the mill was transported to Alston and then taken by rail to Tyne Dock, where it was shipped to Belgium for smelting.

5.18 Between 1897 and 1913, the Vielle Montagne Zinc Company produced 8,135 tons of lead ore, 48,215 ounces of silver and 87,235 tons of zinc ore (Burt *et al* 1982, 105). Both above and below ground operations by the company on Alston Moor ceased in 1921, although the re-processing of old spoil heaps continued through to the Second World War.

5.19 During the Second World War, following the Nazi occupation of Belgium, the mines became cut off from their head office, with currency and export restrictions crippling the business (Cumberland and Westmorland Herald 26.2.49). The new dressing mill and spoil-heaps at Rampgill were also

requisitioned by the Ministry of Supply (*ibid*). Amos Treloar was manager of the mines between 1924 and 1948. His daughter Doreen recalls that during the war, he had many problems as the government threatened to close the bank accounts of the Company, which would have meant him not being able to pay his workers. At the end of the war the directors came over from Belgium, but were in a poor state of health. A Messieur Dupont was said to have only had the suit he stood up in, and his wife had not been out of the house for six months, as she had no shoes. The workers got them some clothes, despite the rationing still being in force (Walsh *pers. comm.*).

5.20 In February 1949, Anglo-Austral Mines Limited, a subsidiary of the Imperial Smelting Corporation Limited, took control of the former assets of the Vielle Montagne Zinc Company. They were mainly concerned with reworking the spoil for fluorspar, as well as developing the mines at Nentsberry for zinc production. The Krupp Gravity Mill was refitted with a flotation plant to treat the fluorspar, mainly from the Cambokeels mine in Weardale and towards the end of the 1950s, an unsuccessful attempt was made to treat the dumps from the Firestone Level dressing operations.

5.21 In December 1961, the smelt mill was sold to the Rampgill Mine Company, who were interested in the recovery of lead and zinc from the dumps of mine-waste around the site. The enterprise was short-lived and their operations ceased in 1963 (NPHT 1999, 11).

5.22 In 1970, the British Steel Corporation leased the whole of Alston Moor to explore for fluorspar. The smelt mill site was largely intact until the early 1970s when demolition of the surviving remains was undertaken to salvage the building material; the café at Hartside was built from the remains of the smelt mill (Fairbairn 1993, 181).

6.0 THE ARCHAEOLOGY OF NENTHEAD MINES

6.1 The following section provides an interpretation of the surviving archaeological remains in the light of the development of the mine complex over the course of its history, which spans at least 275 years. The brief for the works (Gledhill 2013) identified eight separate areas for assessment, with a ninth area added after commencement of the project:

1. Rampgill Reservoir, Dowgang Hush
2. Rampgill Horse Level
3. Nenthead Smeltmill Complex
4. Smeltmill Flue and Chimney
5. Stagg Condenser Wheel Pit
6. Culvert, Smallcleugh Level
7. Powder House at Smallcleugh
8. Retaining walls, Smallcleugh Washing Floor and Dressing Mill
9. Culvert to Rampgill Burn

6.2 The various archaeological features identified and recorded during the field survey are described in detail in the accompanying site inventory (Section 9) and illustrated on Figures 3-16. Each separate area carries a block of 100 feature identification numbers prefixed by the number of that area (so for example, all features relating to the flue and chimney are in the 400 block). References to these features in the following section are given in bold. The numbering system means, therefore, that feature numbers are not necessarily sequential.

6.3 For each of the areas, the following are considered:

- The history of the structures
- Previous investigations in each area
- The function of the structures
- A description of the archaeological features
- Interpretation and discussion

6.4 The results of the survey are used to inform a Statement of Significance, which is outlined in Sections 7 and 9.

Area 1: Rampgill Reservoir, Dowgang Hush (Figure 3, Plate 9)

History

6.5 Rampgill Reservoir (**101**) is located at the foot of Dowgang Hush, one of the most prominent landmarks in the Nent Valley, which follows the Brigal Burn and Dowgang veins (Figure 3). Hushing involved the use of an artificial torrent of water released from a turf dam built near the crest of a hill slope. When enough water had collected, the dam was broken and the resulting surge of water down the slope tore up and removed surface soil and broken rock along its path (Raistrick and Jennings 1965, 12). Dowgang Hush extends for approximately 1.2km in length.

6.6 The exact dates of the hush are not known, though there is a reference to Bacon's Level working the vein in the second half of the 16th century by one George Bacon of Allendale (Fairbairn 1993, 79). By 1737, the vein had been hushed, and possibly worked out (*ibid*). Dowgang Hush includes shafts along its length, which are probably 18th century or earlier.

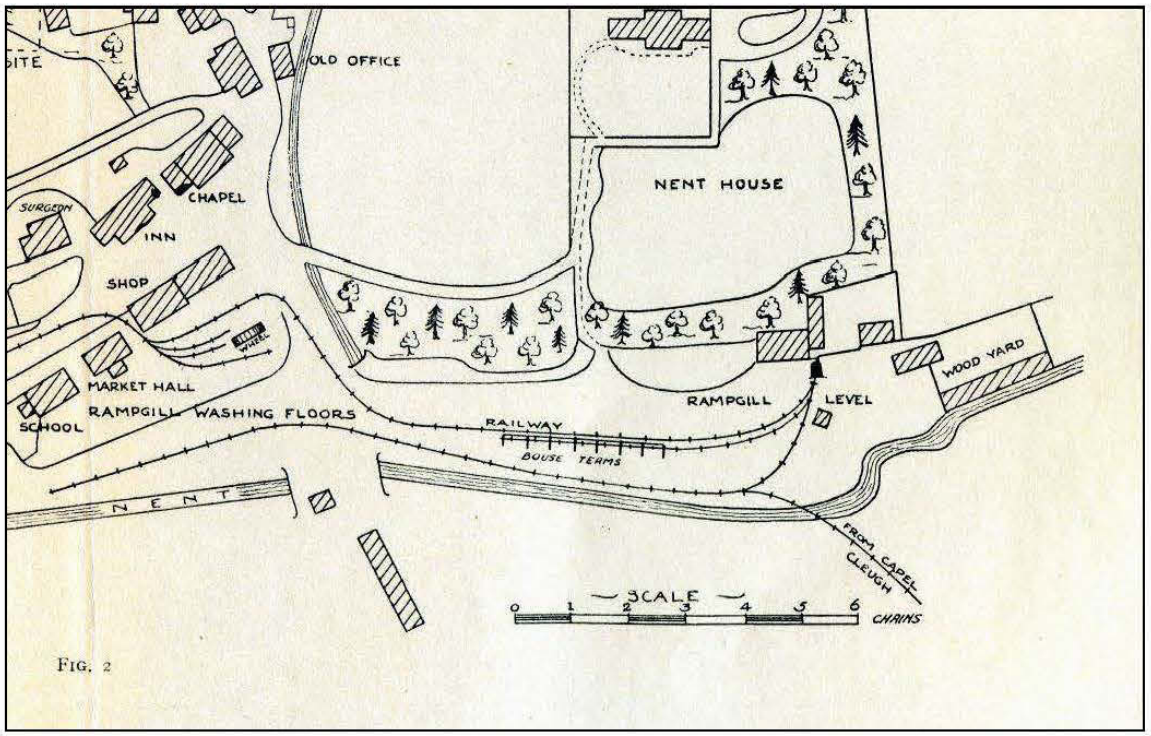

Plate 6: London Lead Company mine plan, c.1825, redrawn by Raistrick (1938, 24)

6.7 The reservoir, though located at the base of the hush, is probably later, established after the hush was being worked. Its location is likely to have been selected as a convenient point from which to collect water, not only from the Brigal Burn, but also from the many natural and man-made water channels which use the hush as a convenient drainage point. The reservoir is located south-west of, and above, the Capelcleugh Horse Levels (**104** and **105**). It was probably constructed around the time they were driven, in order to provide water for dressing processes located on the south side of the River Nent. Capelcleugh Level was originally known as the Brigal Burn Level, and was driven before

the 19th century into the Brigal Burn and Dowgang veins, possibly only as a drainage level. Whether the Brigal Burn level relates to the upper or lower Capelcleugh level is unclear, but the upper level - **104** - seems more probable. The London Lead Company is recorded as driving a further level between 1819 and 1825 (Fairbairn 1993, 76). This level is likely to be the lower level (**105**) adjacent to the River Nent, as it connected to the Rampgill Washing Floors depicted on a mine plan dated to 1825 (Plate 6). The reservoir is recorded on the First Edition Ordnance Survey mapping of 1859 (Plate 7). A sluice gate (**102**) is clearly depicted in the north-east side of the reservoir bank, and the Capelcleugh (upper) Level is labelled as *'Peatstack Mine'*. There are two waggonways (**107**) extending from this upper level, one ends in a short spoil heap to the north, and the second is a longer spur leading north-west to a series of bouse-teams. Parallel to this waggonway, a leat (**106**), running north from the River Nent, circumvents the eastern edge of the reservoir and connects to a rectangular building, possibly a wheel-pit for a water-wheel powering a crusher. The waggonway running north-west from Capelcleugh (lower) Level (**105**) connects with the Rampgill Washing Floor on the north side of the Nent. By the Second Edition Ordnance Survey mapping of 1899, these features are no longer depicted.

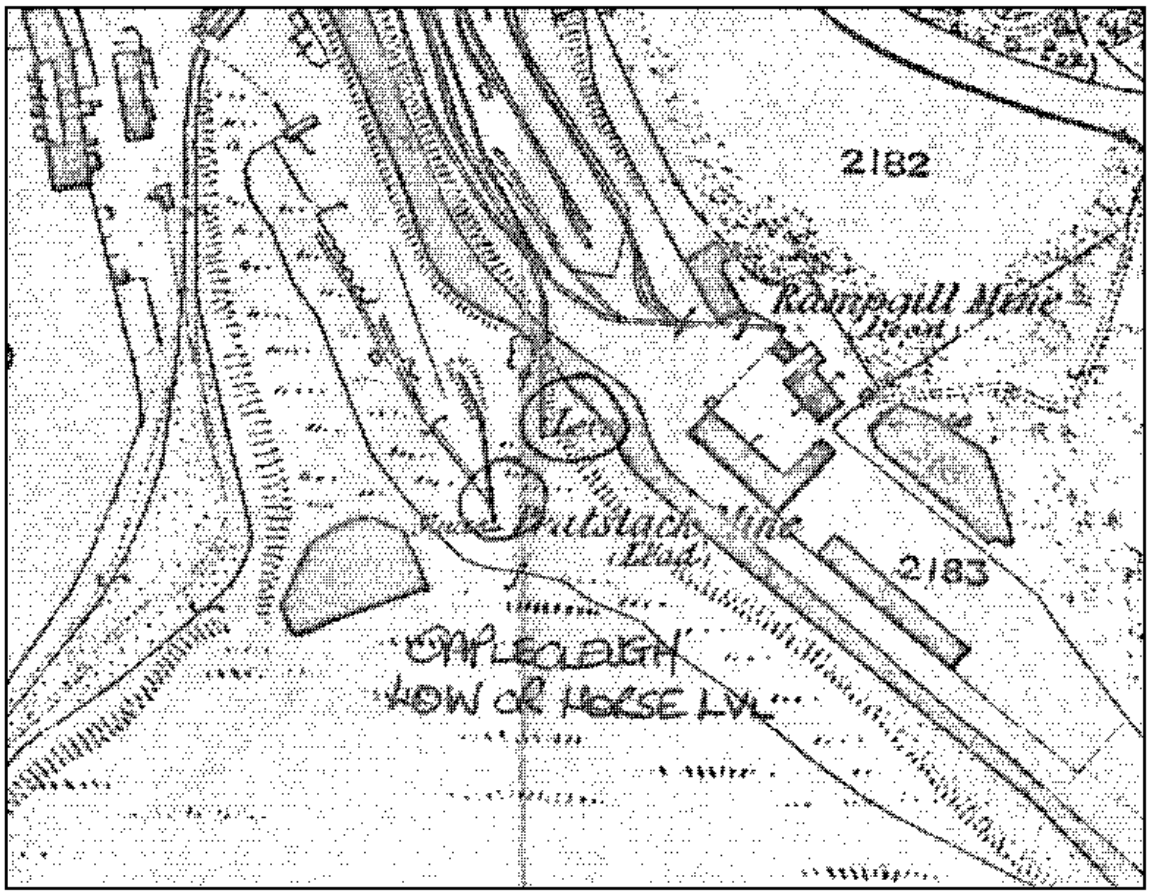

Plate 7: detail of Rampgill and Capelcleugh Levels and associated works, First Edition Ordnance Survey map, 1859 (© NMCS archive)

Plate 8: construction of the new spillway ***112****, August 1999 (© NMCS archive)*

Previous Investigations

6.8 The BHWB survey (1995, Appendix 1/1, 19) records the reservoir as *'approximately D-shaped in plan, and has a dam on its eastern and western sides. The dam is a steep-sided flat-topped earth bank c. 2.5m high. There is no evidence of any internal lining to the dam structure, although large stones, apparently displaced, are visible in several places. The south side of the reservoir is formed by a gently sloping natural bank and there is no trace of any artificial earthworks. The reservoir appears to have been fed by a leat system entering it on its south and south-east sides'*. The sluice gate (**103**) is described as '*stone built, and located on the internal face of the western side of the dam of the reservoir. It is U-shaped, 1.4m wide, 4m long, and survives to a height of 1.5m. The slots into which the sluice gate fitted survive within the stonework. A culvert, now choked with silt, leads away to the west. The sluice has recently either been rebuilt or heavily repointed in an unsympathetic manner. Despite these repairs, the north side of the sluice has collapsed at the bottom, leaving the masonry above unsupported.*' This sluice is also recorded by both the LUEAU survey (nd, 44) and RCHME survey (1993, 5). It is described by the latter as a *'stone-built sluice; two collapses in top of dam probably show its course*'. The RCHME survey also records a secondary breach or sluice 20m to the north of the original sluice (**112**). This breach is recorded as *'breach or sluice, represented as a V-shaped cut c3m wide at the top and 2m deep. It is partially grassed over and moderately defined. The sides are eroding, causing further damage to the dam structure*'. A further note identifies this

breach to have been cut after the sluice gate went out of use, and to be probably fairly recent. The descriptions given are largely correct, though appear to have missed the location of the main sluice-gate on the north side, as depicted on the Ordnance Survey mapping of 1860.

6.9 In 1999, a threefold programme of works was proposed on the reservoir by the North Pennines Heritage Trust Archaeologist (Krupa 1999). The works comprised: the investigation of the existing sluice gate **103** and its repair by means of the reinsertion of a boarded sluice to minimise water damage to the structure; the excavation of a new spillway within the breach in the dam wall **112**; and an evaluation over the site of the northern sluice-gate **102**, to identify the location, form and function of the sluice gate at this point. No records of the repair of the sluice gate were identified, though the spillway was constructed and is still functioning. A short note on the evaluations indicates that Trench 1, located to the south-west of the embankment, revealed a collapsed stone recess containing a cast-iron valve. The write-up of Trench 2 on the north-east side is incomplete.

*Plate 9: Rampgill Reservoir, facing north-west; on the far side, sluice gate **103** lies on the left, the spillway **112** lies in the centre, and the northern sluice gate **102** lies on the right*

Description and Function of Features

6.10 The reservoir has been accurately described by BHWB (1995, Appendix 1/1, 19), and there is little to add with regard to the structure of either the dam **101** or the sluice gate **103**. The survey identified the course of the leats feeding the dam on the south-west and south sides. The south-western leat **110** is only visible as a very shallow earthwork, and appears to have been carried over a natural water-course to the west by a launder, though the course of this was not traced. The leat from the south **109** appears to be carrying water spilling out from a line of shafts and subsidence hollows **111**, and is now quite swampy and difficult to trace. The northern sluice-gate **102** is the current area of concern, as it is eroding rapidly due to the movement of water through the dam wall at this point,

which is visibly leaching out to the north, creating a boggy area. The sluice gate appears to have originally connected to the leat **106** which ran north and served the dressing floor north of the reservoir, shown on the First Edition Ordnance Survey mapping of 1859 (Plate 7). An earthwork relating to the leat, **106**, was seen cutting to the north-west of the reservoir, across a long finger of probable spoil **108**. The course of the leat southwards, where it connects to the River Nent to collect water, could not be traced, though it is clearly depicted on the Ordnance Survey mapping. Both levels, **104** and **105**, are still extant, the lower level in better condition than the upper, and now used as the main access to the mine. The upper level appears to be leaching water, perhaps from the reservoir above, or taking water from out of the mine; this is adding to the boggy area to the north of the reservoir. To the north-west of the boggy area, ephemeral evidence for waggonways **107** was identified in the woodland, though the course of these was not traced as part of this study.

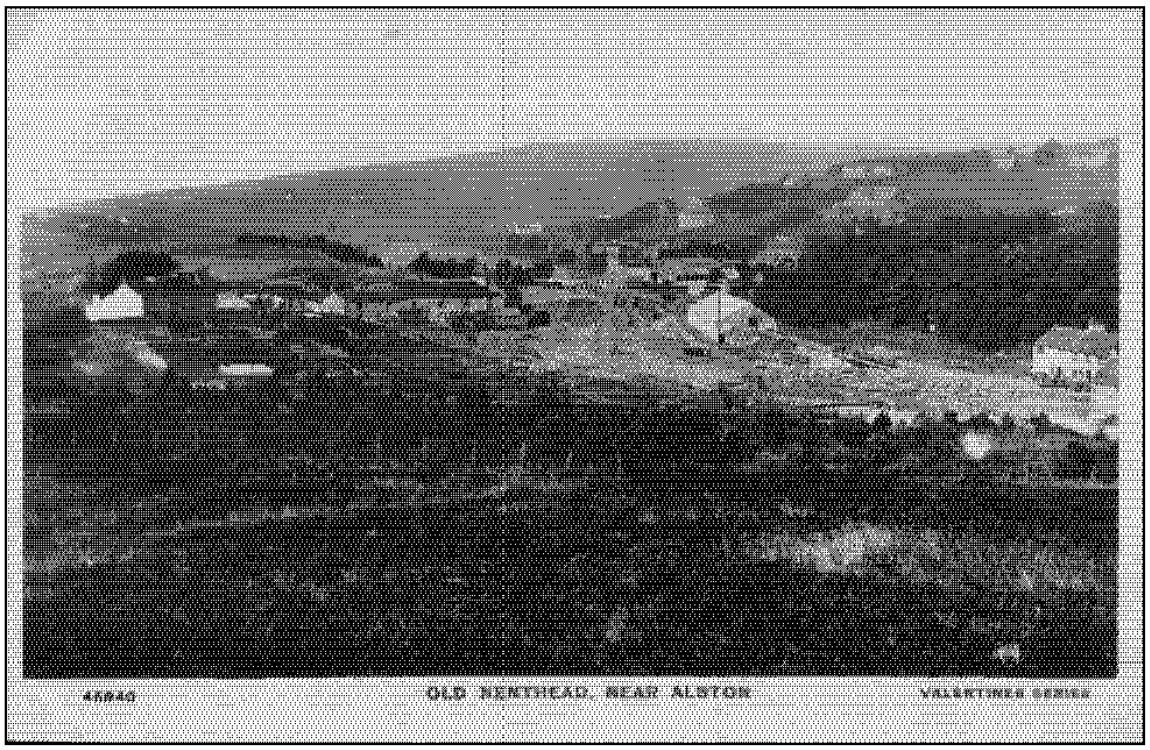

Plate 10: postcard of 'Old Nenthead'; Rampgill Reservoir is visible on the left hand side of the photograph, the dressing floors are in the centre, and Rampgill Mine Shop is visible on the right (© NMCS archive)

Interpretation and Discussion

6.11 The reservoir is a single phase construction, with a sluice gate **102** in the north bank, and an overflow sluice **103** on the west side, letting water back into the Brigal Burn. This failed, and a breach on the west side **112** was enlarged to allow the water to flow out; this breach was later consolidated into a formal spillway in 1999. The reservoir is fed by a number of leats from the south, **110**, and south-east, **109**.

6.12 The reservoir appears to have served a dressing floor to the north of the (upper) Capelcleugh Level

entrance **104**. This floor was primarily fed by a leat **106**, which took water both from the River Nent and the reservoir; the reservoir may, therefore, have been constructed to increase water supply in times of drought. Cartographic evidence shows that the dressing floor included what appears to be a wheel-pit, perhaps for an ore-crusher. To the south-east of this are a series of bouse-teams, which collected bouse from the level mouth, and were served by the north-west spur of waggonway **107**. Records indicate that Capelcleugh Level was being worked prior to the 19th century, and was remodelled by the London Lead Company between 1819 and 1825, when the second (lower) level was driven. The London Lead Company had developed extensive dressing floors north of the river at Rampgill by this time, and this new level was connected to these, which suggests it is likely to mark a secondary phase of development. The earlier dressing floor to the south of the river, and the original upper level, may have gradually gone out of use after this date. The reservoir appears to have not served any further function by the late 19th century, and does not appear to be connected to any of the later phase workings.

Plate 11: Rampgill Horse Level, late 19th century (© NMCS archive)

Area 2: Rampgill Horse Level (Figure 4)

History

6.13 The Rampgill Level **201** has its origins in the early 18th century. Rampgill Low Level was driven in

1736 by the Greenwich Hospital from the banks of the Nent, to prospect the main Scaleburn and Rampgill veins together with numerous cross veins. Liddle, writing in 1737, refers to it as Fairhills Old Level, after Fairhill Vein, which it follows. It would appear that the Greenwich Hospital level may have been a development of an existing level, begun sometime earlier (Fairbairn 1993, 62), perhaps around 1690. Greenwich Hospital leased the vein to Liddle for six months, then after 1745 it passed to the London Lead Company, along with the Scaleburn Vein in 1756.

6.14 By 1778, trials of the veins had begun. Two routes were driven, the Scaleburn branch, which tapped the Scaleburn and Scaleburn Cross veins, and the Rampgill branch, which ran south-east along the High Fairhill Cross vein to the Rampgill, Rampgill Sun, Rampgill Second Sun and Rampgill Cross veins. This ground proved to be the richest ever worked on Alston Moor and between 1703 and 1886, 140,000 tons of lead ore were raised (Fairbairn 1993, 63). The Low Level was of small dimensions, and was probably conceived originally as a drainage level. In 1800, Mr Dodd, agent for the London Lead Company, drove a new horse level above the line of the old drainage level.

Plate 12: Rampgill Horse Level, early 20th century (© NMCS archive)

6.15 By the early 19th century, the Rampgill Horse Level had become one of the main underground horse haulageways, extending for some 5.6km and giving access to the Smallcleugh and Middlecleugh workings via the Hangingshaw Level and J Irwin's cross cut. The position of the Mr Dodd's level is shown on the mine plan of 1825 (Plate 6), which positions it at the corner of the Rampgill Mine Shop **205**. The exact date of construction of the mine shop is not known; on the original mine plan, dated c.1825, it is described as a *'smithy and shop'*. Robert Stagg became superintendent of the London

Lead Company in 1816, and undertook a lot of new building in the period between 1818 and 1820, when lead prices were low and projects needed to be found for the workforce. In addition, there was also a policy within the London Lead Company to introduce mine shops specifically for their workers by 1818, so this seems a probable date for its construction. It is interesting to note on the plan that the smithy/stable (**206**) is depicted on the plan (on the original drawing described as a '*shop*' (mine shop), as well as a further long building abutting the south-east side of the mine shop and running eastwards towards the bank. This now longer survives, but would have been located in the approximate location of the embanked area to the rear of the retaining wall **202**. A '*horse house*' is depicted south of the waggon-ways leading from the level, as a small square building. The level was connected by a waggonway to the Rampgill washing floors, which are now broadly in the position of the modern car park.

Plate 13: Rampgill Mine Shop, in the early 1970s (© NMCS archive)

6.16 The level was subsequently remodelled again, and moved to its present position, as shown on the First Edition Ordnance Survey mapping (1859, Plate 7), at the corner of the Rampgill compound. It is interesting to note that the area above the level was used for a number of undetermined functions in the 19th and 20th centuries: Plate **11** shows what appears to be belt driven grinding-stones, whilst Plate 12 shows a timber building in this position. Evidence of these structures may still survive on the raised area to the east of the retaining wall **202**.

6.17 By the middle of the 19th century, outputs were declining and the London Lead Company gave up the Scaleburn vein in 1882. However, the Rampgill Horse Level continued to be used by the Vielle Montagne Zinc Company into the early 20th century for access to other mines, and in 1902, a 12

horse-power single-cylinder petrol-driven locomotive was introduced, capable of pulling twenty-five waggons at a time (Anon 1914, 151).

Previous Investigations

6.18 The level entrance **201**, being one of the most readily accessible features within the Nenthead Mines complex, has been recorded extensively throughout the 20th century. In 1999, the level was identified as being near collapse, with both the side walls bulging outwards for a length of 6m from the entrance. A proposal to remove the roof slabs and to rebuild the side walls was duly carried out. Removal of the covering deposits above the roof slabs was undertaken under archaeological supervision; a metal pipe of uncertain function was identified running across the top of the slabs. During the dismantling of the walls, it was identified that the deposits behind the level walls comprised deads for the full length of the repair. A 10 inch diameter flanged mine tub wheel was recovered from deposits behind the north wall (Krupa 1999).

*Plate 14: Rampgill Horse Level portal **201**, with retaining wall **202** to left, smithy/stables **206** to the right and culvert **208** at the base of the photo; the modern pipe houses a recently installed meter*

Description and Function of Features

6.19 The portal of the level **201**, which is 1.2m wide and 2m high, comprises walls of roughly coursed squared stone rubble set with a lime mortar (Figure 4). The level is roofed with flat stone slabs at the

entrance for a short distance; beyond this, the slabbed roof is replaced by stone arching, before being cut into solid rock. There is a small square recess in the west wall, a short distance inside the portal. Though the level itself lies outside the scope of this survey, approximately 100m beyond the entrance, a short side passage branches off the main level and leads to the open Brewery Shaft. The level at this point is 28m below the shaft collar and the shaft continues downwards for another 80m to the Nentforce Level. Much of the pipework forming part of the hydraulic system remains and the compressors and generators at the base of the shaft, are still *in situ* (this is most fully covered in Wilkinson 2001). The Rampgill Horse Level portal is gated.

Plate 15: retaining wall ***202***

6.20 The floor of the level includes chairs and sleepers for the waggonway, visible under a constant and substantial flow of water, which emanates from the mine. The water flows into an underground culvert **203**, approx 2m wide and 0.3m high at its mouth, which is flagged with stone flags supported on iron rails. The course of this culvert is not known, but it appears to follow a diagonal path westwards across the car park to a small aperture built into the retaining wall, on the north-east side of the river, from which a constant stream of water flows. It is possible that this culvert utilises the line of the first level, driven in the early 18th century or earlier. Leat **204**, now largely inactive, may have connected to this culvert, running beneath the position of the mine shop.

6.21 The west side of the portal is abutted by a retaining wall **202** , made of random coursed and squared stone rubble, bonded with lime mortar. The wall runs west to the position of the mine shop **205**,

which was demolished 1972-3; this shop originally had two storeys, the upper storey accessed on the south-east side by an external staircase. The area of the demolished mine shop was subsequently disturbed by modern dumping, and the remains of these tips and the demolished structure were pushed back and heaped into the current bank in the late 1990s, during a general programme of tidying up of the area. At the time of the BHWB survey (1995, 34), the north wall of the building still survived, standing up to 1m high and built of roughly coursed squared stone rubble. A blocked recess, possibly a fireplace, was recorded at the western end of the wall with a small iron pipe projecting from the top. There are now no structural remains visible. The retaining wall between the portal and building measures approximately 8m in length and 2m in height. This wall, which forms the basis of the main conservation works, is otherwise featureless, but photographs dating from the late 19th and early 20th centuries indicate that at one time it included a recess at the top of the wall to allow ladder access to the raised area behind the wall (see Plates 11 and 12).

6.22 The east side of the portal is abutted by building **206**, now incorporated into the former cafe at the Visitor Centre, but believed to have originally functioned as a stable or a smithy. This is the building marked as a '*shop*' on the 1825 mine plan.

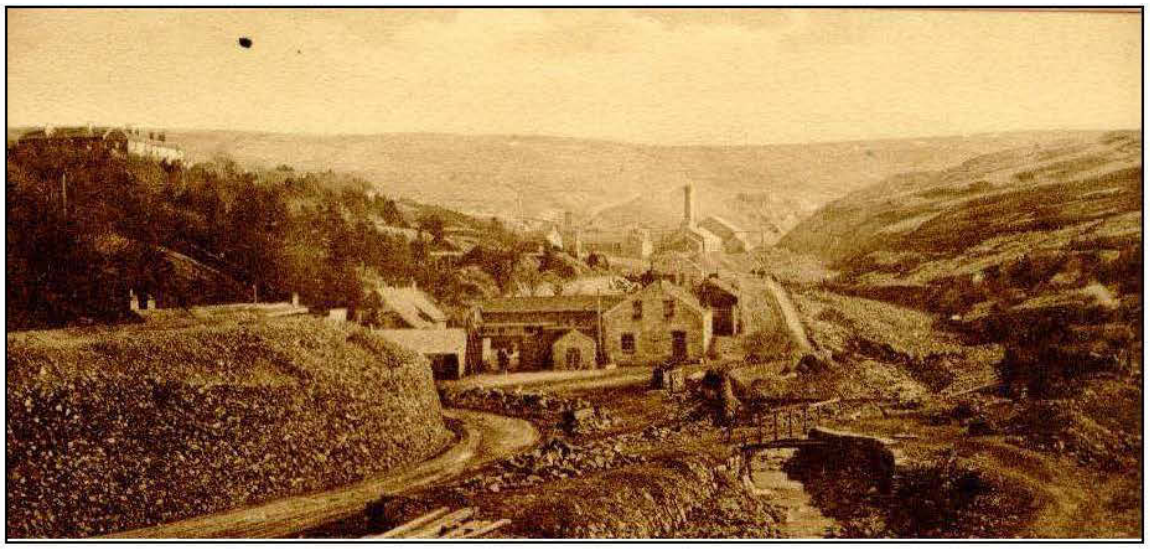

Plate 16: Rampgill Compound, late 19th century; the smelt mill complex is visible in the middle distance. The deads on the left have been mounded up for reprocessing (© NMCS archive)

Interpretation and Discussion

6.23 The Rampgill Horse Level, in its current form, appears to originate between 1825 and 1859, and has been remodelled at least three times since it was first driven, probably in 1690, but certainly by the early 18th century. The level still includes a number of its original features, but was rebuilt in the late 20th century as part of consolidation works by the North Pennines Heritage Trust at the mine. The portal **201** lies inbetween two buildings, a mine shop **205** (now demolished) and a smithy/stables **206** which may also have served as a mine shop. These buildings both probably date to between

1818 and 1825. An earlier building, depicted on the south-east side of the mine shop in 1825, is no longer extant. Photographs taken in the late 19th century and early 20th century showing buildings on the high ground to the rear of the retaining wall **202**, would indicate that archaeological features or deposits could survive to the north of the retaining wall. The retaining wall itself, which probably dates to between 1825 and 1859, is a simple stone wall, and is featureless.

Area 3: Nenthead Smeltmill Complex (Figures 5 and 6)

Introduction

6.24 The Smeltmill complex (**300**) at Nenthead is a complicated structure, which has developed organically since at least the middle of the 18th century until the present day. The complex comprises at least nine buildings, paved courtyards and passageways, the Bingsteads, and the Spine Wall, the latter two elements being the largest upstanding remains within the complex (Figure 5). Previous reports (e.g. Town 2005) have used a system of letters for naming the individual buildings. This system was developed historically, and is still used to a certain extent on site today. These letters are used where relevant in this report (Figure 6). The individual history of each building will also be discussed where known. The areas are discussed broadly chronologically, as follows:

- The Smelt Mill and Spine Wall
- Building A
- Building B
- Building F
- Building F-B
- The Pattinson House (Building C)
- The Rozan House (Building D)
- The Robey Boiler House (Building E)
- Lancashire Boiler House (Building H)
- The Bingsteads

Previous Investigations

6.25 Most of the smelt mill structures were summarily assessed during the early survey (RCHME 1993, BHWB 1995), and the first metric survey of the standing structures was carried out by Lancaster University Archaeological Unit in 1997 (LUAU 1997). From 1998, the first programmes of clearance and consolidation started on the smelt mill. This mainly involved clearance of materials derived from the collapsed and demolished buildings in the area, and the deposits of mine waste, which had accumulated across the site. The degree of survival and condition of the mines were initially assessed

through the excavation of a series of test-pits, followed by targeted machine clearance, during 1998-9. Other parts of the smelt mill complex (mainly the Pattinson and Rozan Houses) were subject to further clearance in 2001. No further works were carried on the smelt mill complex until 2005, when the author undertook the first in a series of periods of archaeological recording in order to fully integrate all the available plans and elevations of the structures. This is reported in Town 2005 and Cavanagh and Town 2009a.

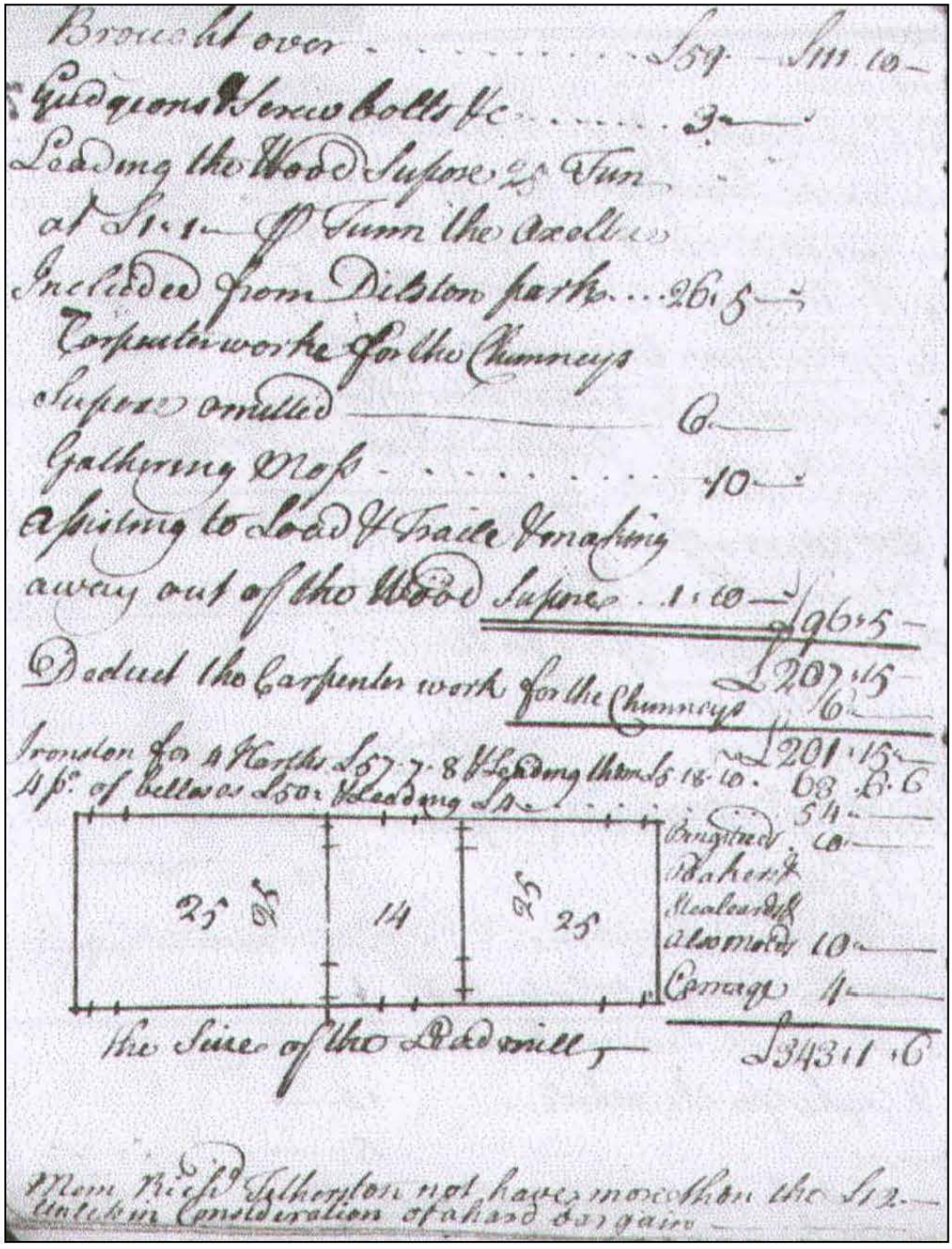

Plate 17: detail from Liddle's account book, May 26th 1737. The rectangular outline at the bottom represents a plan of the proposed lead mill (© NMCS archive)

History, Description, and Function of Features

6.26 *The Smelt Mill and Spine Wall:* George Liddle was responsible for erecting the first smelt mill at Nenthead in 1737. Details of the mill are included in Liddle's account book, written in Alston on May 26th of the same year. The description details that the roof was of slate, and that the mill consisted of seven rooms, each room 3½ yards or 3.20m in width. The walls, chimneys (several are indicated, but the number is not given), and wheel-pit were presumably of stone construction, since the description details a Peter Muncaster and Nicholas Lee as *'... winning Leading and walling all the Hous & Wheel hole and plastering the Chimneys casting the foundations of House and Wheele hole etc'*. A Thomas Forster was instructed to make *'the Wheel* [...] *& Bellos frames and hanging for 4 harths & all other things belonging to ye Ironwork'*. The account also details *'Ironston for 4 harths* [...] *& leading them* [and] *4pr of bellos* [...] *& leading'*. The mill is said to have been completed by Michaelmas (September 29th) 1738, at a total cost of £900 (Fairbairn 1993, 179).

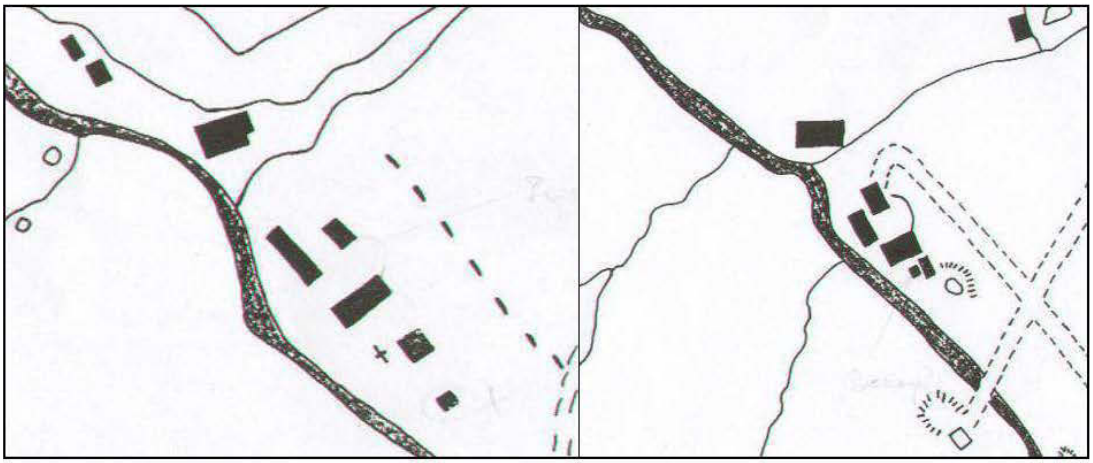

Plate 18: 1773 and 1805 Greenwich Hospital Plans (© NMCS archive)

6.27 The mill therefore had four ore hearths, blown by four bellows powered by a water-wheel (Fairbairn 1993, 178; Fairbairn 1998, 64). Ore hearths were widely in use in Derbyshire and the North of England, and commonly used waterpower to power bellows, with peat and wood as fuel. By 1780, these furnaces bore close similarity to the modern ore hearths which were in use in Newcastle until 1960; contemporary accounts by Mulcaster in 1795 describe the ore hearth as consisting of a cast iron back (including a pipestone through which the bellows provided air-blast) and sides, with a cast iron *'workstone'* at the front, with a channel leading the molten lead to a *'sumpter pot'* (Tylecote 1971, 3).

6.28 A few years later the smelt mill was sold to the London Lead Company. The exact date of the smelt mill being reopened is unclear; a date of August 1746 is given (Fairbairn 1993, 179), and the smelt mill was certainly in use by 1750 (Almond 1977, 28). The current smelt mill building is likely to be the original Liddle smelt mill; there is some debate as to whether the smelt mill was in fact entirely rebuilt and that the current structure could represent a later mill building constructed by the London Lead Company, but the author feels this is unlikely. The smelt mill built by Liddle was a new

building, only eight years old, and it would have been an unnecessary expense to demolish and rebuild a functioning smelt mill, though this possibility cannot be totally discounted (see Town 2005).

6.29 Nevertheless, changes were certainly made to the building, and Raistrick (1938, 23) states that in 1753, the smelt mill was extended, but provides no further detail. London Lead Company minutes dated 3rd September 1764 state *'Nenthead Smelt Mill is nearly repaired and there will soon be two smelting hearths and one slag hearth. There are now two pairs of double bellows there and it is expected they may be ready to work in two months time. £131 11s 0d paid for five pairs of smelting refining bellows sent to the Company's works in the North'* (Greenwich Hospital Minutes transcription, NRO). The minutes record a further hearth being built there in 1767, and that *'all unrefined ore near said mill be smelted there for sale in pigs of one hundredweight each'* (*ibid*).

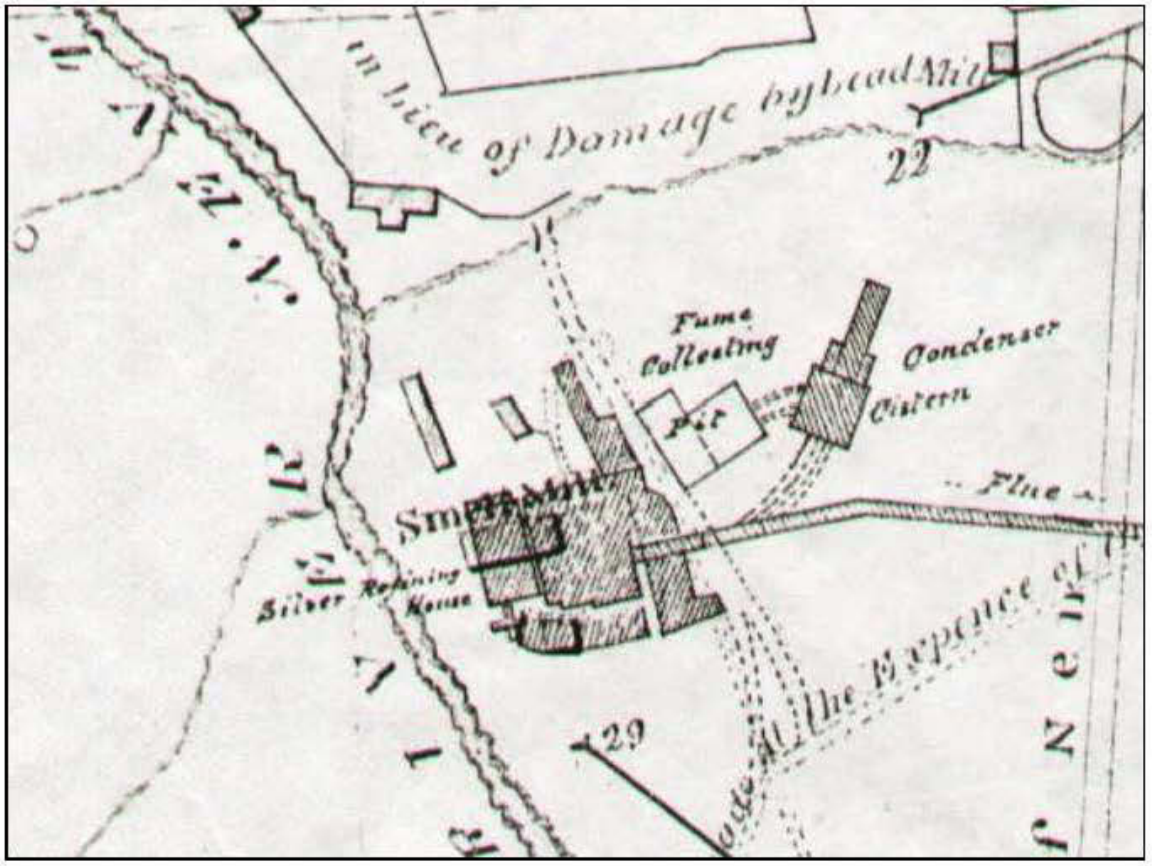

Plate 19: Detail of 1825/1848 Greenwich Hospital Plan (© NMCS archive)

6.30 In minutes dated the 11th December 1788, it is recorded that Robert Stagg, superintendent of the mines, started trials at Nenthead on the efficiency between the ore hearth, blast hearth, and coal-fired reverberatory furnaces for different ores (Greenwich Hospital Minutes transcription, NRO), over a period of years and using coal supplied from Coanwood colliery and the local mines. The London Lead Company had successfully used the coal-fired reverberatory furnace for non-ferrous smelting in its Flintshire works by the 18th century (Tylecote 1971, 2). According to Dufrenoy, who visited the area at the time, reverberatory roasting furnaces were introduced to Alston Moor by 1810, with the

roasted ores subsequently smelted in an ore hearth (Tylecote 1971, 6), and minutes of 12th September 1811 record that '*the court decided to erect a Roasting Furnace at Nenthead Smelt Mill on the advice of Robert Stagg* [Robert Stagg's son, and the subsequent superintendent]' (Greenwich Hospital Minutes transcription, NRO). A report by Pattinson, in 1831, confirmed the use of the reverberatory furnace for roasting in the North of England (Pattinson 1831, 153-6).

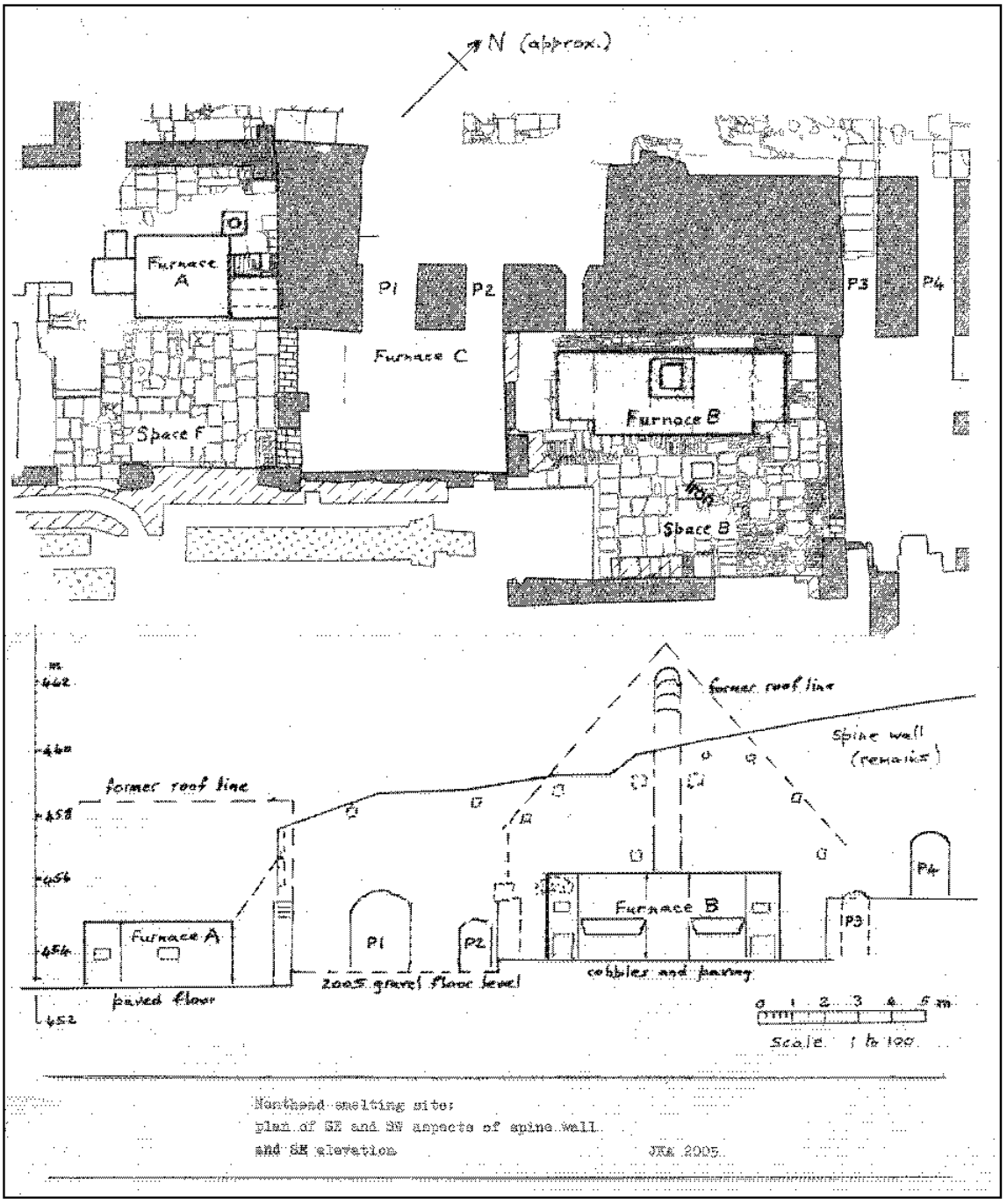

Plate 20: plan elevation showing disposition of smelting equipment south-east of the Spine Wall (after Almond 2005)

6.31 The ground plan of the original smelt mill built in 1737, certainly did not allow for much expansion in terms of the construction of additional hearths, and it is clear that more space would have been

required. The construction of an extension therefore seems logical, and may account for the construction of Building A, a long rectangular building constructed onto the north-west side of the original structure. Archaeological work within Building A has identified that it was the location of three furnaces, though these almost certainly date to the final phases of lead mining at the complex, as hearths and furnaces were rebuilt regularly. Early Greenwich Hospital plans of the smelt mill from 1773 (Plate 8) show four buildings within the smelt mill complex, the north-east to south-west aligned building being the smelt mill. A similar, though slightly more schematic, layout is shown on the 1805 Greenwich Hospital plan (Plate 18), though not enough detail is provided of the layout to be clear.

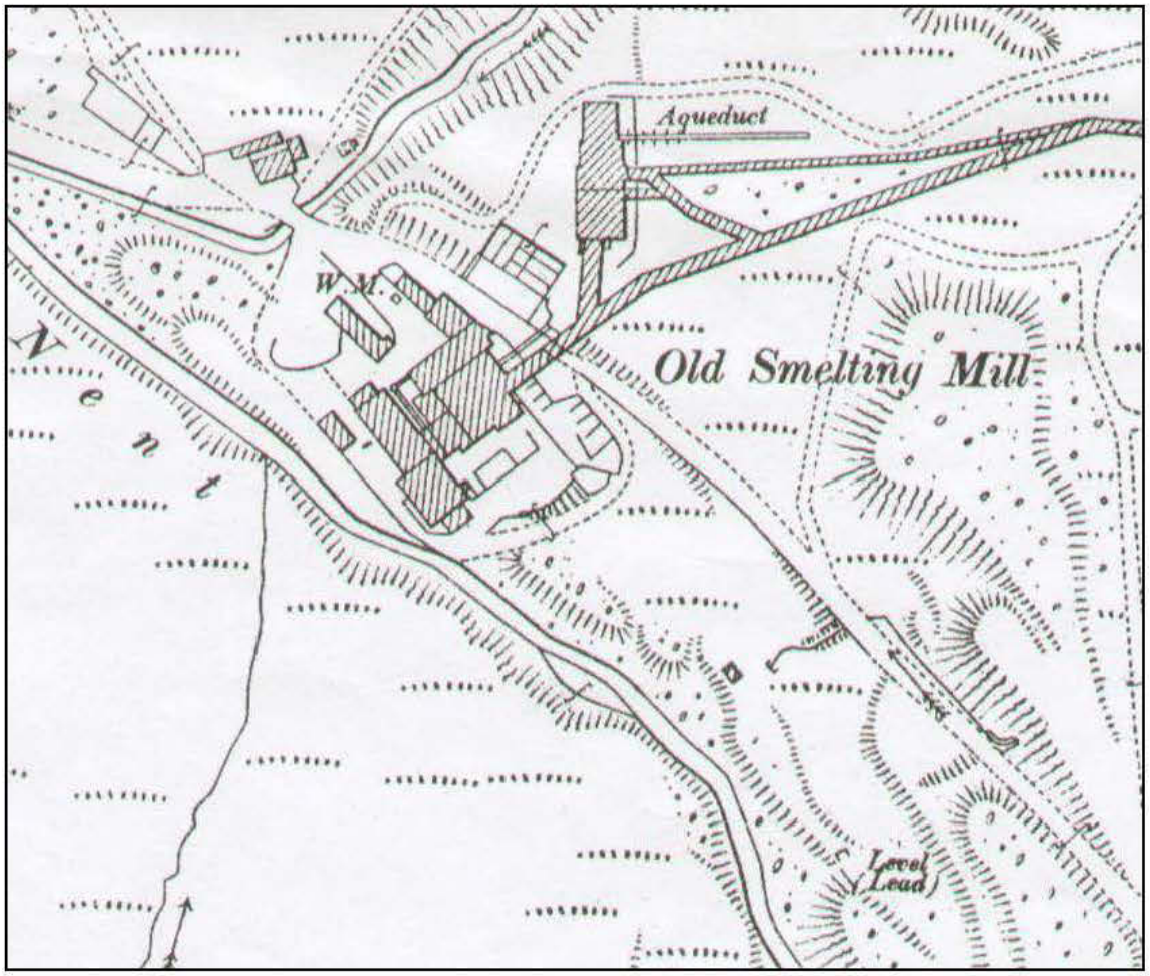

Plate 21: Detail of 1898 Second Edition Ordnance Survey Map - note 'old smelting mill'(© NMCS archive)

6.32 The horizontal flue is known to have been planned as early as 1802 (Greenwich Hospital Minutes transcription, NRO) and the flue appears on a Greenwich Hospital estate map of c.1822, which implies construction between these dates. The flue was supported by the Spine Wall which has been demonstrated archaeologically to abut the smelt mill on its south-east side. The flue is more extensively discussed in the following section.

6.33 Between 1818 and 1826, Robert Stagg is said to have redesigned the smelt mills at Nenthead and

Eggleston *'with astonishing results in the way of increased efficiency and improved quality of lead, and also considerable saving on costs'* (Raistrick 1938, 145). In 1821, the smelt mill is described as having the following equipment installed: four roasting furnaces, two refining furnaces, one reducing furnace, four ore hearths and one slag hearth (Almond 1977, 28; Fairbairn 1993, 179). By this time, the mill was one of the company's two main metallurgical plants (the other being at Eggleston in Teesdale), capable of treating 3250 tonnes of lead concentrate a year, producing 2540 tonnes of market lead. On the 10th of May 1864, a resolution was passed at a meeting to erect a *'Calcining Furnace'* (roasting furnace) at Nenthead Smelt Mill, and on the same day *'the superintendent was authorised to construct a double roasting furnace at Nenthead Smelt Mill'* (Greenwich Hospital Minutes transcription, NRO). Gill (*pers. comm.*) noted that this may have been Alfred Jenkin's patent double roasting furnace of 1855 (Smith and Murphy 1998, 91). Whellan, writing in 1865, describes the smelting process at Nenthead: *'the roasting is what a metallurgist calls a beautiful process; the ore is spread on the sole, or floor of the furnace, and is heated to a temperature at which it parts from its sulphur and takes up oxygen but does not melt. In another furnace it is melted, and you see the molten stream flowing from the mouth into a pot. In another, the stubborn slag, or dross or refuse, is heated by a roaring blast, becomes docile, yields every particle of lead, while splendid blue and green flames leap in the impetuous current'.*

6.34 It is clear that any original provision for smelting at the site would have required considerable additional space following the redesigning of the smelt mill undertaken by Robert Stagg around 1819. It is therefore probable that this provided the impetus for the construction of additional buildings around the Spine Wall - Buildings F, B and F-B - which are of a similar date. Mike Gill (cited in Almond 2003, 1) stated that:

- roasting is likely to have occurred on the south-east side of the Spine Wall, nearest the bingsteads (Building B)
- the ore hearths would have been located at each end of the wheel-pit (Smelt Mill)
- the slag hearths would have located close to the ore hearths (perhaps in Building A)
- and the refining furnaces would have been located at the south-west end of the Spine Wall, close to the desilvering plant.

6.35 Later some of the buildings are thought to have been used for the specific purpose of production of litharge for commercial sale to the chemical industry, a product that is thought to have been introduced to Nenthead in circa 1880: *'there was introduced into the mill a process by which a certain product was extracted and casked for sale to meet a new demand in chemical factories elsewhere...it was the colour of gold dust and was so fine in texture that when disturbed it flew into the air. It was rankly poisonous...it generated cholic...from which no one survived beyond the third attack'* (Chester Armstrong 1938 *Pilgrimage from Nenthead* cited in Almond 2005, 13; Plate 20).

6.36 With the uptake of the leases by the Vielle Montagne Zinc Company in 1896, the smelt mill was

closed down, as the zinc smelting process was different to lead smelting and could not be carried out in the same furnace. No photographs survive of the original smelt mill still standing, and it is probable that it was extensively robbed as it was the least useful building on the site (other buildings being more easily adapted for other functions).

Plate 22: ore hearth partially excavated in 1998 (© NMCS archive)

6.37 The smelt mill building was not clearly identified until works undertaken in 2005 (Town 2005) identified the structure as a building in its own right, and indicated that this structure was likely to be the earliest smelt mill on the site (Figure 6). The report identified that the building was rectangular and constructed around, and aligned with, a central wheel-pit. The north-western and south-eastern walls appear to lie at around 3.5m from the wheel-pit, while the south-western and north-eastern walls are at approximately 8m from the respective ends of the wheel-pit. The walls are now only visible for the most part as wall stubs. The building measures 24.7m in length by 9.2m in width, and survives to only a few courses in height, except on the north-east side where the walls still stand to approximately 2m in height. The building is divided by stone walls into three areas of approximately 8m width each. The north-east and south-west cells were working areas, where the lead was smelted, whilst the interior cell housed the water-wheel and the air-blast generation equipment.

6.38 The two main working areas both retain evidence for a pair of brick hearths built against the inner dividing wall, with a flagged floor in front of the hearths; as discussed above, these hearths date to the very final days of the smelt mill being worked, probably by the Nenthead and Tynedale Lead and Zinc Company the period 1882 to 1895. Most of the bricks in the smelt mill are late 19th century in date, and are stamped 'TYNE', with a crown logo (from the Tyne Crown Firebrick works, which

operated in the Tyne Valley c.1880 – Davison 1986, 86), 'R, F & S' (possibly from Rutherford, Forster and Stobart, who operated a brickworks at Corbridge Station in 1877 – Davison 1986, 86) and 'HUDSPITH' (William Hudspith owned the South Tyne Colliery at Haltwhistle between 1870 and 1901 – Gill *pers. comm.*). The large, rusted, rectangular, iron plates, set within the flags, are thought to be discarded furnace components, probably hearth bottom pans or *'working stones'* (Almond 2003a, 2)

6.39 The inner dividing wall, where it survives, includes a broad wedge-shaped stone behind each hearth, which would have represented the pipestones for the bellows. The hearths and flooring survive best in the north-east cell; one of the hearths in the south-west cell, has now been robbed out but its position can still be inferred. Most of the flooring in this area has also been removed. The hearths were separated from each other by a thin stone wall (again, only visible in the north-east cell), and springers for arching are also visible, which would presumably have crossed the front of the furnaces supporting a fume-hood (Almond 2003a). The fume, presumably originally went straight up a chimney, but was latter capped and sent at an angle into the spine wall. The cells are accessed by two doorways each, those in the north-east cell connecting to a passage-way through the Spine Wall.

6.40 The central cell includes the wheel-pit, which presumably dates to the same period as the construction of the building. The wheel-pit measures 7.45m by 0.87m, and extends to 2.25m in depth. The base of the wheel-pit is constructed of large stone flags laid end to end, with a slight south-western slope. The tailrace culvert entrance is capped by a large stone block, overlain by three courses of stonework, which are set back and angled to accommodate the wheel. At the north-eastern end, the wall also angles back to accommodate the wheel, and consists of at least eighteen courses of stonework. The lower three courses are also angled outwards on the northern side of this wall, forming a curve to the face towards the base of the wheel-pit. Both side-walls have a timber balk lying across the tops of the walls for the length of the wheel-pit, and these balks are the remnants of a timber shroud that originally housed the wheel. Both balks have a series of mortises cut into their upper surface; the north-western balk has twelve mortises and the south-western balk has opposing identical mortises, though due to the damage caused by a fire these now only number eight in total. The water-wheel was supported on two mounting blocks arranged each side of the wheel-pit. The wheel-pit dimensions imply a water-wheel of around 7m in diameter.

6.41 North of the wheel-pit, the flagged surface appears to incorporate a number of elements that may relate to the original air-blast system, which would have used bellows, powered by the water-wheel. An arrangement of timber and a series of stones with square sockets are visible. These are thought to have originally held a frame to support the bellows, which may also have been connected to the timber wheel-shroud. Almond (2003b, 4) also suggests the possibility that the frame may have held a horizontal shaft, perhaps relating to the rotary mechanism for the bellows.

6.42 At some point in the mid to late 19th century, the bellows were replaced by a belt-driven fan, located on a machine base to the south-east of the wheel-pit, and directing the air into a pipe partially cut into the Spine Wall. Brakell's Fan of 1869 is one possible type, which may have been used. The air-

blast appears to have been directed underground through a brick inlet, into an arrangement of iron pipes; the air-blast was then directed to the surface through square brick outlets, set behind the walls to the rear of the furnaces. An iron pipe was presumably fixed to the outlets in order to feed the air-blast directly at the heat source. A series of iron column bases, adjacent to the south side of the wheel-pit, mark the supports for the belt-drive mechanism (Almond 2003b, 7). The position of the fan and its mechanism would have made the usage of the original doorway through the Spine Wall difficult; it is possible that when the fan was installed, the door was blocked, and a new doorway inserted. The dating of the installation is uncertain, but a late 19th century date cannot be ruled out (Almond 2003a; Almond *pers. comm.*).

6.43 The building survives largely as it was recorded in 2005, though large dumps of stone from the failing Spine Wall have fallen on the surviving hearths, damaging them badly.

Plate 23: Building A, south-west gable, photographed by Peter Jackson, early 1960s (© NMCS archive)

6.44 *Building A:* Building A measures 25m by 7.6m, and incorporates the northern wall of the smelt mill within its construction (Figure 6). The walls only survive to a few courses in height, and little is known of the original openings. The building was accessed through the south-western elevation by a large double-door, with a smaller door to the south-east (shown partially blocked in photos), and a rectangular central window, with a drain beneath. The north-western side of the building included at least seven further windows, whilst the south-east wall included two archways, connecting the building with the smelt-mill. These archways were bricked and walled up, probably around the time of the installation of the fans (Plate 24). The arrangement at the north-eastern end of the building is unknown, as it is obscured by a large stone hopper constructed in 1961 by the Rampgill Mine

Company, but never used (Peter Jackson *pers. comm.*). The north-eastern wall stands to its full height (c.4m) and preserves the ridge-line of the building within the stonework. Fairbairn noted that the roof structure consisted of king post trusses with additional metal ties. The roof was covered in slate (Fairbairn 1998, 66).

Plate 24: Blocked arching, Building A 1960s (© NMCS archive)

6.45 Very little of the interior floor now survives, having been extensively robbed, though sections of flagged floor survive at the south-west end, and as small islands within the centre. When the building was initially stripped of rubble in 2001, a waggonway connected to a turntable was identified, which runs north-eastwards off the waggonway in the alley through the double doors, and through the interior on the north side of the building. Little is now visible of this feature as it was reburied *in situ*, though isolated timbers can still be seen along this side. The waggonway appears to have been constructed to transport lead ore from the bingsteads up into this building for smelting.

6.46 Only one original hearth now survives in this building, comprising a brick structure measuring 3m by 1.5m, made of similar brick to that used in the smelt mill and therefore of late 19th century date. The air-blast was via an outlet to the rear of the hearth, and connected to the fan within the smelt mill building. The position of two further hearths or furnaces can be inferred from the position of two further inlets through the south-eastern wall, broadly in the location of the blocked arching between the smelt mill and Building A; the flags in this area are badly heat-affected, and some evidence of brick structures is evident adjacent to this area, suggesting a furnace or furnaces stood in the centre of the building at this point. There are no other obvious internal features within the building, other than a concrete machine-base (probably of early 20th century date) and some evidence of brick

infilling where an unidentified internal feature (possibly another machine base) has been removed.

Plate 25: Building B, photographed by Clough, c. 1951 (© NMCS archive). The spine wall abuts the north west wall, and the cart entrance is visible in the south east wall.

6.47 *Building B:* Building B measured 10m x 7.35 m and was constructed along the Spine Wall, which formed the northern wall of the structure (Figure 6). The original use of Building B is not known, though it was probably constructed to house a furnace, as there is a 1.0m wide area of heat-affected burnt stone that runs the full height of the Spine Wall, located in the centre of the building. The survey carried out by Lancaster University Archaeological Unit states that the shape of the burning, coupled with the occurrence of two recesses to the south-west and one to the north-east, suggests a free-standing flue held in position by timbers housed in these recesses (1997, 81). This suggests that a flue was affixed to the outside of the wall, and turned inwards to the main flue carried by the Spine Wall just above the surviving lip. These flues may have been metal ducts (Almond 2003a). The type of furnace in this building is not known; Almond (2005) suggests that it later housed a large refractory furnace for cupellation. Although the surviving archaeological evidence for this is scanty, some features of the building do accord with this interpretation. The cupellation process involved a furnace with a large removable base or "*test*", which was changed on each firing. As each test could weigh

up to half a tonne, the provision of a waggon entrance and a loading bay, perhaps for the removal of the spent tests, seems quite sensible. The building is depicted on the 1859 First Edition Ordnance Survey map, and is also shown on the Second Edition map of 1898. It stood substantially intact until circa 1961; photographs (Plate 25) show it to have a steeply pitched stone-slated roof, with the roof ridge aligned at right angles to the Spine Wall. The southern wall incorporated a small ground floor level window at its western end and a large arched cart entrance in its eastern end. Subsequent photographs show the building to have decayed rapidly, the structure being completely demolished by circa 1970.

Plate 26: plan view of flooring, Building B

6.48 Structurally the building is a simple stone construction, with some evidence of repairs and rebuilds in brick. The south-eastern wall incorporates a large cart entrance noted in historical photographs, with a central stone door-stop and sockets indicating it held double-doors. The south-western wall also incorporated a small doorway into Building F/B, which was subsequently blocked up. Building B is

floored with rectangular stone flags which are mostly well-preserved, but there are several patches of sub-rounded cobbles that appeared to be later insertions or repairs. Of particular interest is a large patch of cobbles situated centrally in the room, immediately adjacent to the Spine Wall and directly beneath the burnt wall marking the location of a now-lost vertical flue. It is likely that the patch of cobbles marked the location of a robbed out furnace. The floor surface here is relatively high and Krupa proposed that any remains of the furnace may have been buried by the later raising of the floor level, with spaces between the cobbles suggesting that there are voids below this cobbled floor (Krupa 1999).

6.49 In the south-west corner of the building is a large sunken area, revetted with stone-built walls which represents a purpose-built loading bay inserted into the building at a later date. The loading bay led into the Lancashire Boiler House (Building H); in the 20th century, the building was used as a coal-store (as evidenced by the clinker inbetween the cobbles) and the bay was to allow easy loading of the boiler from this building.

Plate 27: plan view of floor, Building F, shortly after excavation in 1998 (© NMCS archive)

6.50 *Building F:* Building F measured 10.5m x 9.2m and was constructed against the south-western end of the Spine Wall (Figure 6). The original building depicted on the 1859 First Edition Ordnance Survey map appears to have been slightly smaller, but was expanded to the south-west between 1859 and 1882, in order to utilise the walls of the Pattinson House and Rozan House. The building survived, albeit latterly in a semi-roofed and derelict condition, until circa 1970. The roof of Building F was one of several that were recorded by Fairbairn in 1974 prior to their demolition. Fairbairn noted that the roof structure consisted of a ridge beam, supported by king post trusses, with additional posts and

two through purlins on each side. The roof ridge ran parallel to the Spine Wall, and comprised king-posts with additional posts, covered in grey slate (Fairbairn 1998, 68).

6.51 The south-eastern wall includes three entranceways: a cart entrance at the north-east end, with an adjacent doorway; and a further adjacent opening to allow the passage of a waggonway up the alleyway to Building A. From the available cartographic evidence, this alleyway was open in 1859, but was partially covered over by 1899. All three of the entrances were blocked with a mixture of brick and stone rubble. This is likely to have occurred when the building housing the Lancashire Boiler (Building H) was constructed, immediately to the south, by the Vielle Montagne Company after the cessation of smelting activities, in the early 20th century.

Plate 28: flue within the south-west end of Spine Wall, note blocked arching to Building F-B, and adjacent arch springer

6.52 Internally the building has the remains of a flagstone floor surface, which respects the line of the waggonway, particularly noticeable where the cobble infill between the longitudinal timber sleepers of the waggonway gave way to carefully laid flagstones within the footprint of the building. In the southern part of the building, the floor surface appears to have been re-laid or patched after the waggonway went out of use. Several areas of the floor appeared to be patched with later infill, indicating the removal or alteration of internal features. Adjacent to the Spine Wall, a rectangular patch of flagstones, concrete and brick, appears to be filling a void left by a robbed-out furnace that was associated with a firebrick flue inserted into the Spine Wall at a height of 1.60m. A machine

base is also visible, probably a later insertion. Building F is thought to have later been the site of a reducing furnace, smelting litharge to create metallic lead (Almond 2005).

6.53 *Building F-B:* Building F-B is a small (7.45m x 2.20m) building and was constructed along the Spine Wall, which formed the northern wall of the structure (this building is therefore post-1802 - Figure 6). The building is situated between (and is later than) Buildings B and F (it was not given a formal letter title at the time of naming), and appears to have infilled an existing space between the two buildings. The building was largely unknown until the excavations undertaken in 1998-9, as it does not appear on any of the historic photographs (being obscured by adjacent buildings) though it is clearly depicted on the 1859 First Edition Ordnance Survey map as a roofed structure. The structure had been substantially demolished by 1967, and was completely obliterated by 1970.

Plate 29: Building F-B in 1998, after clearance of rubble (© NMCS archive)

6.54 Structurally, the building is a simple rectangular stone construction. A south-eastern wall connecting the two buildings, originally defining its south-eastern extent, was later modified and rebuilt in brick following the construction of Building H, which housed the Lancashire Boiler. There appear to have been doorways on the south side of both the south-western and north-eastern walls, marking access points to Buildings F and B respectively, and there appears to have been a corridor or working area between the two doors. Limited excavations within the building uncovered the remains of two furnaces, both situated adjacent to the Spine Wall, and probably later than the building itself: a brick-built structure immediately to the west of north-west passageway, and a refractory brick constructed plinth straddling the south-western passageway. Both are located below heat-reddened areas on the Spine Wall, which appear to have been cut by the insertion of the south-eastern arch. LUAU (1997,

80) proposed that the shape of the burning suggests the two structures had a shared flue above a certain height, and that one of the structures may have been removed when the brick arch was inserted. Fumes from the furnace were led to the main Spine Wall flue via a now-lost flue that was constructed against the Spine Wall, resulting in heat damage to the Spine Wall stonework.

6.55 The south-western wall originally incorporated an arched opening through from Building F, but this was blocked up with stone, either when the building was constructed, or when the furnaces were inserted (Plate 28). This wall incorporates a stone pier, which looks to be the support for an arch springer, which would presumably have crossed the front of the furnaces supporting a fume-hood (Almond 2003a). The furnaces have been preserved *in situ*.

6.56 The small size of the working area and the location between two existing furnace buildings suggests that Building F-B may have been something of an afterthought, inserted between Buildings F and B, which had been purpose-built to house furnaces, and was itself subsequently remodelled to incorporate the furnaces in its centre. Almond (2005) identified the building as a site of commercial litharge production, and this is plausible, particularly since the likely second phase of expansion and establishment of the furnace within the building (circa 1850-1896), accords well with documentary evidence regarding the introduction of the process (circa 1880).

Plate 30: the complete destruction of Buildings F, B, F-B and the Pattinson House – taken in the 1970s (Dr Patrick D. Armitage; © NMCS archive)

6.57 *The Pattinson House (Building C):* the Pattinson House measures 23.2m in length by 11.3m in width, and now only exists as very low bases of walls, apart from the south-eastern wall, which survives to

2m in height (Figure 6). The building is named after Hugh Lee Pattinson, who discovered in 1829, initially by accident, then through a series of experiments, a process for desilvering lead, to which he gave his name (Forster 1883, 203), and which he patented in 1833 (Tylecote 1971, 9).

Plate 31 Hugh Lee Pattinson, reproduced from Raistrick and Roberts (1990, 72)

6.58 The separation of silver from lead by cupellation was undertaken at Nenthead from 1791 (Almond 2005, 1), but was only undertaken on ore with eight or more ounces of silver per ton of lead, in order to make it economically viable (Nall 1886, 20). In 1835, the first large-scale trials of Pattinson's new desilvering technique were carried out in *'the old smeltmill'* at Nenthead (Almond 1977, 28). The process, known as '*Pattinsonisation*', involved the heating and cooling of lead in large '*Pattinson Pans*'; the lead was heated to molten state, and then allowed to cool; the cooled lead formed dendrites on the surface of the molten lead, which were less silver-rich and could be scooped out. By repeating this process, the point was reached where it was uneconomic to go on separating what remained of the lead. The process did not give pure silver, but rather a silver-rich lead, which was

refined in the usual way. Anecdotal evidence suggests that after the introduction of the process, an offer of *'new lead for old'* was introduced in the area, on the basis that the old lead could be removed, de-silvered and replaced for less than the value of the recovered silver. Unfortunately, removal of the silver resulted in a reduction in creep strength, which allowed lead to flow in warm conditions. The processed lead therefore had to be replaced again, so this idea was short-lived (Graham 2002, 34).

6.59 The licence to use the process was purchased by the London Lead Company for £1,050 in 1836, and became the sole process used by the Company (Fairbairn 1993, 179). In 1839, a new, purpose-built *'crystallising house'* was established at Nenthead (now called the Pattinson House) (Almond 2003b, 1). The Pattinson House is clearly marked as a *'Silver Refining House'* on the revised Greenwich Hospital plan of 1848 (Greenwich Hospital Plan No. 4 1825/1848; Plate 19). The process was considerably more economically viable than previous cupellation methods, and it was possible to extract silver from lead containing only two or three ounces per ton. In 1837 it was said that *'the loss of lead by the process is only equal to 1/373rd part of the lead used'* (Raistrick 1938, 109).

Plate 32: the Pattinson House in operation at Nenthead (Raistrick; © NMCS archive/Beamish)

6.60 The method was improved by Joseph Dickinson Stagg (1815-51), then an assistant to his father Robert; he developed a system of cranes, which eased the heavy manual work needed by the process (Almond 1977, 28), and a number of his improvements were patented by him (Fairbairn 1993, 179).

In 1837 it was stated that *'considerable improvements in the process have been made by Mr. Stagg, and experiments with his improvements are highly satisfactory though requiring changes in the mode of conducting the process'* (Raistrick 1938, 109).

6.61 With the cessation of smelting at Nenthead in 1896, the Vielle Montagne Zinc Company looked to other uses for the buildings within the Smelt Mill complex. One result of the company taking over the leases was the sudden and rapid increase in the size of the workforce to 300; an extract from the Cumberland and Westmoreland Herald of March 1897 states that *'the working of the Nenthead lead mines continued to be carried on with the greatest vigour and the outlook was most encouraging. Almost every week additional men were being engaged. So many had started work in the past year that houses could not be obtained and it was difficult to secure lodgings. Part of a smelt mill was being fitted up for the accommodation of lodgers'*. The company is thought to have fitted out the Barracks and Pattinson House for this purpose.

Plate 33: the Pattinson House, photographed by Peter Jackson, early 1960s (© NMCS archive)

6.62 The building was still standing in the 1960s, as it was used by the Rampgill Mine Company as a store for the reprocessing of materials (access being gained to the building by means of a ramp, built up on the demolished remains of the Rozan House). In the 1970s, Fairbairn noted that the roof structure consisted of highly-modified king post trusses and the roof was covered in Welsh slate, not introduced to the area until the late 1830s (Fairbairn 1998, 68). By the early 1970s, it was fully demolished (see Plate 30), and was not uncovered again until the area was stripped in March 2001, and recorded in 2005.

6.63 The building is built of stone rubble, seemingly random coursed from historic photographs (Plate 33),

and includes at least seven doorways on the north-east and south-west sides. The doorways were later blocked up and used as windows (probably in the early 20th century when it was converted accommodation) and at least one doorway was enlarged on the southern end of the south-east side. There were three doors in the south-east wall, all infilled either in the early 20th century or in the 1960s.

6.64 The number of doorways is of particular interest, and seems to correspond with the internal position of the bases of the Pattinson pans; this suggests that the doorways operated also as a means to control airflow to the pans, and aided ventilation of the building, which must have been a very hot place to work.

Plate 34: panoramic view of the Pattinson House

6.65 The interior of the building is flagged, with a number of robbed out and damaged sections. The recesses for the pan bases were filled in with brick in the early 20th century, when the building was converted to accommodation, but it is still possible to discern their position. On the south-west side, the recesses measure 2.3m in diameter, and have rectangular flues on the sides facing the doors, also infilled with brick, which would have provided a down-draught to the base of the pans. Adjacent to the pans, at 45° from the flues, are large rectangular stone bases with iron fixings, which correspond to the positions of the cranes added to the pans by Stagg. A stanchion block lies adjacent and in-line with these, with a large iron ring in its upper surface. On the north-east side, the arrangement is slightly different; the positions of the pans are harder to see, and may have been smaller, but edges can just be discerned within some of the relaid flags. Further large rectangular crane bases are visible, as large blocks with iron fixings, but seemingly without corresponding stanchions, perhaps implying the loads being lifted on this side were smaller. The pans were warmed by means of a series of individual fires under each pan, with air-flow controlled from the vents, and smoke from the fires vented by means of three chimney flues on the north-west and south-east walls.

6.66 The building was mainly altered in the 1900s along the south-west side, through the insertion of a series of machine bases and two brick walls which supported a gangway.

6.67 *The Rozan House (Building D):* the Rozan House measures 16.4m by 14.3m, with walls standing to

approximately 2m on the north-west side, sloping down to 1m on the south-east side (Figure 6). The south-west wall is mostly robbed down to ground level. The reason for the relative survival of this building, in comparison to (for example) the Pattinson House, is that the walls were pulled down and the interior levelled up to form a ramp by the Rampgill Mine Company, in order to allow material to be tipped into the Pattinson House, which was used for the reprocessing of spoil.

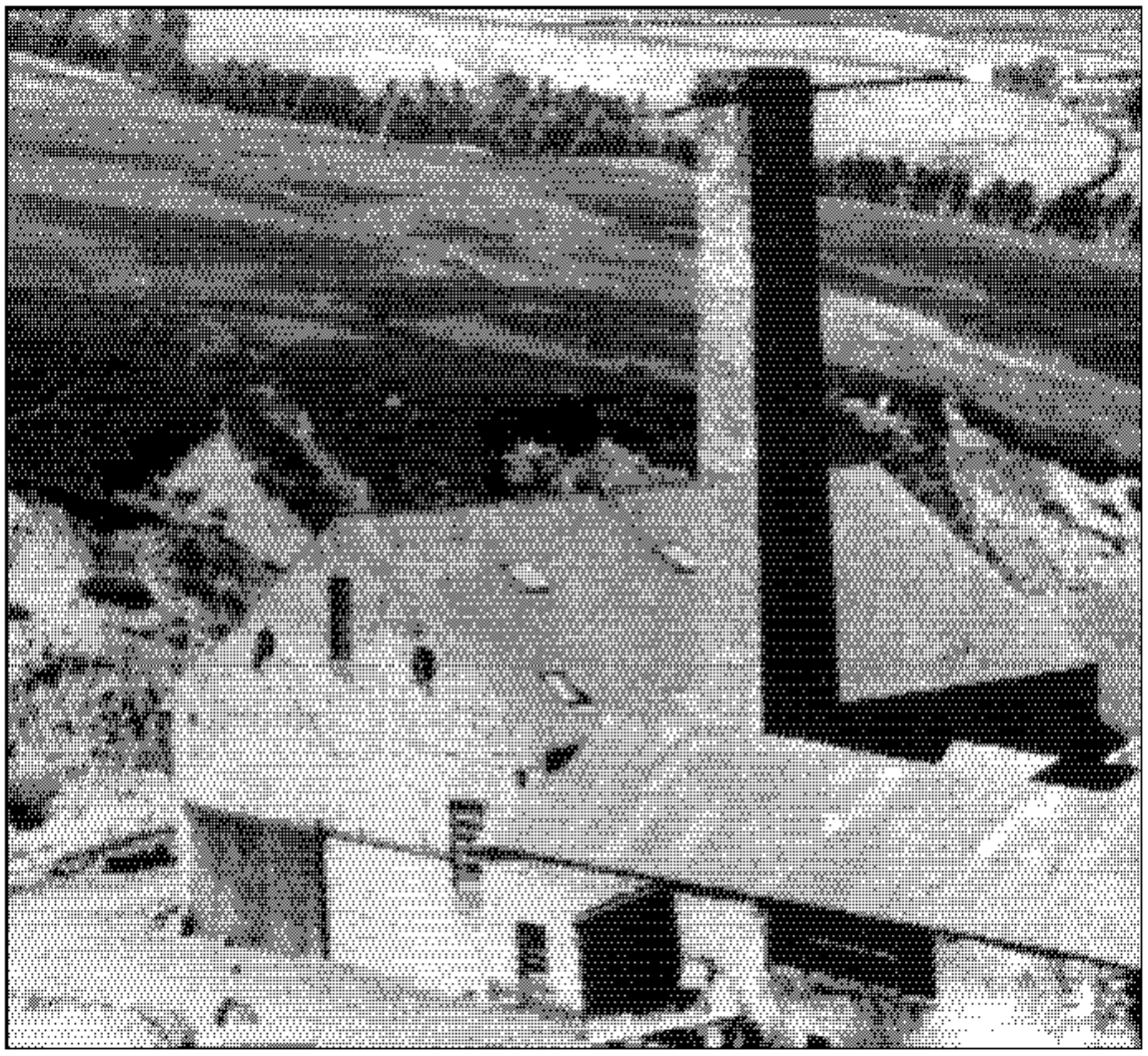

Plate 35: the Rozan House in the 1930s (Raistrick; © NMCS archive)

6.68 The building is named the Rozan House, because it was used to house a major new process of desilvering lead, introduced to Nenthead in 1882. Luce and Rozan had developed a technique in Marseilles (patented in 1869), whereby steam was blown into the molten lead, at the same time cooling and stirring it. This meant that the large number of pots required for *'hand Pattinsonisation'* could be reduced, though the process, known as the Rozan Steam Process, needed a large specially shaped, crystallising vessel (a detailed description of the process is given in Forster 1883, 204). The process was also used at the plant at Eggleston, and at Cookson's plant on the Tyne. For every use of the patent, a 3s 6d royalty was charged on each ton treated, but the technique cut the processing costs by 12s a ton, which made it economical (Almond 1977, 28; Fairbairn 1993, 179). The building,

which housed the process, is shown on the 1898 Ordnance Survey map, lying to the south-east and abutting the Pattinson House (Plate 35).

6.69 By 1901, the Rozan House, and parts of the smelt mill, had been converted for the use as a steam powered compressor plant, to be used in case of a failure of the hydraulic system. It formed part of the hydraulic compressor system, which was introduced by the Vielle Montagne Zinc Company between 1903 and 1915 to power mechanised drills which were used in their workings. This conversion effectively removed all the interior workings related to the Rozan Steam Process.

6.70 The walls of the building on the north-west side incorporate the south-east side of the Pattinson House. The south-west and south-east sides include large double doors, the latter of which was subsequently blocked during the insertion of the air compressor bases. The north-east side of the building includes two large doorways with firebrick arches, and a smaller door at the south-eastern end of the elevation. The function of these doors is not known, but they were subsequently blocked after the construction of the building housing the Lancashire Boiler (Building H).

6.71 The interior of the building is entirely covered in concrete, and includes a series of large concrete machine bases. The northern half of the building is occupied by a very large concrete base measuring 10.6m by 4.5m, whilst the southern half is occupied by a series of five smaller machine bases measuring 5.8m in length and 0.9m in width (Plate 36). The larger machine base held a McCulloch compressor, powered by the Lancashire Boiler in Building H, which produced 20 cubic metres of air per minute. The smaller bases held Schramm compressors, producing 35 cubic metres per minute, and powered by the Robey Boilers in Building E (Anon 1914, 152). A crane base is visible adjacent to the middle of the smaller compressor bases, and this is visible on the early photographs of the plant in the 20th century.

Plate 36: panoramic view of the Rozan House; the chimney base for the Lancashire boiler lies in the foreground

6.72 *The Robey Boiler House (Building E):* the Robey Boiler House measures 17.5m in length and 6.7m in width (Figure 6). Though the walls now only survive to a few courses in height, the coursing is still visible, and comprises randomly coursed squared stone rubble blocks, up to 1.5m in height. The

building is not shown on the Second Edition Ordnance survey mapping of 1898, but walling is shown in this area, which may have been incorporated into the later building. The building was probably built in the early 1900s specifically to house the Robey Boilers, manufactured by Robert Robey from around 1872.

6.73 The interior of the building is laid with a rough concrete surface, though the north-eastern end includes some flagging (Plate 37). There are six brick and concrete lined pits evenly spaced through the middle of the building; the sides each measure 2.5m by 1.2m, with an interior pit of 1.9m by 0.7m. The pits would have supported the boilers, probably on a brick structure above. In the south-east wall, each pit has a corresponding opening, which leads through to a long rectangular space, which lies approximately 2m below the track on the south side. This was probably the storage area for the coal which fed the boilers; each corresponding opening allowed the coal to be shovelled directly to the mouth of the boiler, limiting the amount of work required to keep them fired. There appears to be a door in the north-eastern end of this wall, to access the recessed space, and the wall opposite includes a wide open space, perhaps occupied by roller doors, though no physical evidence for this now survives.

Plate 37: the Robey Boiler House

6.74 *The Lancashire Boiler House (Building H):* the Lancashire Boiler House measures 17.3m in length and 4.5m in width (Figure 6). The walls, which appear brick-built, have been largely removed to foundation level, though the north side, which incorporates some stone-work from Buildings F and F-B, stands to about 1.2m in height (Plate 39). The building is depicted on the later editions of Ordnance Survey mapping, and was constructed by the Vielle Montagne Zinc Company in the early 20th century to power the McCulloch compressor in the Rozan House. Lancashire Boilers were a horizontal cylindrical steam boiler with two internal firetubes and grates (Plate 38), first patented in 1844 by William Fairbairn and John Hetherington, and were a variation of the Cornish Boiler, which only had one firetube and grate. The boilers were extremely common, particularly in textile mills, and thousands were made (Jones 1996, 216). The boiler at Nenthead was also connected to an economiser, which was fitted to the flue leading to the chimney. The economiser comprised a bank of vertical tubes of cast-iron, which heated the feed-water to the boiler by means of a heat exchange between the hot gasses passing between the bank of tubes and the cold water inside the tubes. The

economiser improved the thermal efficiency of the boiler, hence its name (Jones 1996, 123).

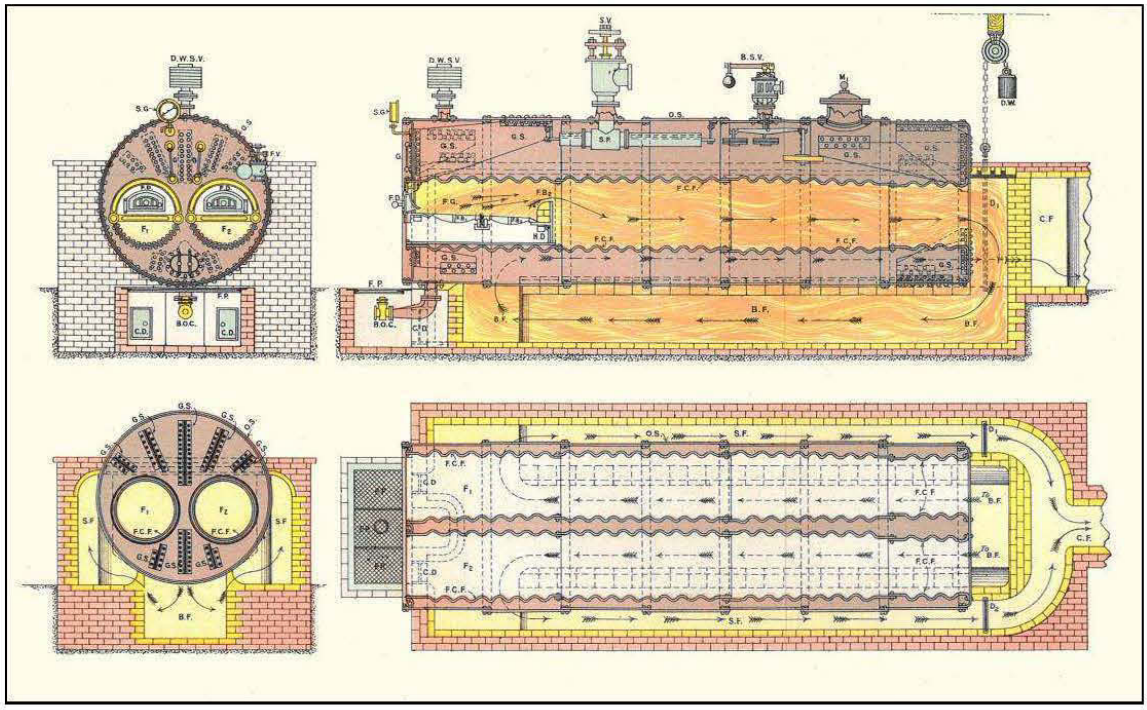

Plate 38: the Lancashire Boiler (reproduced from Andrew Jamieson 1897 Elementary Manual on Steam and the Steam Engine)

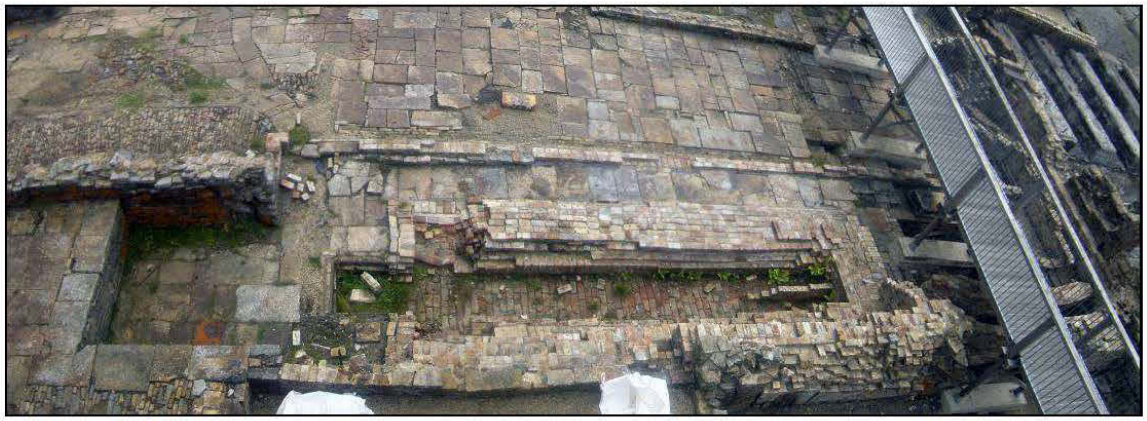

Plate 39: the Lancashire Boiler House; the economiser is located just beneath the walkway, and the chimney lies top-right of the photograph

6.75 The remains of the base for the Lancashire Boiler are visible as a large area of brickwork c.8.5m by 2.7m, with a central flue measuring 7.5m by 1.5m, and a iron-lined square recess at the north-eastern end which housed the valve for the blow-down. The gasses from the boiler were carried westwards by means of a brick flue, which curved southwards along the north side of the Rozan House to a large square chimney base, 2.5m square (visible in the early photos of the smelt mill – Plate 35). Immediately west of the boiler was a short spur leading to a rectangular brick pit 3.3m by 1.4m, which housed the economiser. The gases from this exited back into the main flue.

6.76 On the south side of the boiler is a flagged passageway, and a doorway is visible through the southern wall at its eastern end. The boiler was fed by means of a loading bay into Building B, through which coal was shovelled (Paragraph 6.49).

Plate 40: the Bingsteads in the 1930s, referred to as 'coke bins' (Arthur Raistrick; © NMCS archive).

6.77 *The Bingsteads:* the original phase of construction of the bingsteads is probably contemporary with the development and operation of the smelt mill. They were probably built for use as storage by the London Lead Company in the later 18th century, though the ore bins are not clearly illustrated on any mapping until the First Edition Ordnance Survey of 1859. At this time, only the bins adjacent to the Spine Wall, and two of the larger bins, were constructed, the remaining three not appearing until the Second Edition Ordnance Survey of 1899. A probable sequence suggested by the building remains (though hard to prove now) is that the area of the three smaller bins adjacent to the Spine Wall originally continued further north-westwards onto the stepped area immediately north-east of the Wheel-House. With the construction of the Spine Wall, in or after 1802, (which included an entrance way through at this level), the capacity for storage was reduced and the four smaller bins were constructed. As production increased, more bins were constructed and resulted in the arrangement seen today. In the 20th century, the ore bins were converted to store coal for use with the Robey and Lancashire boilers (RCHME 1993).

6.78 The bingsteads appear to have been constructed sequentially, north-west to south-east, with the final two ore bins (the largest) being added last; this confirms the suggestions above. Each of the ore bins contains the remains of stone flagged flooring, although some of this had been robbed in the past. The dividing walls now mostly exist as foundations, as well as two return walls partially enclosing

the entrances to two of the bins. The bins were supplied by a waggonway running across the top, with side-tipping waggons depositing ore into timber ore chutes on three of the ore bins. The ore bins were fully consolidated in 1998.

Plate 41: General Shot of Bingsteads after clearance, 1998 (© NMCS archive)

Watching Brief

6.79 On the 13th of November 2013, a watching brief was carried out during the excavation of a test-pit, which involved the removal of part of the hard-capping on the top of the Spine Wall. The hard-capping had been laid down in 1998, and has started to fail. The capping comprised stone rubble from the original core-work for the wall, bonded with a cement and lime mortar mix. There was no evidence of a damp-proof membrane beneath.

6.80 The removal was undertaken within a small controlled area immediately south-west of the large rectangular recess in the Spine Wall. This recess forms part of the structure and was constructed to allow the removal of fume into the smelt mill (Figure 6). A test-pit measuring 1m by 1m was excavated by hand, through the manual removal of stone and capping material, to a depth of approximately 1m. The test-pit confirmed that, beneath the capping, the wall comprises facing stones holding a loose deposit of rounded and sub-angular stone rubble in a degraded lime mortar matrix, with large voids and fissures evident around the edges of the stones. There was no evidence of any structures or flues within the test-pit, and it seems likely (as discussed above) that the flue was carried on the top of the Spine Wall, and that any additional and later flues were affixed to the outside of the Spine Wall, rather than inserted into it.

Plate 42: position of test-pit, facing south-west

Plate 43: the completed test-pit, facing south-west

Interpretation and Discussion

6.81 The earliest building on the site is probably Liddle's 18th century smelt mill, though evidently modified once the London Lead Company took over in 1745. The bingsteads were probably first constructed to the north-east of the smelt mill around 1745, but were subsequently extended as demand increased, and after the horizontal flue was added to the smelt mill in 1802. The flue was supported by the Spine Wall, that abuts the smelt mill building on its south-east side. Additional buildings (A, F, F-B and B) were added around the smelt mill and Spine Wall, in part to increase the smelting capacity within the complex. These have been tentatively dated to around 1819-22, though some may have been added later (in the case of F-B) or earlier (in the case of A). All the buildings were extensively altered throughout their life-times, and probably served a number of different smelting functions during various periods, as evidenced by documentary sources. The introduction of a new technique of desilvering, Pattinsonisation, led to the construction of the Pattinson House in 1839; this in turn was replaced, or perhaps augmented, by the construction of a further desilvering house, the Rozan House in 1882.

6.82 By the late 19th century, and the tenure of the Vielle Montagne Zinc Company, the smelt mill became entirely redundant, as lead production was stopped completely. This is known to have occurred by 1897 at the latest. The Pattinson House was converted to worker's accommodation, and the Rozan House was converted to house air compressors; these were powered by Robey and Lancashire Boilers, set within their own purpose built buildings (Buildings E and H), which connected to a large chimney, located against the north-east wall of the Rozan House.

6.83 From the 1960s, the complex became largely redundant, and was gradually buried in rubbish deposits before being entirely buried by demolition deposits as the Spine Wall and surrounding buildings were plundered for stone.

Area 4: Smeltmill Flue and Chimney (Figure 7)

History

6.84 The development of the flue on lead-smelting sites appears to have arisen as a result of two specific needs: the desire to minimise the damage to the environment and the health of those within the vicinity of the smoke of the lead-smelting mills; and, perhaps more saliently, to recover the particles of precious metals (lead, zinc and other compounds), which were being lost up the chimney.

6.85 Lead smelting produces considerable quantities of fine-grained materials, which are passed away with the waste gases through the chimney. These materials comprise dust (fine particles of ores, fluxes from the charge and so on) and fume (volatilised substances such as lead, zinc, and their sulphides and oxides, which form a powder). The two forms of material are almost indistinguishable in practice, and as such are commonly described under the catch-all description of *'fume'*.

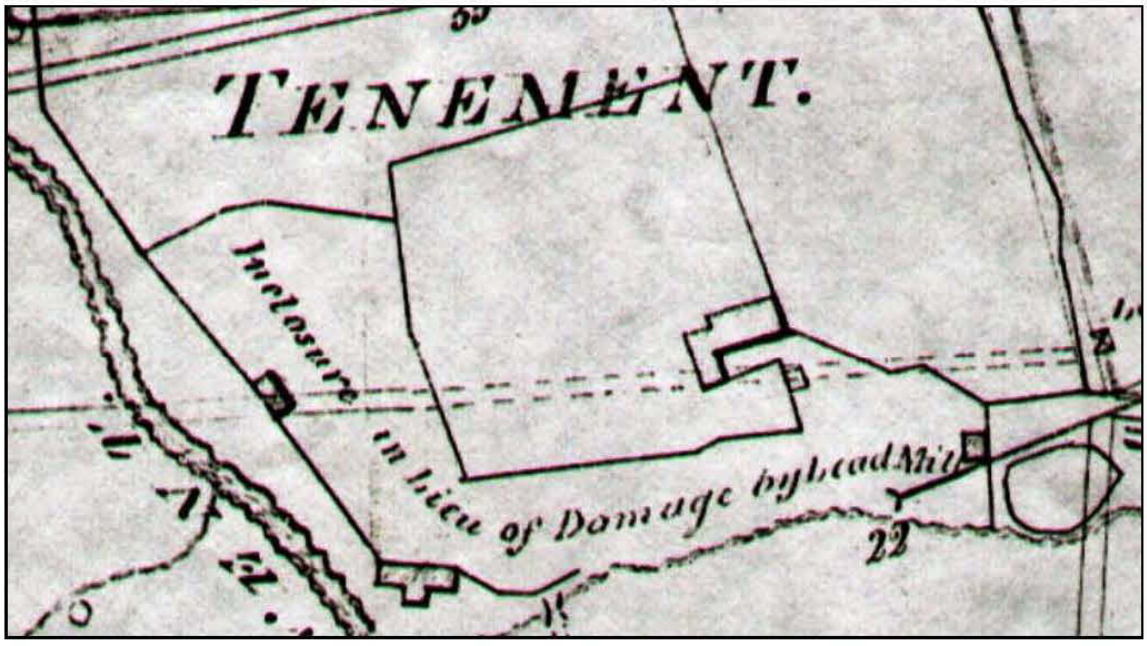

Plate 44: 'Inclosure in lieu of Damage by Lead Mill', Greenwich Hospital Plan No 4, 1825, revised 1848 (© NMCS archive)

6.86 Prior to the development of the flue, little effort was made to retain the fume. The poisonous smoke from the smelt mill was carried directly up the chimney, causing undesirable damage to the surrounding countryside, through the release of substances such as lead, antimony, arsenic and sulphur dioxide (which in turn could form sulphuric acid and acid rain). The damaged vegetation, in turn, could poison sheep and cattle. In the 18th century, there were many recorded incidents of poisoning of both land and animals, particularly at Langley, where large compensations sums are recorded as being paid out to farmers (Turnbull 2006, 67). At Nenthead, the effects on the environment were severe: the 1825/1848 plan shows land adjacent to Mill Cottage as *'Inclosure in lieu of Damage by Lead Mill'*, clearly indicating that the land was being poisoned by lead deposits (Plate 44). An account from 1842 describes the problems of the smoke from the smelt mill at Nenthead: *'when the wind carries the smoke upon the road, as [...] must be the case about three parts of the year out of four, it is most offensive to travellers, and in a populous district it would not be endured for half an hour. Even at the distance of half a mile it is disagreeable, and would be destructive to the health if a person remained long in it. When the wind blows in such a direction as to carry the smoke to the washing-floors upon the children, or upon the village, it must be disagreeable'* (Dr James Mitchell, cited in Almond 1977, 28).

6.87 By the later 18th and early 19th century, flues were being constructed to draw the gases away from the populated areas around the smelt mill, up to a point some distance away where the toxic sulphur dioxide fumes could be released without causing significant harm. The construction of flues was not fully altruistic, however. John Robinson, the agent of the Derwent Lead Company writing at that time, records that: *'to save the surface of the land from injury, we carry from the smelting hearths a tunnel arched a mile long, and let the smoke up by a chimney. At the end of the year we clean the*

chimney, and smelt the matter obtained, called fume, and get from this a great quantity of lead, sufficient to remunerate our expenses of making the tunnel, and yield a profit besides' (cited in Turnbull 2006, 70). Mulcaster, writing in the late 18th century, stated that a single years profit from the reclamation of material from a horizontal flue could account for 70% of the original cost of building the flue (Tylecote 1971, 11).

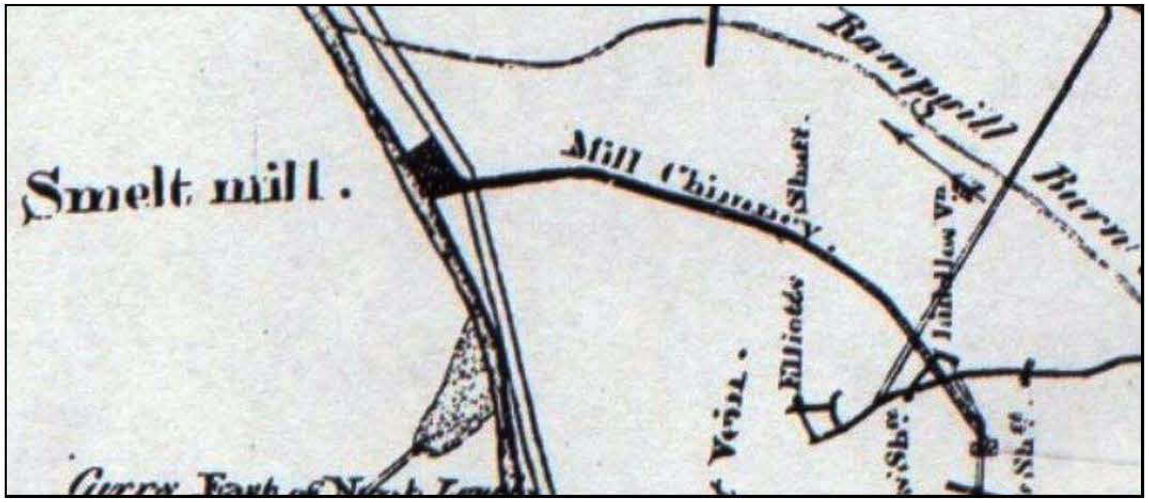

Plate 45: depiction of smelt mill flue, marked as 'mill chimney', Greenwich Hospital Plan 1822 (© NMCS archive)

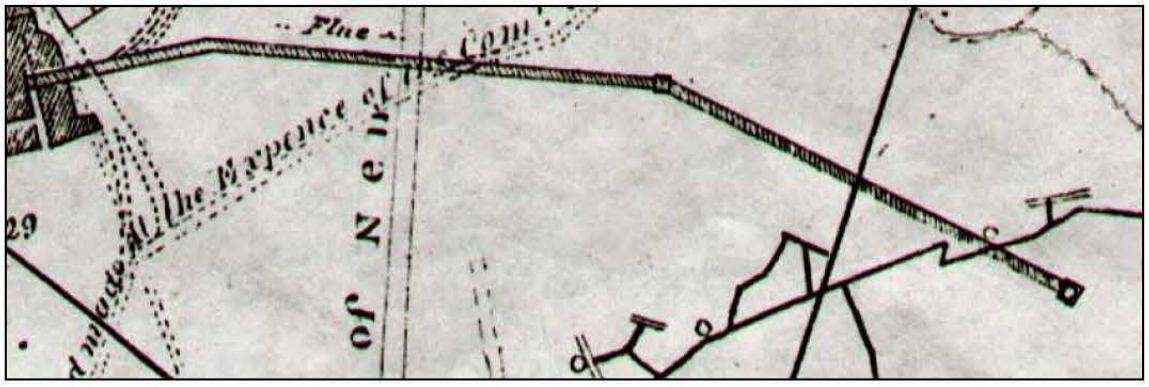

Plate 46: depiction of the flue, Greenwich Hospital Plan No 4, 1825, revised 1848 (© NMCS archive)

6.88 A flue typically comprised a horizontal tunnel leading from the smelt mill to a chimney, which it still needed in order to maintain the required draught to pull the smoke the long distance up the hillside. The flue was invariably built of different materials, dependent on the area of the country in which it was constructed, and in the North Pennines, the flues were predominantly stone built. Construction methods vary, but typically the flue had a flagged base and was constructed within a wide trench, with the arching commencing at about ground level. The arching was covered in turves, to stop the smoke leaking out. Most of the flues in the North Pennines are straight, having the benefit of distance and space for their layout, but elsewhere, zigzag or more complex arrangements were used where the topography was less accommodating, and many smelt mills were situated in the lower part of a

valley for this very reason.

6.89 The collection of fume was of paramount importance, and a number of different methods were employed to increase the surface area of the interior of the flue and slow the movement of the gases. This increased the amount of fume deposited, which could then be scraped or washed off to be re-smelted. Interior baffle walls were used for such a purpose, being a long dividing wall running down the centre of the flue onto which the lead-rich deposits could accrete. Access points were included within the design of the flue, usually manholes, to allow the periodic cleaning of the flue to recover the lead. The flues also included an arrangement of leats, which were diverted to run through the flue to settling tanks, built along the side, which would also collect the fume as a fine sediment. Later these were augmented through the use of condensers - structures in which the waste gases from the smelt mill passed through water, baffles and/or brushwood, to force the fume within them to precipitate into the water (see below).

Plate 47: late 19th century photograph of the flue, with large settling tanks (left centre), and chimney up on the hillside (top right). The Staggs Condenser is in the foreground (© NMCS archive)

6.90 The horizontal flue at Nenthead **400** was probably built in the early 19th century; minutes dated 30th November 1802 state: *'...chimneys at the mill to be made in a horizontal direction as soon as the season for the Company's concerns will permit'* (Greenwich Hospital Minutes transcription, NRO). The fumes were led away from the smelt mill by means of a flue constructed on the Spine Wall (see above) and supported by an arch over the roadway and up the hillside. The flue appears on a Greenwich Hospital estate map of c.1822 (Plate 45), shown at c.350m in length (Wilkinson *pers. comm.*), which is shorter than the 1.1km length flue which survives today (Fairbairn 1993, 180). By 1848, the Greenwich Hospital plan shows the flue still at its shortened length, ending in a chimney (Greenwich Hospital Plan No. 4 1825/1848; Plate 46). The flue appears to have been lengthened, perhaps after the death of Joseph Stagg in 1851, and as a result of the refinements to the system by Stokoe in 1856 (see below). The flue is shown in its current form by the time of the First Edition Ordnance survey mapping in 1859. Whellan, writing in 1865, noted that the fume *'sometimes two feet thick is dug out and scraped off once a year and converted in the furnace into solid marketable*

lead'. A memorandum of 1882 states that *'the condensation of fumes from the lead-smelting house [...] is so effectual that the Mill-Master thinks 2000 pieces or 100 tons of lead will be made from the chimney-sweepings next time it is swept'* (cited in Almond 1977, 29). A photograph taken in the late 19th century, probably at the time of the commencement of tenure by the Vielle Montagne Zinc Company, clearly depicts the flue extending directly from the smelt mill as a flat topped, above ground, structure, leading to a series of large square settling tanks (Plate 47). This is presumably the course of the original flue as constructed in the early 19th century, and the location of the earlier chimney is thought to have been in the area of the tanks. From the settling tanks onwards, the course of the flue becomes more sinuous as it follows the line of the hillside, and terminates at the chimney far up on the hillside.

6.91 The flue became redundant following the cessation of smelting in 1896; sections have collapsed and been progressively robbed of stone since then. In 1988, the chimney was recorded by Done as being c. 60 feet high ((BHWB 1995, Appendix 1/8, 105). The chimney collapsed in November 1991; there are few photos of it still standing (see Plate 48), though the photographs that do survive depict a similar profile chimney to that in the late 19th century photograph.

Plate 48: photograph of the standing chimney, late 1980s (© NMCS archive)

Previous Investigations

6.92 The course of the flue has been extensively surveyed in the past (most recently as part of the Miner Farmer Landscapes Project – Railton and Wooler 2012). The Management Plan undertaken by BHWB in 1995 recorded the flue as a single component (comprising four sub-components), with the chimney forming a further component in its own right. The components were described as poorly preserved or gradually collapsing. No excavation has been carried out on the line of the flue. The course of the flue was crossed by the pipeline for the Nent Hydro Scheme around 2004 to 2005; the excavations were archaeologically recorded by the North Pennines Heritage Trust but this project has never been written up or published.

Plate 49: the course of the flue looking east towards the Quarry track; note the wall lines in the rubble

Description and Function of Features

6.93 The flue, at 1.1km in length, rises from 460m AOD in the west, to 580m AOD at the chimney, and is a fairly complicated structure (Figure 7). As such, this report has broken the flue down into areas for ease of discussion. The areas are as follows:

- Smelt Mill Spine Wall to Quarry Track
- Quarry Track to feeder leat for Smallcleugh / Handsome Mea Reservoir

- Settling tanks east of feeder leat for Handsome Mea
- Underground flue from settling tanks to Chimney
- Chimney

*Plate 50: flue **405** extending east to feeder leat, showing damage by track on northern edge. J. Wallace's shaft **406** is to the right of the photograph*

6.94 *Spine Wall to Quarry Track*: east of the track which bisects the line of the Spine Wall, a further section of supporting wall forms the bridge abutment which originally carried the flue over the track. This has been discussed in greater detail in the section on the Spine Wall (above). As the flue reaches ground level, there is a fork to the north which takes the flue towards the Stagg Condenser; this is discussed in the section on the condenser itself (below). The section of flue to the track (here numbered **400**) comprises low stone spreads, up to 0.5m high, with very few visible walls surviving, though these seem to be buried and presumably survive at foundation level. Where the return flue from the condenser rejoins the main line of the flue, there are surviving walls on the north and south

sides, corresponding to the outside walls of the flue itself. Just east of this point, a large heaped mound of stone, 1.5m in height, appears to be a section of inwardly-collapsed and undisturbed arching. The flue north of this point is visible as a 2m wide section comprising three lines of walling (Plate 49). These equate to the inner and exterior wall, and the interior baffle wall which ran down the centre. There are gaps, 0.9m wide, between each wall.

*Plate 51: panoramic view of the settling tanks **408** and **409**, facing west*

6.95 *Quarry Track to Handsome Mea feeder leat:* the quarry track visibly cuts through the line of the flue, obliterating it at this point. Recent new excavations of a ditch on the east side of this track have also cut into and disturbed the flue, which is visibly damaged at this point. It would be advisable to address this damage as part of the current management of the site, perhaps through the insertion of a land-drain pipe into the existing drain, to remove the need for further excavation.

6.96 The three lines of walling visible west of the track continue for a short distance eastwards as **401**, before being cut through by the line of the Nent Hydro Scheme, which appears to have removed c.18m of the line of the flue. A further short section **402** reappears to the east of the pipeline, but is then obscured by extensive dump of soil and rubble **403** across its surface. This is related perhaps to the construction of track **404**, which appears to have been bull-dozed through the line of the flue just east of the dumps, though clearly not recently. The track has now been blocked by a modern soil bund. The three lines of walling **405** reappear east of the line of the bull-dozed track, and extend eastwards as far as the feeder leat to Smallcleugh / Handsome Mea Reservoir. The flue in this section is much wider, at c.5m in width, and a series of bitumous deposits and timbers are visible on the baffle wall east of bulldozed cut. Though the flue survives reasonably well, the north side of the line has now been partly subsumed into a modern track, which is using the stone spread as a firm base for driving vehicles on. Again, this needs addressing as part of the management plan. The south wall of this section survives well, and is visible where the line of the flue crosses J. Wallace's shaft **406**, a large-water filled shallow shaft of uncertain date. At the point where the flue crosses the line of the feeder leat, a series of large *ex-situ* slabs **407** lie adjacent to the leat. The author remembers these

being cleared from the leat in 2005 during cleaning works, and these presumably supported the side walls of the flue at the crossing.

6.97 *Settling Tanks:* the settling tanks **408**, were located within a large rectangular building, built onto the south side of the flue, visible in Plate 47. The building has been demolished and the site now comprises a large area, c.25m square, surrounded by rubble banks up to 1m in height, and stone spreads and lynchets within the interior (Plate 51). A wall, running north-south down the centre, divides the square structure into two rectangular areas. There are large spreads of rubble located to the south and west of this square structure, the latter being revetted back from filling the feeder leat by a series of boards and upright reused lengths of rail. Abutting the east side of the settling tanks are a group of cisterns **409**, probably related to the cleaning process to extract lead from accretions on the flue lining. Broadly rectangular, and aligned north to south, the cisterns comprise two water-filled ponds, c.2m wide and 8m long, with low walls around the edges and one dividing pond. The connection to the flue is visible as an earthwork **410**, and water was presumably flushed down the flue into these tanks to assist the cleaning process.

*Plate 52: eastern end of flue section **413**, with baffle wall in-situ*

6.98 *Underground flue:* at a point just east of the settling tanks, the flue runs partially buried underground, the base and side walls being set within a trench, with arching above ground level, and covered in turf. For 300m, the flue **411** is visible running up the hillside as a c.2m wide trench, with low flanking banks, entirely turfed over. There is little or no structural evidence visible, apart from a few

sections of low walling surviving to c.0.50m in height within the base of the trench. The trench begins to climb up the side of the hill, and on the hill slope, between the base and the brow of the hill, are four surviving sections of arching (**412A-D**) within a 55m stretch of flue. Each section of surviving arching measures 2m to 3m in length, the open ends of each section having banks of turfed over collapsed material sloping down into the interior, which is 1.5m lower than the top of the banks. The base of each flue section is covered in rubble, and in only one case is there any evidence of the baffle wall surviving. Apart from the first arched section, which retains approximately 0.8m of soil above, most of the arching is only covered by a very thin deposit of soil and turf. In several places this has worn thin, and small collapses are evident.

6.99 On the brow of the hill is the best preserved section of flue, **413**, extending for some 75m in length, and with the arching mostly intact, though some small collapses are evident (Plate 52). This section retains its baffle wall in various states of decay, but in some sections it extends nearly to the ceiling. Previous surveys suggest that this wall has been added as an afterthought (BHWB 1995, Appendix 1/8, 103), and it is clearly not well built, utilising random pieces of stonework roughly mortared together. The report on the Miner Farmer Project suggests that the internal division may have allowed one side of the flue to operate whilst the other side was cleaned and *vice versa* (Railton and Wooler 2012, 103) – in view of the lack of seal, this seems unlikely, and would almost certainly have proved fatal for anyone attempting to clean the chimney whilst it was in operation. A further very small section of arching **414**, survives a further 100m along the flue, this section is less than 2m wide and is very close to collapse.

6.100 Five *'inspection chambers'* into the flue were identified. These are located in a group on the brow and top of the hill, on the south side of the flue; they are between 60m and 80m apart. The entrances all measure 0.7m wide and 0.75m in height; previous surveys identify steps into the flue in at least one example, though these were not seen during this survey (BHWB 1995, Appendix 1/8, 103). Most of the entrances only survive as earthworks, though there is one well preserved, stone built example survives, with a stone lintel and the east and west stone retaining wall. There is some doubt as to whether these are in fact entrances for inspecting the flue, in view of their arrangement so close together, and their narrow dimensions. The Allen Mill flues, for example, have wide loading bays, with arched tops, which allowed easy access and egress by cart, and the recovered material could be easily loaded and transported back to the mill for smelting (Forbes *et al* 2003, 52). This is clearly not the case here. An alternative possibility is that the entrances served as vents, and were opened up to the prevailing wind when the flue was not drawing well, in order to better pull the smoke up to the chimney. Their position on the windiest point of the hillside make this quite probable.

6.101 *Chimney:* the chimney **415**, depicted standing in Plate 48, now only survives as a short stubby base 4.5m by 4.5m in plan (Figures 7-9). The chimney has several phases of construction, and this implies it has fallen down and been rebuilt at least once. The exact sequence is not entirely clear, but may be as follows.

6.102 The chimney has wide exterior stone walls, built of random coursed and squared rubble, mortared in

lime mortar and with some suggestions of lime render on the east face. The walls are c.1m thick, and the south, west and north walls have mostly collapsed almost to foundation level, most of the upper structure being supported by the east wall and the corners of the north and south walls. The north wall stands to about 2m in height.

6.103 Within the exterior wall is an interior wall, which appears to be later. The wall is constructed of flat cleaved sandstone, with no obvious mortar, and appears to have been constructed packed tight to the exterior wall. Where the exterior wall has fallen away, the interior wall has been left proud, but is very flat, which makes any clear conclusions regarding phasing difficult. However, the interior wall supports large flags, which have been laid straddling both the interior and exterior wall. The flaggings support approximately eight courses of very damaged fire brick coursing (unfrogged bricks), up to 0.8m, which is all that remains of the brick chimney. The inner wall encloses a chimney flue, square in section and 0.6m wide, which runs up from a segmental arch on the west side, connecting the chimney to the main flue. The arch comprises two rows of fire bricks, supported on a large, stone, capping lintel over the main entrance, with stone infill above. The use of bricks and capping stones in both the arching and the chimney suggest that this is a later addition to the earlier, outer stone walls, which presumably supported an earlier phase of chimney (probably stone).

6.104 Most of the west and south sides of the chimney are obscured by the fallen stone from those faces, but adjacent to the west face, on the south side of the flue, is an opening in the main flue wall, which appears to be a doorway, 2m from the chimney. The collapsed brick chimney, **416**, has fallen in a broadly south-west direction, and has largely been destroyed by its fall. The use of six iron straps, pulled tight onto a series of (originally vertical) timber boards, and mostly still *in situ*, has preserved some of the arrangement of brick courses, but no faces of the chimney stack now survive.

6.105 The Miner Farmer report (Railton and Wooler 2012, 103) suggests that an earlier chimney may also have been located 45m west of the surviving remains of the current structure, where the north and south banks of the flue were noticeably lower with overgrown rubble spreads (**417**). This area, which measured c.6m by 6m, was devoid of vegetation which suggests a high toxic content. Detailed examination of this area failed to identify any evidence for a chimney, though a high concentration of toxins is reasonably certain. This may serve to confirm that a succession of small chimneys were built and collapsed, perhaps due to their exposed positions, and that new chimneys were routinely rebuilt as a matter of course by the London Lead Company.

Interpretation and Discussion

6.106 The flue, first conceived in c.1800, clearly underwent a series of alterations and extensions over its subsequent 90 year history, before smelting ceased in 1896. The original flue appears to have been constructed above ground, and connected to a chimney in the approximate position of the north end of Smallcleugh / Handsome Mea Reservoir. It was later extended up the hill as a partially buried arched flue to its present position sometime after the mid-19th century, perhaps after the death of Joseph Stagg in 1851. There a number of suggested positions of chimneys at the east end of the flue,

and it is clear from the surviving fabric that the chimney has been remodelled and rebuilt several times. Other than the Stagg Condenser, which is discussed below, a number of other variations and improvements appear to have been made to the flue during its lifetime, including the diversion of water through the flue down to a series of settling tanks, to wash out the fume, and the construction of an interior baffle wall, which served to increase the surface area onto which the fume could collect. The 'inspection chambers', so recorded by a number of surveys, may also have served as vents to increase the draw when the flue was not pulling well.

Area 5: Stagg Condenser Wheel Pit (Figure 5)

History

6.107 The construction of the flue at Nenthead in the early 19th century had fulfilled its two functions – mitigating against some of the health issues for workers in the immediate vicinity of the smelt mill chimneys (though not for the smelters themselves), and also allowing the precious lead deposits which collected on the sides of the flue to be collected and reprocessed. However, there remained a constant and driving need to improve the flue system, in particular with respect to the latter.

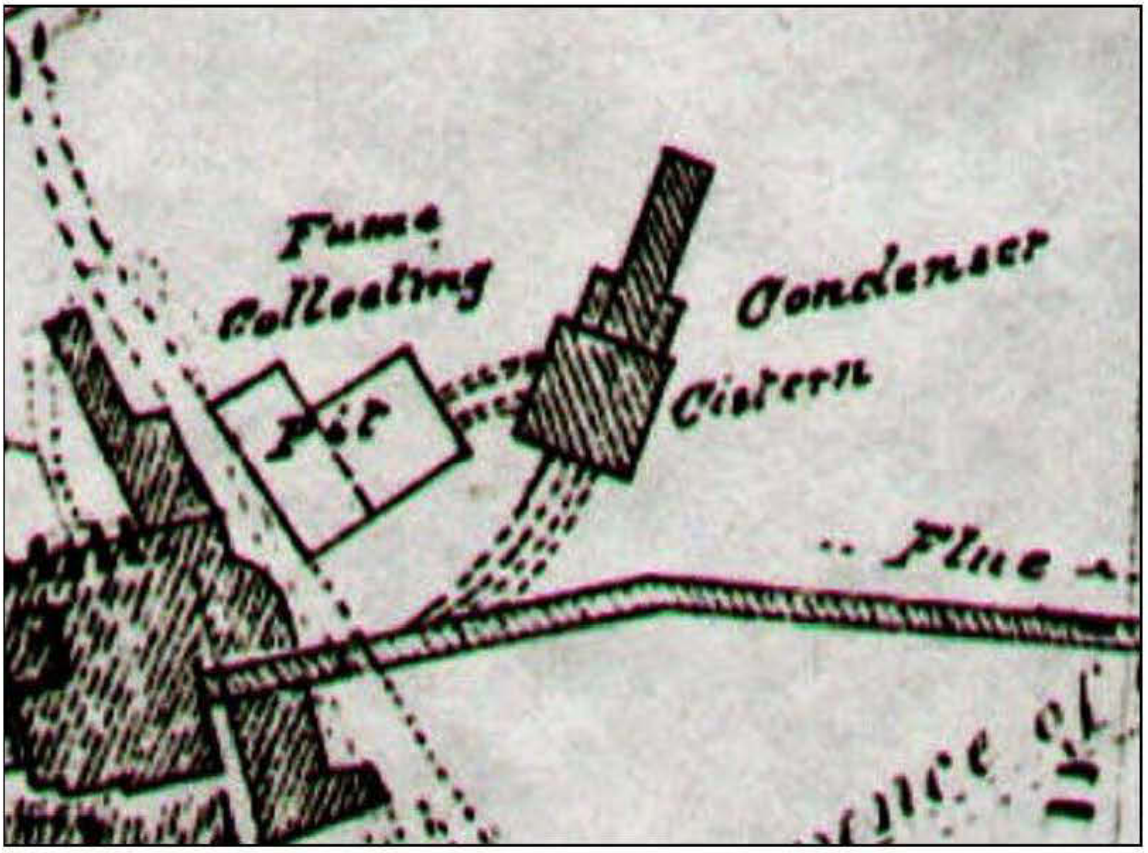

Plate 53: 'condenser', Greenwich Hospital Plan No 4, 1825, revised 1848 (© NMCS archive)

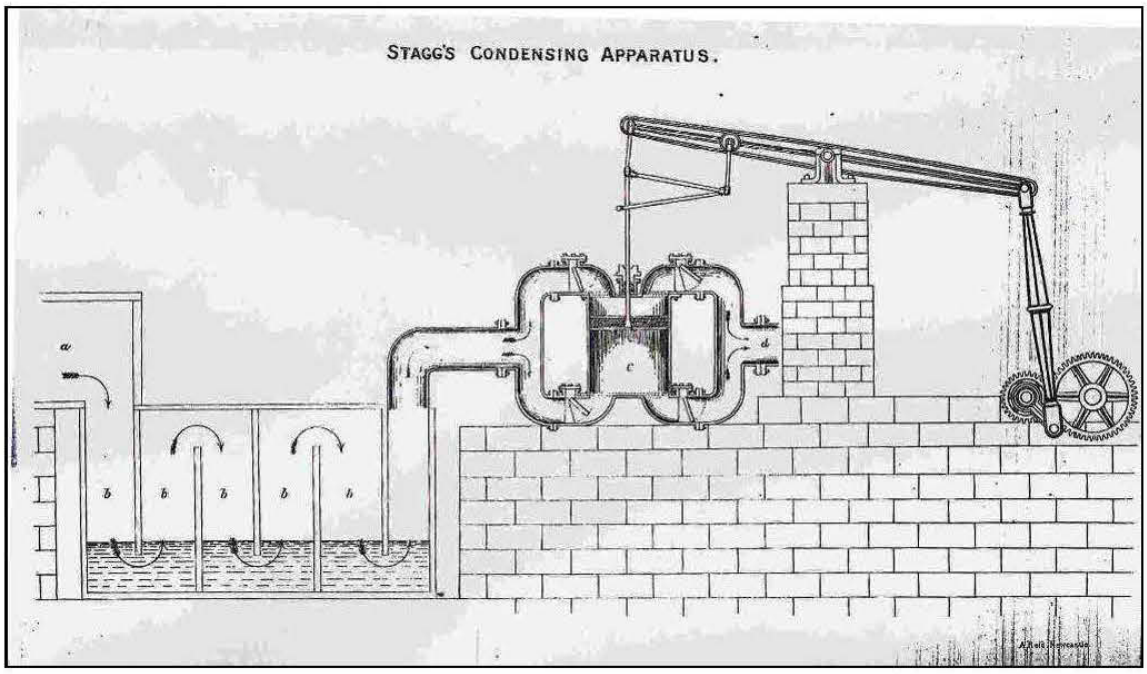

Plate 54: depiction of the Stagg Condenser (Patent 9920) (© NMCS archive)

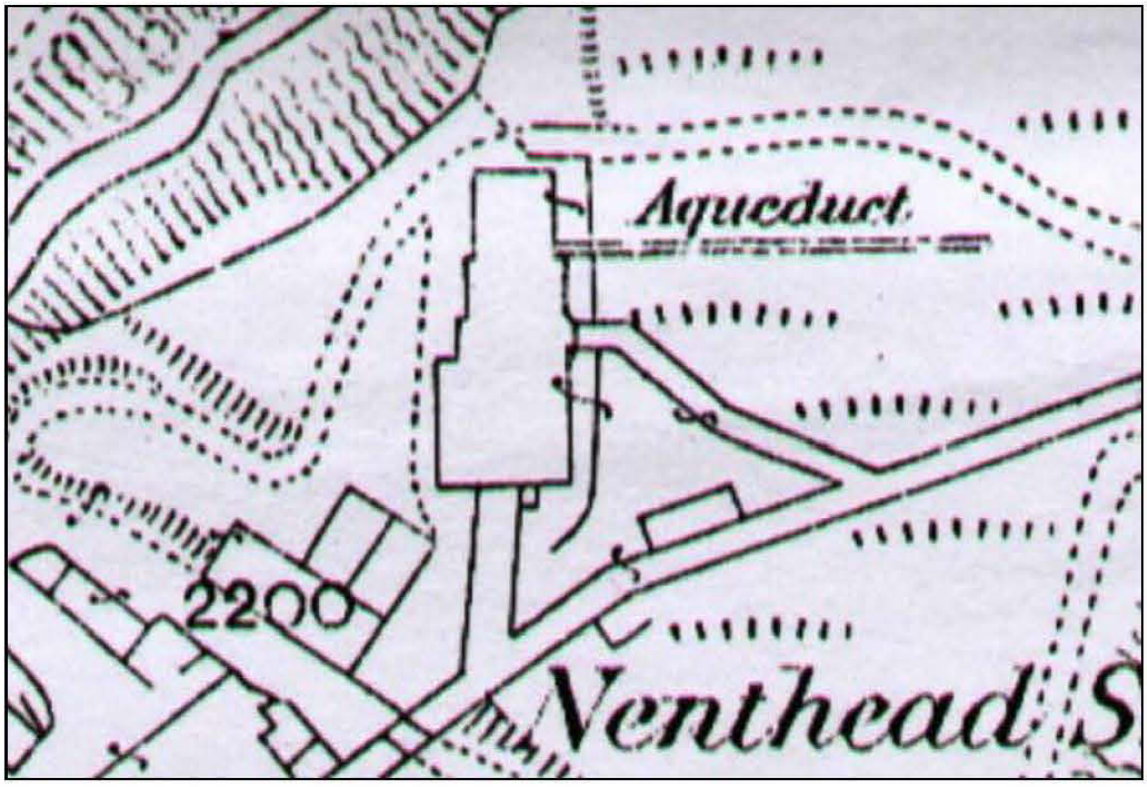

Plate 55: detail of the condenser, First Edition Ordnance Survey map, 1859 (© NMCS archive)

6.108 In 1842, Joseph Dickinson Stagg (1815-1851) was appointed as the *'manager of the mills, washing floors and counting houses'* (Almond 1977, 39) after a promising early career as an assistant to his father Joseph Stagg, who was a Superintendent for the London Lead Company at Eggleston Mill in

1832 (Raistrick 1938, 146). Perhaps his greatest achievement at Nenthead was the creation of the Stagg Condenser, a fume condenser which he patented in 1843 (Patent No. 9920; Plate 54). The condenser, which features in Percy's *Metallurgy* (Percy 1870, 441) represents one of the earliest and most important forms of condenser constructed, and the example at Nenthead is the best surviving example.

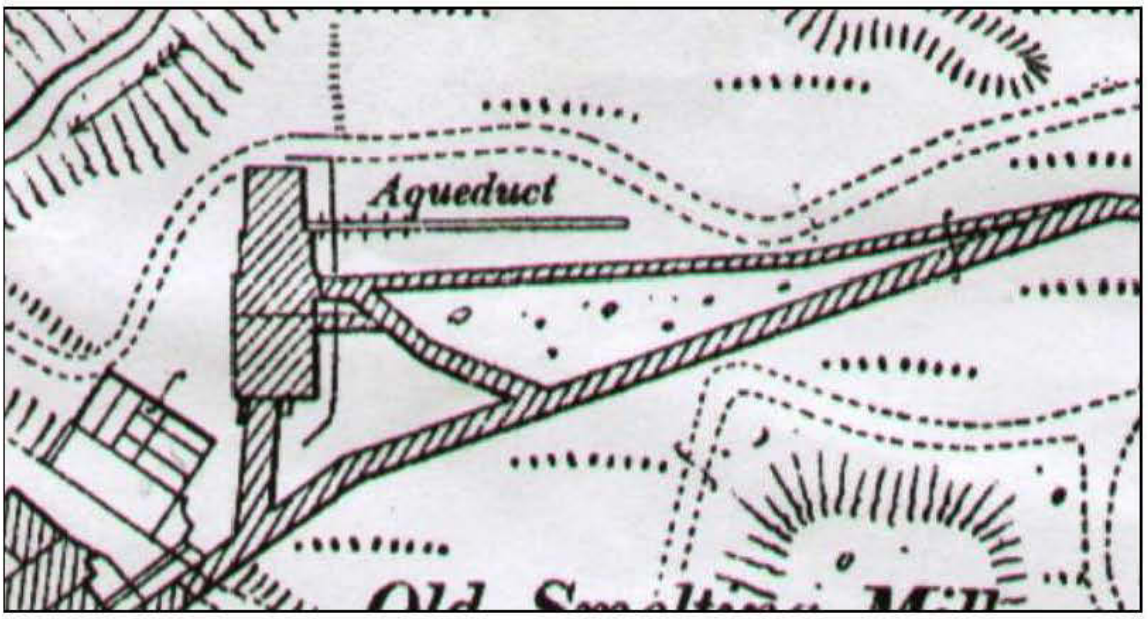

Plate 56: detail of the condenser, Second Edition Ordnance Survey map, 1899 (© NMCS archive)

6.109 The operating principles and arrangements of Stagg's condenser are described in detail in the original Patent document (*"A New and Improved Plan for Collecting, Condensing, and Purifying the Fumes of Lead, Copper, and Other Ores and Metals, and Also the Particles of Such Ores and Metals Arising or Produced from the Roasting, Smelting, or Manufacturing Thereof; and Also the Noxious Smoke, Gases, Salts, and Acids, Soluble and Absorbable in Water, Generated in Treating and Working Such Ores and Metals"* 1843, No 9920). The process worked as follows: the toxic sulphur-rich fumes, given off during the smelting process, were drawn down the feeder flue by means of suction generated by the air pumps. The pumps were water-powered; a large water-wheel transmitted power via reduction gearing to connecting rods, which were attached to a horizontal rocker beam situated on top of a bearing wall. The bearing wall acted as a fulcrum, and at the other end of the beam, a vertical connecting rod transmitted the power to a piston within a cylindrical air pump.

6.110 The air pump forced the fumes from the smelt mill to be pulled through a water-filled cistern divided by a series of internal baffles, which *"must alternately reach from the bottom of the cistern to within such a distance of the top thereof as will allow a proper space for the passage of smoke &c., and from the top of the cistern to within a like distance of the bottom thereof...so, that nothing but purified vapours and gases that are unabsorbable or not soluble in water may pass"* (shown as 'b' in Plate 54). The purified gasses exited by means of an exhaust flue. The contaminated water from the

cistern was run off to a settling tank, where particulate matter would settle, to be re-processed later, whilst the water itself could be evaporated or treated in other ways to recover any valuable dissolved salts or acids.

6.111 Stagg was given permission *"for the erection of a flume condenser at Nenthead"* in 1844 (London Lead Company Minutes, 5th sep 1844 LLC 25), and the fume condenser was probably constructed in 1845; Greenwich Hospital Minutes from May of that year instruct *'Mr Bainbridge to estimate the cost of Flume Condensing apparatus and a water dam proposed to be erected at Nenthead'* with orders to proceed and divide the costs over a number of years at £1000 per year. The water dam referred to in the minutes is Priorsdale, or 'Perrys', Dam, which covers an area of 3 hectares, held 80,000 m³ of water (equivalent to 17.5 million gallons) and was constructed circa 1848 (Almond 1977, 28).

6.112 The condenser is first depicted on the revised Greenwich Hospital plan of 1848 (Plate 53), which shows the condenser (labelled) for the first time. The wheel-pit forms the north spur of the depicted structure, with the rectangular cistern (labelled) to the south connected by a short length of flue (depicted as four dashed lines) to the main flue. A further short dashed line depicts an exit leat from the cistern to the *'fume collecting pit'* (labelled), which comprised the settling tanks for the water from the cistern. It is interesting to note that no exhaust flue, reconnecting with the main flue, is depicted on this plan, and it is possible that the purified fumes exited by means of a chimney.

Plate 57: late 19th century photograph of the Stagg Condenser and wheel-shroud (© NMCS archive)

6.113 The oscillatory motion of the water was described by Stagg as *'materially aiding the washing, condensation and purifying of the fume'* (cited in Almond 1977, 28), but in actual fact the motion was a nuisance, and most later fume condensers contained brushwood or pebbles to dampen the pulsations. The chambers, valves and other parts suffered seriously from the effects of the sulphur-laden gases, but these difficulties were eventually overcome. The operation of the condenser

complex is said to have been adapted and improved by Mr. Stokoe in 1856. Stokoe had developed a different type of condenser, using a fan-blast rather than suction, to great effect in the smelt-mills at Langley and elsewhere. The lead fumes were driven by a fan blast through a series of ascending and descending columns, partially filled with brushwood on pebble stones, down which a stream of water fell, to condense the lead fumes. The water collected in tanks at the bottom of the columns, and the fume was allowed to condense. It is unlikely that Stokoe wholly redesigned the condensers at Nenthead but it is possible that his improvements involved the reconnection of the condenser back to the main flue, as depicted on the First Edition Ordnance Survey map (Plate 55). The mapping also clearly depicts a timber launder (labelled as *'aqueduct'*), supported by timber posts, running from a culvert to the east. The launder is set at right angles to the wheel, suggesting that the wheel was side shot.

6.114 Despite its vaunted efficiency, the condenser was not well regarded; John Percy, writing in 1870, doubted whether anyone would ever erect another such design again due to the expense, and in 1895, Sir Isaac Lowthian Bell dismissed it a failure (Almond 1977, 29). Stagg retired in 1844 through ill health, and died young (Almond 1977, 28). The condenser clearly continued in use into the late 19th century, and by the Second Edition Ordnance Survey of 1899, further flues were depicted connecting to the main flue (Plate 56). The function of these is not clear, but a late 19th century photograph clearly depicts the same arrangement, with a narrow flue visibly running up the hillside just to the rear of the launder (Plate 57). The photograph also depicts the buildings for the first time; interestingly, the buildings along the west and north side of the wheel-shroud appear to have short stubby chimneys. The condenser house and flue south of the bearing wall are also clearly depicted, and the launder which fed the wheel is visible as set high up on splayed wooden supports.

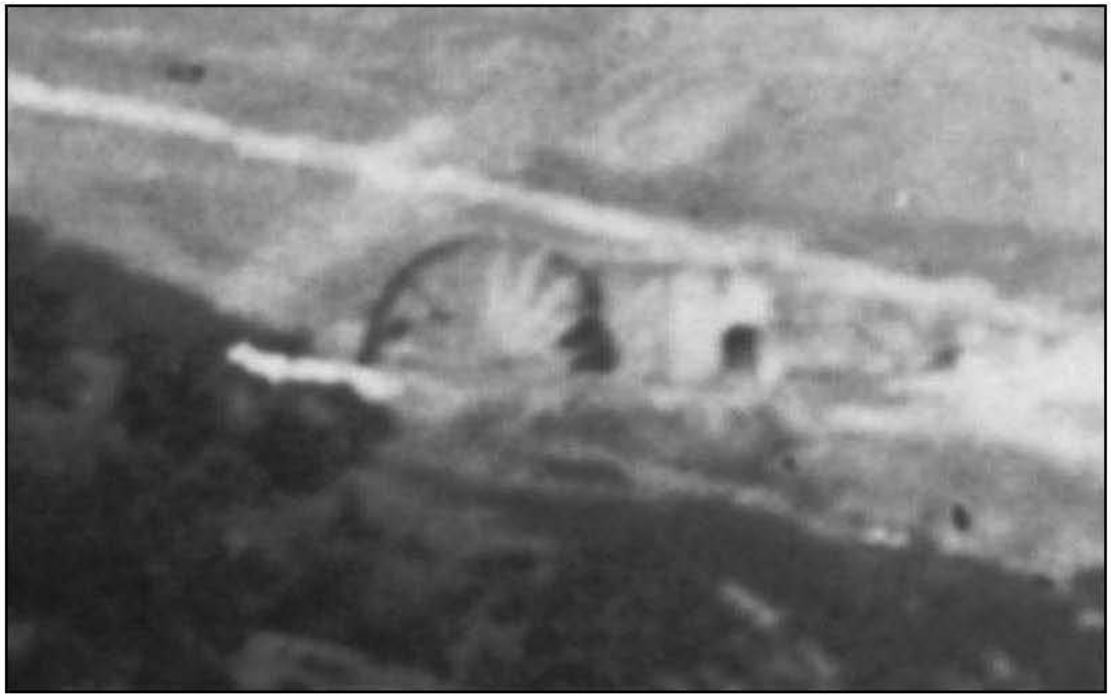

Plate 58: 20th century photograph of the Stagg Condenser and Wheel (© NMCS archive)

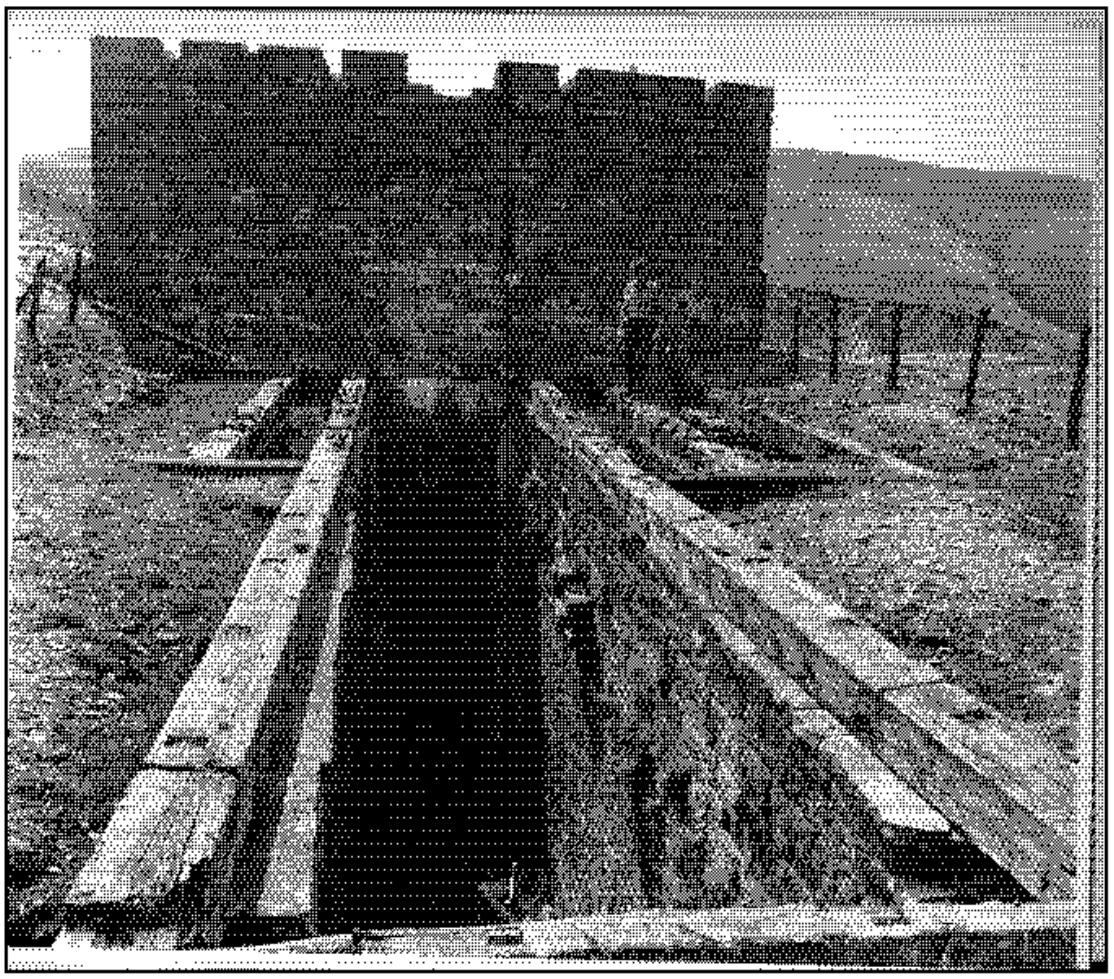

Plate 59: the Stagg Condenser wheel-pit in 1975 (© NMCS archive)

6.115 With the closure of the smelt mill in 1896, the condenser became redundant, and there is no evidence to suggest that the wheel itself or its associated machinery were adapted for any other purpose. An anonymous account of a visit to Stagg's Wheel in 1914 noted that *"...it was still there but had quite a different appearance to that it had when it was in proper working order"* (Anonymous 1914). A second photograph from the early 20th century shows the wheel with the shroud removed (Plate 58); this is the only known photograph of the wheel, which was reputedly 15m in diameter, and side shot. This photo possibly relates to the dismantling of the wheel, wheelhouse, framework and associated machinery; unconfirmed reports suggest that in the 1920s, the wheel was shipped to Belgium for reuse.

6.116 There are no further known photographs of the wheel pit before 1975, and the wheel pit appears largely as it does today, though the timber beams forming the base of the shroud, and the beams supporting the superstructure, which held the bearings for the wheel, were in somewhat better condition then than they are now. Shallow rectangular sockets for the uprights are clearly visible on the beams surface, with fixing bolts for the mechanisms. The base of the wheel pit is shown partially backfilled with debris, and some of the stones in the side wall are visibly hanging.

Plate 60: the Stagg Condenser wheel-pit in 1998 (© NMCS archive)

Previous Investigations

6.117 The wheel-pit, being such a large component of the site, has been extensively surveyed in the past (most recently as part of the Miner Farmer Landscapes project – Railton and Wooler 2012). The Management Plan, undertaken by BHWB in 1995, identified ten surviving components of the condenser, which were looked at as part of the current survey. The Stagg Condenser wheel-pit was described as in an overall good condition, although partly infilled with modern rubbish. The tops of the sidewalls exhibited some slight collapse, and there was a prominent bulge in the masonry of the south-western wall. Very little excavation has been carried out at the site; in part due to the fact that the operation of the smelt mill flues and Stagg Condenser have left a legacy of exceptionally high, heavy metal toxicity within the soil in this area. In 1998, an evaluation and subsequent watching brief was carried out within the wheel-pit itself, prior to clearance of the accumulated rubbish from its interior. The correction of the bulging masonry was undertaken using the bucket of a tracked

excavator, which pushed the masonry back in position (Jackson *pers. comm.*). Limited recording was also carried as part of the field school at Nenthead, which is reported on in Town and Cavanagh (2009a, 84); this included the recording of the elevations of the main bearing wall and the north-facing elevation of the wheel-pit.

Plate 61: the Stagg Condenser wheel-pit in 2013

Description and Function of Features

6.118 The main bearing wall **500** is approximately 11m in length, and 1.8m in width at base, tapering to 1.2m at the top of the wall (the south-facing elevation face incorporates a ledge at a height of 3m above ground level - Figure 5). The wall stands to 4m in height and is topped by eight massive stone blocks, which give the appearance of crenulations. The blocks are paired, with a 0.34m wide slot that runs across the whole thickness of the wall between each block. Fixing points for the rocker beams are visible astride the gaps between the pairs of blocks on the wall top (Plate 62). The fixing points comprise a series of 0.60m square recesses, in the base of which are four paired square bolt-

holes and four paired round bolt holes with in-situ iron bolts The position of the fixing points indicates that the wheel-pit operated four beams, two pairs on each side of the main wheel-pit. Between the two main sets of pairs is a 1.45m gap, aligned with the centre of the wheel-pit. Some of the central stones in the upper courses of the south-facing elevation have fallen away at this point, though archive photos seem to indicate this is not a recent occurrence.

Plate 62: mounting points for the rocker beam, wall (500) (© NMCS archive)

6.119 The two main elevations of the bearing wall contain four pairs of rectangular niches (each pair 0.5m apart), in an approximate horizontal line, 1m above ground level. The niches align with the fixing points for the rocker beams in the stone bearing blocks. The north-facing elevation also contains a further horizontal line of four niches at a height of approximately 3.45m. These niches are slightly offset from the line of the beam slots. A further line of four niches is also visible within this face, midway between the two rows, at 2.4m.

6.120 Within the north-facing elevation, a 2.0m wide curved recess forms the start of the arc of the wheel-pit **501**, which extends down 9.3m to the arch of the tail-race, which itself stands 1.75m in height. Timbers are incorporated into this face, corresponding with the timbers which originally held the shroud for the wheel-pit (see below); these have visibly started to fail. The wheel-pit measures 15.85m in length, 1.95m in width and is 8m deep. The east and west-facing elevations are formed of coursed, squared stone, with no obvious openings or recesses, though the east elevation now

incorporates a drain for a leat tapping the water of the old launder which originally fed the wheel. The south-facing wall of the wheel-pit is also gently curved, to accommodate the wheel. The curve forms the arc of a circle and was clearly constructed to closely fit and follow the circumference of the wheel itself, which fits with the supposed diameter of the wheel. The wheel-pit has a flagged base, now partially obscured by debris.

Plate 63: detail of niches and fixings on north-facing elevation, facing south

6.121 On each side of the wheel-pit, south of the mid-point of the wheel-pit, are a pair of north-south aligned rectangular pits **502** and **503**, now partly infilled but seemingly with similar squared rubble coursed walls. The walls support a network of large timber baulks, all with a square profile of approximately 0.40m, with *in-situ* iron bolts projecting from their upper surface. The beams and pits clearly held the gearing for the pistons attached to the rocker beams, with pistons projecting from each pit to the rocker beams above. The timbers around the pits extend and connect to the large timbers around the wheel-pit which presumably originally held the shroud.

6.122 Though the management plan is mainly focussing on the wheel-pit itself, some discussion of the features surviving in the wider area is useful (Figure 5). Abutting each side of the large bearing wall are two L-shaped arrangements of walling, 0.65m thick, now robbed down to foundation level, but presumably originally forming part of the condenser house, which lay immediately south of the wall (Plates 65 and 66). The walls are formed of flattened dressed stones with no evidence of bonding, and measure approximately 3.25m by 2m on each axis. Interestingly they both seem to terminate at a

wall stub on the south ends of both walls; this seems to correspond with the location of an opening, possibly a doorway, which is visible on the late 19th and early 20th century photographs of the structure when it was still standing. BHWB (1996, 59) suggest that these walls were used to support a wooden structure, in view of the absence of scarring on the side walls.

Plate 64: pits for gearing, on the west side of wheel-pit 501

6.123 The condenser house **504** has been entirely removed, and is now represented by little more than a low rectangular mound of rubble, surrounded by a sub-rectangular depression with low rubble banks, c.20m long and c.10m wide, defining the edge of the depression. No definite evidence of walling can be seen, though this clearly survived into the 20th century.

6.124 The line of the flue **505** leads to the condenser house, and is visibly raised above its position by at least 2m. The flue comprises three lines of rubble, 0.6m wide and 1.2m apart, corresponding to the sides and inner wall of the structure, with walling only intermittently visible. A very small standing section of walling on the east side may relate to this structure, but no more than four courses of walling now exist. On the main flue is a dividing wall, which appears to relate to the junction with this flue, A rectangular structure which survives on the south-east side of the main flue, may perhaps also be related to this junction. The junction is now partly obscured by new dumps of stone from recent consolidation works.

Plate 65: L-shaped wall adjacent to west side of bearing wall

Plate 66: location of condenser house 504, facing north-west

Plate 67: location of settling tanks, facing north-west; note line of leat just right of ranging pole

6.125 The condenser house is connected by a timber leat **506** to the settling tanks **507**, a sub-rectangular area comprising: remnants of short stone retaining walls; timber frames infilled with fire-bricks, other timber structures; and areas of greyish silt. The leat is now entirely filled with soil and loose stone, though its course is still just discernible and timbers project out over the edge of the position of the settling tanks. The fumes from the condenser were carried up the hill by two flues. The smaller of these, **508**, is 0.5m wide, and was probably constructed to improve flow from the main flue. It is shown on late 19th century photographs connecting to a settling tank at its junction with the main flue (see Plate 47). The line of this flue extends east from a position adjacent to the bearing wall, and is visible as a sunken earthwork approx 1m wide and 0.5m deep. The earlier flue **509** dates to the construction of the condenser or just after. This flue lies to the south, and is much shorter and wider, being more akin to **505**, and the main flue, with wide arching and a central dividing wall. This section has now been entirely robbed away and only exists as an earthwork.

Interpretation and Discussion

6.126 The Stagg Condenser wheel-pit, though impressive, is the sole surviving remnant of a much larger complex which incorporated structures around its east and west sides. These included a large condenser house and settling tanks to the south and a complex arrangement of flues and launders, most of which are now no longer extant (though foundations and floors presumably still survive, as

yet unexcavated). The condenser was built c.1845, and appears on mapping from 1848, with alterations visible on the later mapping in 1859 and 1899. Smelting ceased by 1895, so it probably fell out of use by the late 19th century. The wheel-pit is largely thought (correctly) to be of one single phase, though alterations to the buildings and flues adjacent are evident, and probably relate to improvements made to the system by Stokoe and others following Staggs' death in 1851.

6.127 Despite the absence of most of the main structural elements of the condenser itself, and the lack of archaeological investigation of the structures, a reasonably detailed description of its operation exists, and sufficient physical evidence survives to allow its operation to be inferred. Nevertheless, there remains a general absence of record for large sections of this structure, and, in particular, no definitive plan exists of the archaeological features around the wheel-pit itself.

Plate 68: Smallcleugh mine shop and level, later 19th century (© NMCS archive)

Area 6: Culvert, Smallcleugh Level (Figure 10)

History

6.128 The culvert at Smallcleugh measures 28.3m in length, and approximately 2.5m in width at its widest point; Old Carr's Burn flows through the culvert from south-east to north-west. The culvert was constructed to provide a broad working area in front of Smallcleugh Level, which was the third of the principal underground haulage ways in the 19th century, and extended for a distance of 6.8km. The level entrance lies approximately 6m from the original eastern edge of the burn, and is excavated into the hillside, running north-eastwards. Without the culvert it would have been very difficult to utilise the level for anything other than drainage, and as such the culvert was probably constructed

immediately around the time the level was first driven.

6.129 The level is thought to have been started by Errington and Wilkinson in 1770, as they were looking for the continuation of Hangingshaw's West of Nent vein on the north side of the Nent. They abandoned their search a short time later, but in 1787, Dodd, the agent for the London Lead Company, continued Errington and Wilkinson's level up to Smallcleugh Cross vein, which proved to be very profitable and produced an immense quantity of ore. The level was subsequently extended south-east towards Middlecleugh and Longcleugh, to which the London Lead Company also had the leases. The level was continuously used throughout the 19th century; the recorded figure of 4,999 tons of lead ore between 1848 and 1882 probably represents a small fraction of the total yield (Dunham 1990, 148). The level continued to be used by the Nenthead and Tynedale Lead and Zinc Company and the Vielle Montagne Zinc Company into the early 20th century, providing access into the Middlecleugh complex.

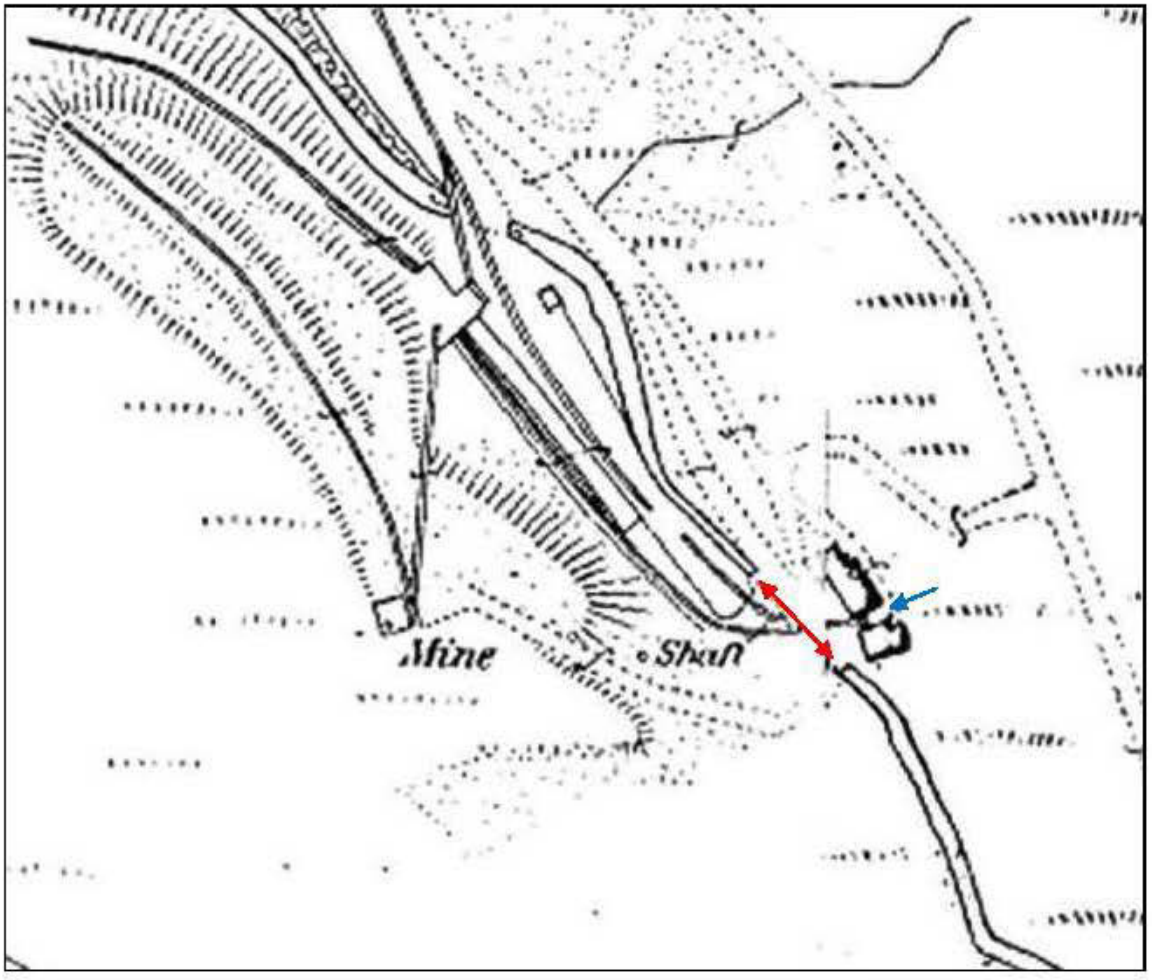

Plate 69: Smallcleugh Level (arrowed blue), with buildings shown north west and south east of level entrance, First Edition Ordnance Survey map, 1859 (© NMCS archive). The direction of the culvert is shown in red.

6.130 A series of buildings were constructed around the mine entrance, which lies immediately east of the culvert. North-west of the entrance was a large two-storey miners lodging shop, and south-east of the

entrance was a further small building, probably a candle store (BHWB 1995, Appendix 1/9, 46). West of the level entrance and the burn was a further building, thought to have been a smithy, possibly powered by a water wheel (but see below). The exact date of their construction is unknown; the buildings either side of the mine entrance do not appear on the early 1800's mine plans, but are certainly present by the early 1820's, and are depicted on the First Edition Ordnance Survey of 1859 (Plate 69). The London Lead Company was introducing mine shops specifically for their workers at their more remote workings by 1818, so this seems a probable date for their construction. The smithy was presumably built sometime after 1859 and before 1882; a slump in production after 1870 may have seen less investment in infrastructure after that date.

6.131 A photograph from the late 19th century shows the arrangement of these buildings, and also depicts a waggonway, which leads from the mine entrance (to the rear of the shop) down to the Smallcleugh Washing Floor (Plate 70). It is interesting to note that the mine shop has an extension on its north-west side, which is also clearly visible on the First Edition Ordnance Survey map of 1859 (Plate 69). There was a peak year in production between September 1824 and September 1825, when 80 men are recorded to have removed 436 tonnes of lead ore from the mines; the increasing workforce may have been a catalyst for the extension to the shop.

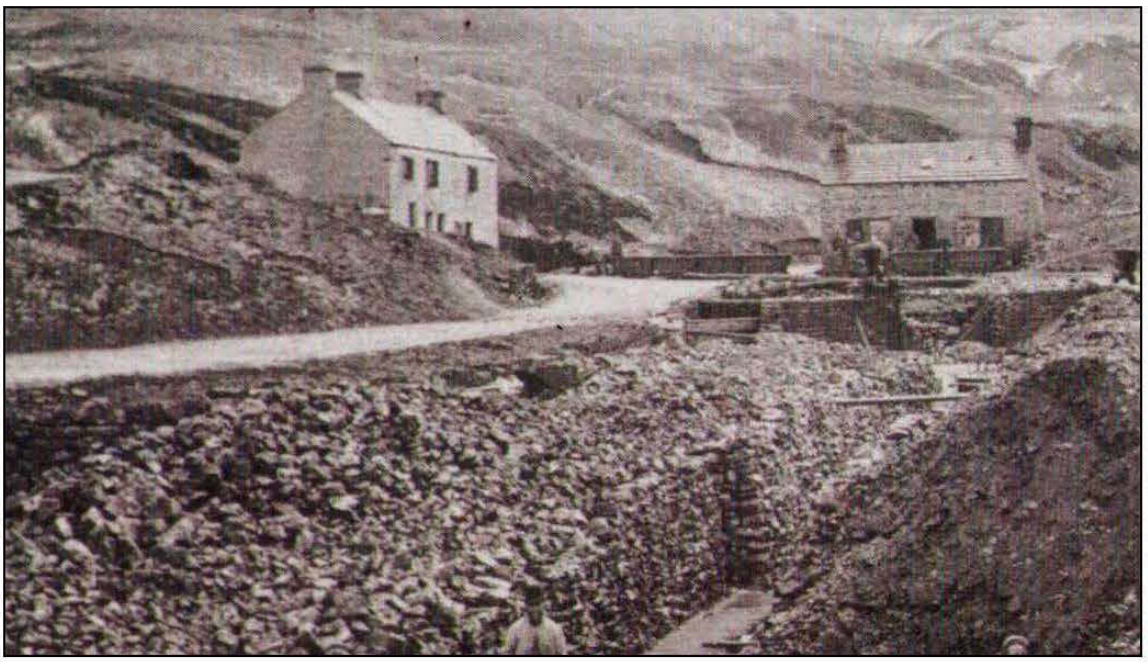

Plate 70: the Smallcleugh mine shop (left) and smithy (right), with waggons on the tracks crossing over the culvert. The culvert mouth can be seen right of centre (© NMCS archive)

Previous Investigations

6.132 No previous archaeological work has been undertaken directly on the culvert, and it has not been recorded on either the RCHME or LUEAU surveys. The BHWB survey (1995, Appendix 1/4, 27) records the culvert as *'a large arched culvert, c.30m long. The north-west end is 2m wide and stands 0.5m high in the centre. The side walls are of roughly coursed squared stone rubble and the arch is*

of roughly shaped rubble voussoirs. The south-east is of similar construction but c.1m high in the centre, with a splayed revetment wall on either side to funnel the water into the culvert.' The description is largely correct, though it is interesting to note the heights of the arching, which may suggest that the culvert was choked at the time of survey.

6.133 In November 2006, North Pennines Archaeology Ltd undertook an archaeological watching brief during the excavation of a trench for a drainage pipe between the level entrance and the north-west end of the culvert. The work was undertaken in order to assist water runoff and aid drainage of the Smallcleugh Level, due to the failure of the original leat. No features of archaeological note were identified, and the excavation work showed that the ground around Smallcleugh Level is mostly made up of redeposited mine waste (Plate 71).

6.134 In July 2008, the Smallcleugh mine shop was excavated, recorded and fully consolidated as part of the Smallcleugh Project, a field school run by the North Pennines Heritage Trust at the mines. A trench was also excavated across the site of the smithy. The works remain unpublished, but excavations within the mine shop uncovered the remains of a blacksmith's hearth, with its associated tuyere for a bellows, quenching tank (bosh), and setting for an anvil. This may suggest that the building known as the *'smithy'* may have had a different function.

Plate 71: excavation of the pipe trench in progress, 2006, facing south-east (© NMCS archive)

Description and Function of Features

6.135 Each end of the culvert **600** was accessed and examined, within the limits of safety and available light, but a full analysis of the interior was not made (Figure 10). The culvert is not a single phase construction, and has been extended at least three times. The main central section (Plate 72) measures approximately 16m in length, and is constructed of large rectangular sandstone rubble blocks. The section has an almost oval profile, the arch springing very close to the base of the side walls. This section is of interest, as along the eastern side of the culvert, a deliberate plinth or walkway has been left, seemingly cut out from the bedrock on which the arching rests. The plinth is not present in any of the extended areas. The position of this culvert at ground level is hard to accurately gauge, but it appears that the section commences in line with the south-western corner of the candle store, and extends north-westwards to end in line with the north-western corner of the (pre-extended) mine shop.

Plate 72: annotated photograph showing north western end of central section, facing towards the south east entrance. Note the plinth along the eastern side.

6.136 The central section has been extended north-westwards by approximately 7m, with slightly finer and narrower stone rubble blocks, and fairly vertical side-walls. This extension appears to align with the north-west extent of the mine shop extension. The culvert exits north-westwards by means of a low flattened arch, which is failing on its western side (Plate 73). This failure appears due to the fact that

the arching has been constructed off-centre, which has put undue strain on the western side of the arch.

6.137 At the south-eastern end of the culvert, the structure has been extended twice (Plate 74). The first extension is approximately 2m in length and is made of large, roughly dressed rectangular blocks, broadly evenly coursed, and with vertical side-walls. The second extension is of much finer stonework, and includes three evenly-spaced square recesses, which presumably accommodated the timber formers for the arch, used during its construction. These recesses were routinely filled in during the construction of arching in mines, and this was carried out by the miners themselves. Culverts, however, were probably built by stonemasons, who had less concern with leaving voids (Jackson *pers. comm.*). The latter phase of extension is contemporary with the exterior south-eastern arch. This arch has a flattened profile similar to that on the north-western exit, but is better constructed. Extending broadly east and south of this entrance, are two well-made retaining walls, both of random coursed and squared stone rubble.

Plate 73: arching on north-west end of culvert. The arch failure is at the 1m mark on the ranging pole. Note the exit of the modern drain in the left-hand wall.

6.138 To the north-west of the junction between the first south-eastern extension and the main section, a large collapse has been crudely repaired by the North Pennines Heritage Trust, using a sheet of plyboard and two timbers nailed to the arch (Plate 75), one of which has fallen away. This correlates on the surface with a small hollow in the track, which the author remembers as the position of the

original hole. The repair appears to be failing, as stones are visibly loose at the top, and the lower section of the side wall has entirely collapsed.

Plate 74: south-eastern end of central section (marked in yellow), and two further extensions, facing south-east.

Interpretation and Discussion

6.139 The culvert served to provide a usable working area to the west of the Smallcleugh Level entrance, an area which would otherwise have been limited by the edge of the burn. The culvert also enabled the waggonways to cross north westwards, up towards the dressing floor. The survey identified that the main central section of this culvert, measuring 16m, was constructed to approximately correspond with the footprint of the original mine shop and candle store. These were constructed to either side of the level entrance sometime around 1820, which gives a probable date for the first phase of culvert; however, a working platform of some description must have been in position prior to this date, in order to allow the working of the level from 1770, so it is possible this section dates back to the 18th century. The north western culvert extension to the first section directly correlates with the north western extension to the mine shop, which was constructed sometime between 1820 and 1859, but perhaps around 1825.

6.140 The two phases of southern extension are harder to date. The first extension may have been built to facilitate movement around the eastern corner of the smithy, as its construction would have created a bottle-neck on the track which accesses Hodgson's High Level, to the west. The second extension was probably built to allow the construction of the track which runs upslope to the south-east of the candle store, then north-westwards up to the main track behind the mine shop. The construction of this track was probably a direct result of the productivity of the mine, which would have caused difficulties for anyone wishing to pass in front of the level. Both events are likely to have occurred sometime between 1859 and 1882, although a slump in production after 1870 probably means a date range of 1859-1870 is more likely.

Plate 75: crude repair to arching, facing north west

Plate 76: miners at Smallcleugh Level, probably late 19th century (reproduced from Raistrick and Roberts 1990, 104)

Area 7: Powder House at Smallcleugh (Figure 11)

History

6.141 The powder house, located on spoil heaps west of the River Nent, has no official name, but is normally known as the '*North Powder Store*', to differentiate it from the '*South Powder Store*'. The latter, which is located south-east of Hodgson's High Level, and south of Smallcleugh Level, is presumed to be a later replacement, and is said to have been built by the Vielle Montagne Zinc Company.

6.142 The North Powder Store is assumed to have been built by the London Lead Company, but its exact date of construction is unknown. It does not appear on the First Edition Ordnance Survey map of 1859, but is shown on the Second Edition Ordnance Survey map of 1899 (Plate 77), so its construction date must lie somewhere in-between these dates. The powder store was probably built as a consequence of the Metalliferous Mines Act (1872) and the later Explosives Act (1875). Under the former, mine owners were obliged to build secure gunpowder stores on the surface, away from the enclosed mines; it was common practice prior to this for miners to take barrels of gunpowder down into the mines and store them in out-of-the-way corners until needed (Forbes *et al* 2003, 68). The provisions in the first Act were strengthened by the second, which was brought in to control the production, storage and handling of gunpowder and other explosive substances. Under the '*general rules*', cited in the 1875 Act, powder stores had to be located in wide, open, spaces, away from both settlement and work-places. Stores are also described as needing to be '*constructed or so lined or covered as to prevent the exposure of any iron or steel in such manner, and the detaching of any grit,*

iron, steel, or similar substance in such manner, as to come into contact with the gunpowder or ingredients thereof in such building'. They also needed *'a sufficient lighting conductor'*.

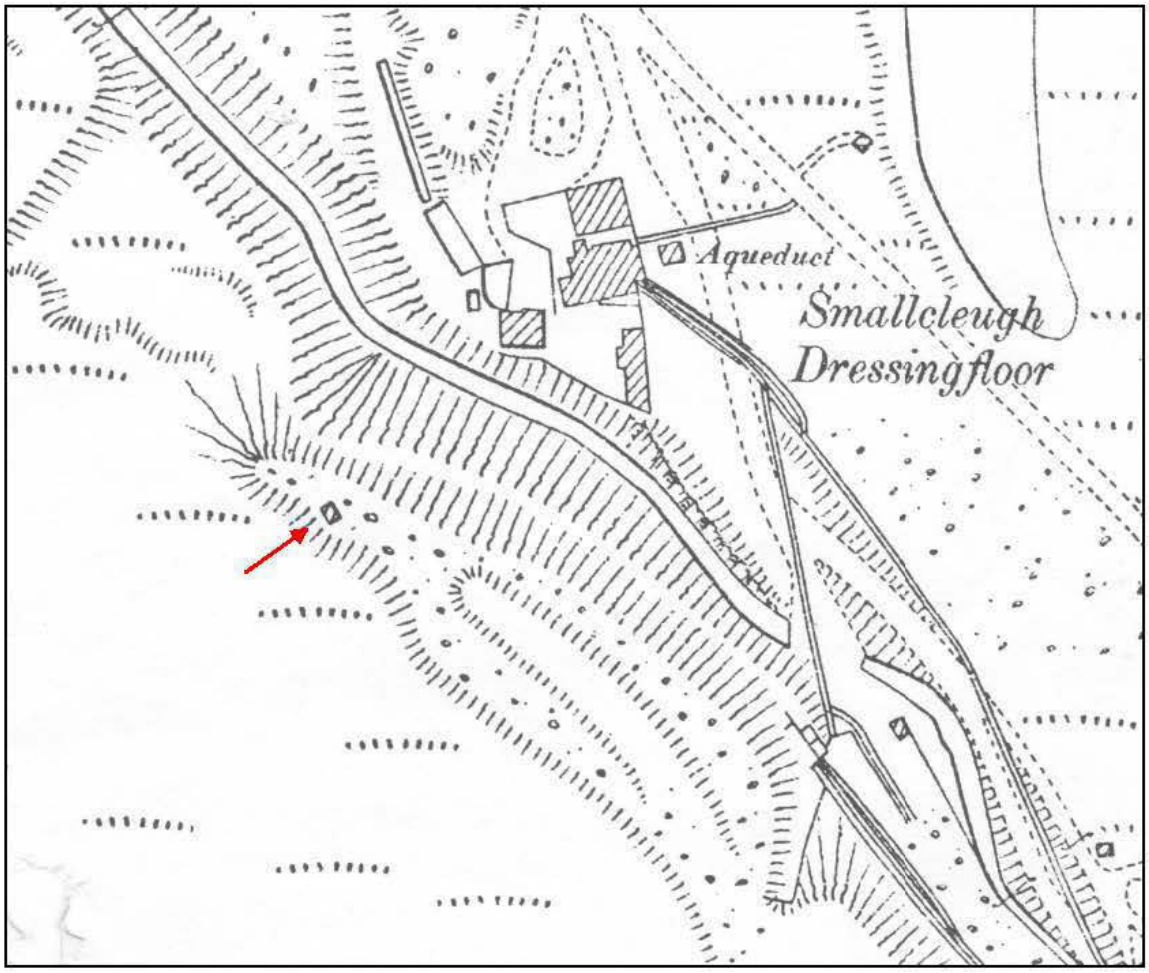

Plate 77: the North Powder Store (arrowed), and Smallcleugh Dressing Floor, Second Edition Ordnance Survey map, 1899 (© NMCS archive)

6.143 The powder store is positioned on a long finger of spoil which extends out from Smallcleugh Level in a north-north-westerly direction, well away from other mine buildings, as is typical for such structures. The building, which was used by the London Lead Company as a magazine for storing gunpowder, was presumably originally connected to the mine via a waggonway. At some point the powder store was cut off by a later encroachment of spoil from Hodgson's High Level, and this may have been the spur for the construction of the South Powder Store, servicing both Smallcleugh and Hodgson High Levels.

Previous Investigations

6.144 The building was probably first published in Jackson (1969, 40. At this time it was still in good condition, roofed in stone slates, and retained its roof and doors (Plates 78 and 79) - an external metal door which opened outwards, and an internal wooden door opening inwards. The interior of the building was lined with wood. In the 1980s, a survey carried out by LUEAU (nd, 60) identified

the site as *"explosives store on Hodgsons High Level"* but made little comment as to its condition. The site was also recorded by the RCHME as *"Magazine on dump 52; North Powder House built by London Lead Company; stone built with some internal timber work, standing to full height but roof is missing"* (BHWB 1995, Appendix 1/6, 13). Little further mention is made of the building until the BHWB survey (*ibid*), by which time the doors had been removed (though the wooden lintel was intact) and the roof had collapsed or had been robbed. The internal fittings comprised only a single surviving batten, and few other fittings survived. There was no evidence of recent maintenance and the wall tops were in poor condition.

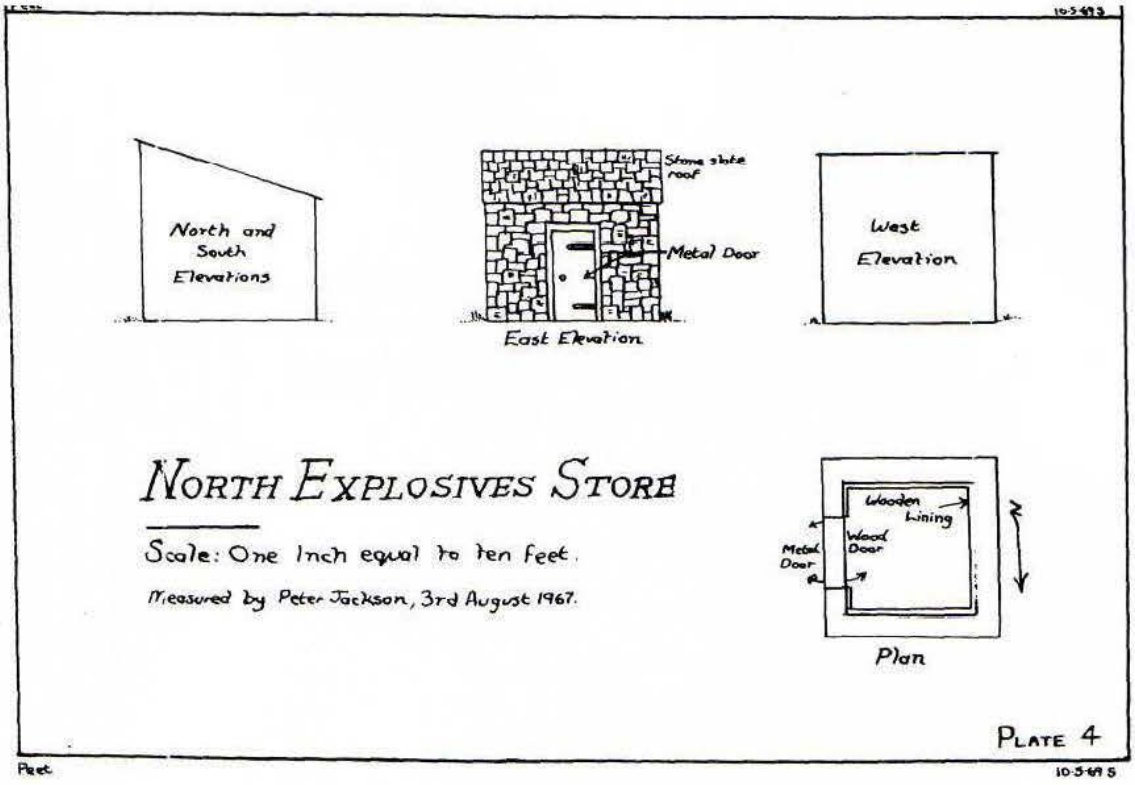

Plate 78: Peter Jackson's 1967 survey of the powder store, taken from Jackson (1969) (© NMCS archive)

6.145 In 2005, the present author recorded the North Powder Store as part of the Smallcleugh Project. At the time, the building was in an extreme state of collapse. Following recording, emergency stabilisation of the side walls was undertaken by the North Pennines Heritage Trust. This comprised the application of a cement cap to the wall tops, and a timber brace to the interior, to support the west wall which was collapsing inwards. Some of the problems of stability had been caused by the rotting of the timber battens, which were set within the walls and had created voids; these were replaced by chemically treated timbers as a temporary solution to the problem.

6.146 As part of the Smallcleugh Project, a small trench (5m by 1m) was positioned across the entrance to the powder store. The simple stratigraphic sequence comprised a layer of building debris, consisting of small to medium sized broken stone slates and wall stones, covered by a thin topsoil. No other significant archaeological features were observed during the excavation (Sowerby 2006, 18).

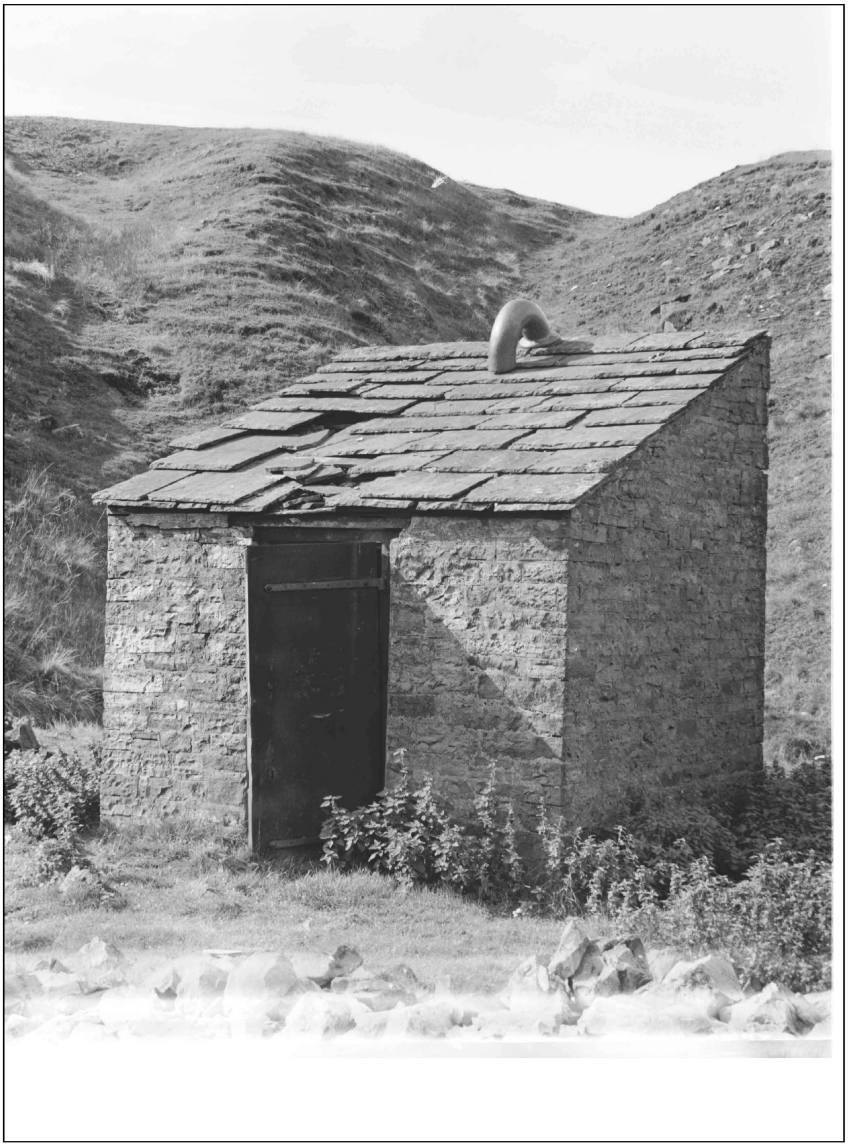

Plate 79: the North Powder Store in 1967 (© NMCS archive)

Description and Function of Features

6.147 The powder store **700** survives as four walls, measures c.3.20m by 3.5m, and is constructed of coursed squared sandstone rubble (Figure 11). The building is unroofed, and now has a cement cap to the wall tops; the original roof was of a single pitch (Plate 79). The walls are bonded with a light grey lime mortar, which may be original; however, as part of the repair works it is clear that some repointing of the interior wall skin (mainly on the north and west sides) has been carried out, in what appears to be cement, and this appears to have failed.

6.148 The doorway is centrally placed in the east wall, and measures 0.95m wide by 1.7m high. The edges of the wall and doorway include roughly dressed sandstone quoins at the corners, and a large flat stone lintel forms the top of the doorway, which is 1.20m in width. The remains of a timber door-frame forms the entrance to the building, however, only the southern upright and lintel survive, with a few pieces of metal sheeting around the frame. There are no longer any doors *in situ*.

6.149 The exterior walls are random coursed. The eastern elevation has 15 courses, and is 1.90m in height. The north and south elevations both have a maximum of 25 courses at their western ends, decreasing with the pitch of the roof to 15 courses to the east. The heights of the walls on both elevations are 3.1m at their western ends, sloping down to 1.9m to the east. The west facing wall is 32 courses and 2.92m in height. The exterior faces of the walls are featureless, apart from the west wall, which has a central square recess.

Plate 80: the North Powder Store in 2005 (left) and 2013 (right)

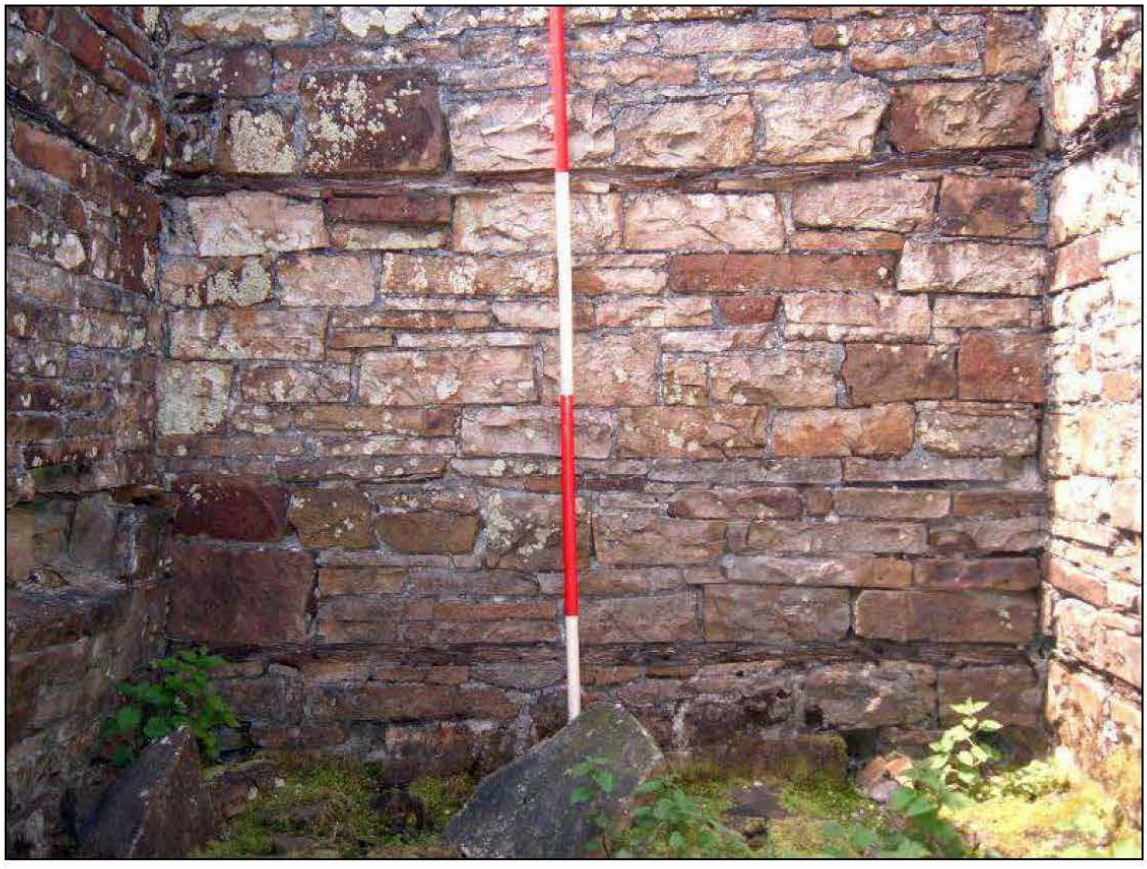

Plate 81: the two rows of battens within the west wall (approximately at the 0.5m and 1.5m marks). The floor joist sockets are visible at the wall base (2005 photo, © NMCS archive)

6.150 The coursing of the interior walls mirrors that of the exterior; set within the faces of each wall are two rows of timber battens, the upper of which has now been replaced with modern timber in the north and east walls. The remainder of the battens have now completely rotted, and the collapsing walls have compressed them to little more than a thin line of decayed wood, but when surveyed in 2005 clearly still held wooden dowelling pegs within some of the original timbers (Plate 81). The pegs would have held a frame covered with timber cladding to cover any hard surfaces and so reduce the risk of sparks. The battens would also have supported timber shelving on which the powder could be kept safely and without the risks of sparks being created (a similar arrangement is visible in the South Powder Store). The west wall also has a square void at the top of the wall, which originally housed a curved ceramic pipe, perhaps a vent (see Plate 79). The interior wall base of the west and east walls include four sockets for timber joists, with two on each side of the door, indicating that the building had a wooden floor.

Interpretation and Discussion

6.151 The building is a single phase, functional building, probably constructed around 1875 for the purposes of storing gunpowder. The building retains evidence of features which are typical of magazines or powder stores of this period, but the internal timber fixtures and doors no longer survive, and it is clear that the roof was stripped off the building sometime in the 1970s. Archaeological work indicates that there are no sub-surface features associated with this structure.

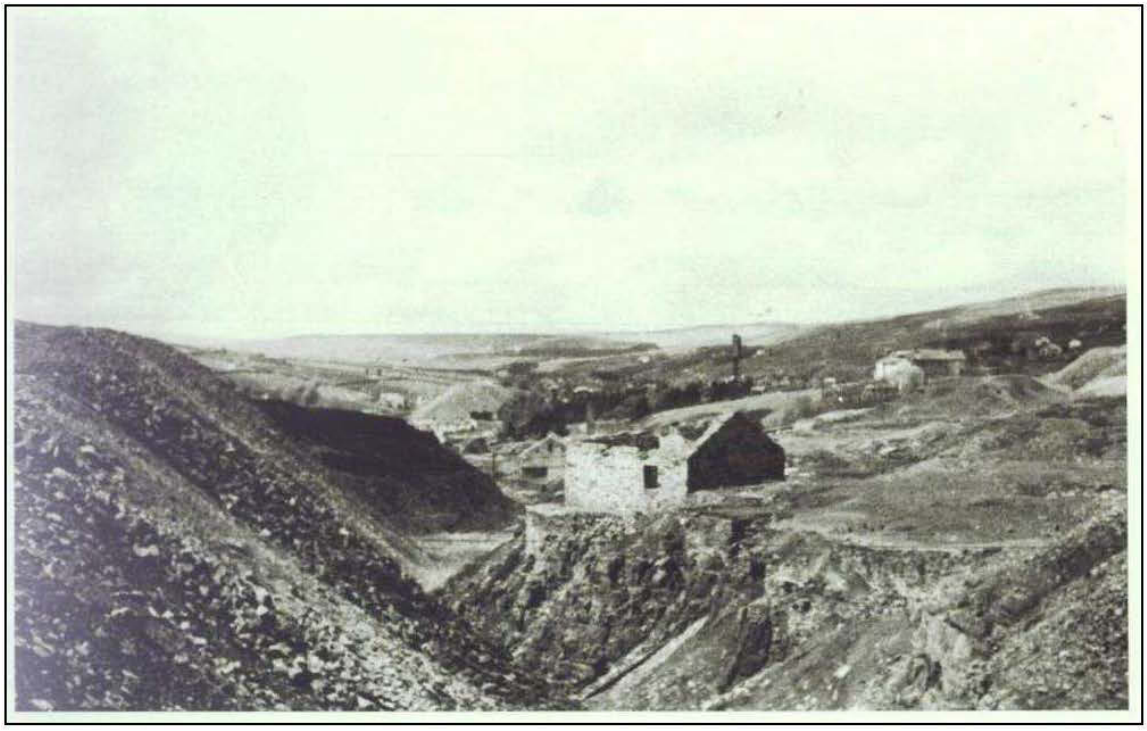

Plate 82: looking north over Smallcleugh Dressing Mill, as photographed by Raistrick in the 1930s (© NMCS archive)

Area 8: Retaining walls, Smallcleugh Washing Floor and Dressing Mill (Figures 11-13)

History

6.152 The exact date of the establishment of the Smallcleugh washing floor is not known, but it is thought to date to the 18th century or earlier. Washing floors were areas where the mine lead ore was processed. After extraction, the mined lead ore was divided into: clean or pure ore, which required no further dressing and could be sent to the bingsteads; rock containing the lead ore, known as '*bouse*', which had to be cleaned and separated, and the '*deads*', waste rock with little or no ore content which was rejected into the dead heap. The bouse was initially broken using a large hammer into pieces about 2 or 3" in size, and the larger pieces of ore were hand picked out. The remainder was then broken on a knock-stone, a large stone serving as an anvil, on which the pieces of bouse were smashed further by boys or women until broken down to the size of small peas.

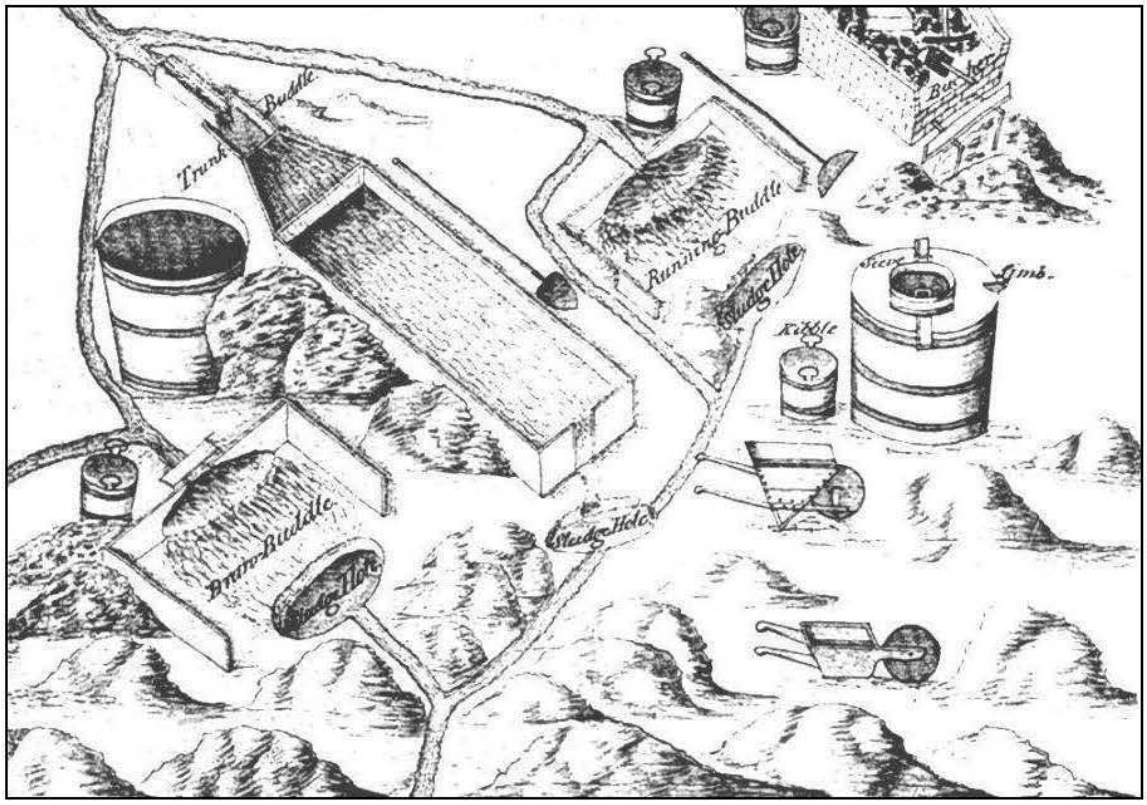

Plate 83: Equipment used for washing lead ore at the end of the 18th century (after Hunt 1970)

6.153 The crushed ore was then placed in a hand sieve and shaken in a tub of water, or a suitable pool in a stream. The bouse gradually stratified into three layers: pure ore at the bottom, a mixture of ore and stone known as '*chats*' in the middle and stone on the top. The top layer of stone was swept off, the ore was put aside, and the chats were crushed again and sieved. The process continued until all the ore had been extracted. The '*smiddum*', the fine particle which fell through the sieve to the bottom of the tub, was then washed in a buddle, which in its simplest form was a few planks of wood laid at a

slight angle on the hillside. Water was run down the buddle in a continuous stream and the fragments of smiddum were dropped in the flow and stirred with a rake. This process again separated it into three layers with pure ore at the top of the buddle, while the mixed stuff and waste was swept further down, or washed off altogether.

6.154 A washing floor, immediately north-west of, and serving, Smallcleugh Level, was located along the western banks of the Nent from the late 18th century. This area of mine workings was associated with Errington and Wilkinson from 1770 (above), but it is not clear at what point the washing floor moved northwards onto the north-east side of the River Nent, just north of its junction with Old Carr's Burn (Plate 77), though dressing was almost certainly occurring in that area in the 18th century. There are at least six shallow shafts immediately east of the dressing floor, which may have provided the initial impetus for its location; these are all undated, but probably originate in the 18th century.

6.155 By 1797, the *'crushing machine'* had been introduced to Alston Moor, and it was the mechanisation of crushing which brought about the most striking improvements in productivity in lead mining. The crushing machine consisted of two or three fluted rollers driven by water power, revolving against each other and crushing ore fed in from above. From the early 19th century, the London Lead Company had installed crushing machines at their works; Lead Company's chief agent calculated in 1811 that the machine *'will make at least 1/5 more of the ore than the common way of washing'*. The separating methods also became partially mechanised. The use of water-washed grating for this purpose lessened the labour required. Buddles became more sophisticated, and by 1842 many different forms were in use, some power-driven, all designed to separate the ore and wastes (Hunt 1970, 94).

Plate 84: Smallcleugh Dressing Mill photographed by Peter Jackson in 1971; the survey area lies in the foreground. In the background is the small office building, now demolished, and the wheel pit to the left of it (© NMCS archive).

6.156 The mechanisation of dressing changed the way miners processed their mined lead ore. Instead of each partnership being responsible for dressing its own ore, the work was undertaken by a specialised workforce on a centralised dressing floor, with machines powered by water-wheels connected by extensive networks of leats and launders to reservoirs, often purpose-built to power the dressing mills. The Smallcleugh Dressing Mill (a crushing mill) was probably established on an existing washing floor by the London Lead Company by the early 19th century, and it continued in use throughout the 19th century and into the early 20th century, when the Vielle Montagne Zinc Company had tenure, though very little is known about it. Whellan (1865) describes a washing floor at Nenthead: '*there are no signs of poverty but abundant signs of work: men and boys washing sorting and crushing ore, amid the splashing of water, the thumping of machinery, and the clattering of falling stones when wagons from the mines drop their burden. From the heaps of ore at one end of the premises to the slime-pits on the other, resolute industry prevails*'.

Plate 85: Smallcleugh Dressing Mill in 2013 (compare with previous photo). Note rebuilt retaining walls on right.

6.157 Smallcleugh / Handsome Mea Reservoir, which lies just east of the Smallcleugh Washing Floor, measures 219m in length and 75m in width. It is believed to have been constructed c.1820, almost certainly to power the dressing processes at the washing floor. The reservoir is formed by a massive flat-topped dam on its west side, which is c.4m high and made of earth although the inner face is formed by a sloping stone lining. The reservoir is fed by two contour leats, from the north and south sides (connected to Rampgill Burn and Old Carr's Burn respectively, though both were extended much further beyond these water courses). The Second Edition Ordnance Survey mapping of 1899 (Plate 77) clearly depicts an aqueduct connected from the reservoir to '*Smallcleugh Dressing Mill*',

and this survives as a flat-bottomed linear depression; the small building adjacent to the reservoir housed the valve which controlled the flow. The aqueduct leads to a waterwheel which powered the crushing plant. The wheel pit, *c.* 6m in length, is now in a very ruined state, and lies just east of the survey area. The remains of massive concrete blocks at the north-west end of the wheel pit, and a concrete machine base to the west of the wheel pit, probably date to the Vielle Montagne phase of development. The crushing mill became the main processing plant at Nenthead in the period between 1905 and 1910 when the old dressing mill at Rampgill burnt down. By 1910, the Vielle Montagne Zinc Company had built the new Krupp Gravity Mill in the village, and the Smallcleugh Dressing Mill is likely to have closed soon after (Critchley 1984, 25; Fairbairn 1993, 166).

Previous Investigations

6.158 Other than previous rapid identification surveys (summarised in BHWB, 1995, Appendix 1/6, 27) and more recently the Miner Farmer Landscapes Project survey (Railton and Wooler 2012, 47-8), no detailed survey or excavation work has been carried out on the dressing floor. Limited recording works were carried out on the repair and rebuilding of the retaining walls to the south-east of the current survey area in 1999 (briefly mentioned in Krupa 1999), but available information and records on this were difficult to find. It would appear from examination of the walls that these were mostly fully rebuilt.

*Plate 86: retaining wall **800**, with waste tip **807** in the foreground, partially obscuring **808** stone revetting*

Description and Function of Features

6.159 The remains of dressing and washing floors are difficult to disentangle because the timber structures, such as hotching tubs, buddles and settling tanks, have either been removed or have rotted away. Smallcleugh Washing Floor and Dressing Mill is now represented by a confusing array of waste tips, wheel-pits, ruined buildings and other structures; detailed survey and examination of this area is badly needed, as it is little understood and a wealth of archaeological material is likely to survive hidden beneath the various heaps of debris and dressing waste, which form its surface. The edge of the washing floor is being severely eroded and the lack of recent maintenance and increased natural and human erosion means that this complex is particularly vulnerable.

*Plate 87: wall **801**, with timber staging **803** above*

6.160 The remit of the current survey was to examine and record the two sets of retaining walls **800** and **801** (Figures 11-13). However, it was felt that there could be little understanding of their function without some further localised survey of the area in the immediate vicinity of these walls, which was also carried out. Ten features were identified; deliberately omitted from the survey, but briefly mentioned here, is the small rectangular building which occupies the south corner of the dressing floor and is visible on both the Second Edition Ordnance Survey mapping (Plate 77) and Raistrick's photograph from the 1930s (Plate 82), which depicts it standing and unroofed. The building is c. 11m long and c. 7m wide, with walls standing to 1.1m in height. The function of this building is not clear, but the apparent provision of inflow and outflow holes in the walls to a possible pit at the east

end, suggests that some dressing plant was present (BHWB 1995, 48).

6.161 There are three sets of retaining walls revetting the western edge of the dressing floor. The first and northernmost, **800**, comprises a large wall of thirteen courses of squared rubble and standing up to 2.5m high, splaying out at its base. The northern end is built onto, and supported by, the outcropping limestone. The main body of the wall sits upon a crude c .3m high sloping stone revetment **808**, which is partially obscured by tailings **807**. To the east of this wall is a large level area. The north and east sides of this area are defined by a retaining wall **810** which holds back a substantial bank of dressing waste. The wall does not appear to be part of a building, but rather defines a rectangular working area which may have housed a series of Brunton buddles or similar, fed by material from the elevated area to the east. The surface of this area is covered in fine crushed material, which is being eroded by water action. This has exposed two planks **809**, which appear to be structural, probably a buddle. South of the planks are two pairs of squared upright timbers **806**, broadly 7.5cm across, which appear to have acted as the upright supports for a chute, from which waste was tipped over the edge of the wall. This waste is represented by a large tailing dump **807**, a fine dark grey silt, which has been heavily disturbed by rabbits.

*Plate 88: tailings at the base of wall **802**, retaining planks **805** in the foreground*

6.162 The southern retaining wall **801** lies immediately south of **800**, and comprises a 1.4m high retaining wall built of similar random coursed stone, but further down the slope. The wall is c. 20 courses in height at the south end, diminishing to c. 10 courses at its northern end, where it has collapsed and has become buried by fine dressing waste. A short length of later wall **802** abuts its southern end; this wall retains a number of timber planks and may be the base of a chute, though this is not clear. The wall has been constructed in front of one of the (rebuilt) retaining walls which extends south from this point.

6.163 Above wall **801**, are several parallel timber structures **803**, some buried to c.1m, possibly representing the remains of settling tanks or catch-pits. Immediately east of the planks is a small square stone **804**, perhaps the base of a launder. At least four lengths of timber planking were identified, forming a series of steps heading downslope towards **801**. A further series of retaining

planks **805**, were also recorded much further down the slope, just above the crest of the bank over the river. This whole area is associated with a large deposit of very dark dressing waste, tipping down the hill from the corner of the building. This has been washed out by later water action. The material was presumably being allowed to settle prior to reprocessing.

Interpretation and Discussion

6.164 The retaining walls appear to represent a series of attempts to stabilise the western edges of the washing floor, whilst also defining a broadly level area on which a number of dressing and washing functions were carried out. The processes carried out in this area are largely unknown, but it would appear that this area was mainly concerned with separating the finer materials out; there is a possible buddling area defined by the low retaining wall to the north, and a series of settling tanks or catch-pits to the south, perhaps collecting materials which were being processed in the southern building. Waste material was being tipped off the edge of the levelled area by a series of probable chutes, their positions suggested by isolated survival of timber uprights and planks and the positions of tailing dumps, rather than any defined structures.

Area 9: Culvert to Rampgill Burn (Figures 14-16)

History

6.165 The origins of the culvert are linked to the development of the Firestone Level, which lies approximately 110m to the north-east, and also to the development of the Smallcleugh Dressing Mill, from the early 19th century. The Firestone Level was driven in 1830 to give easy access into the Rampgill vein at a higher horizon than the Rampgill Low Level, and also to improve ventilation to the mine workings (Critchley 1984, 14). The entrance to the level is located to the north of Rampgill Burn, with the portal close to the Nenthead-Killhope road, which it runs underneath. A prominent flat-topped spoil tip extends south from this, to *c.* 10m in height.

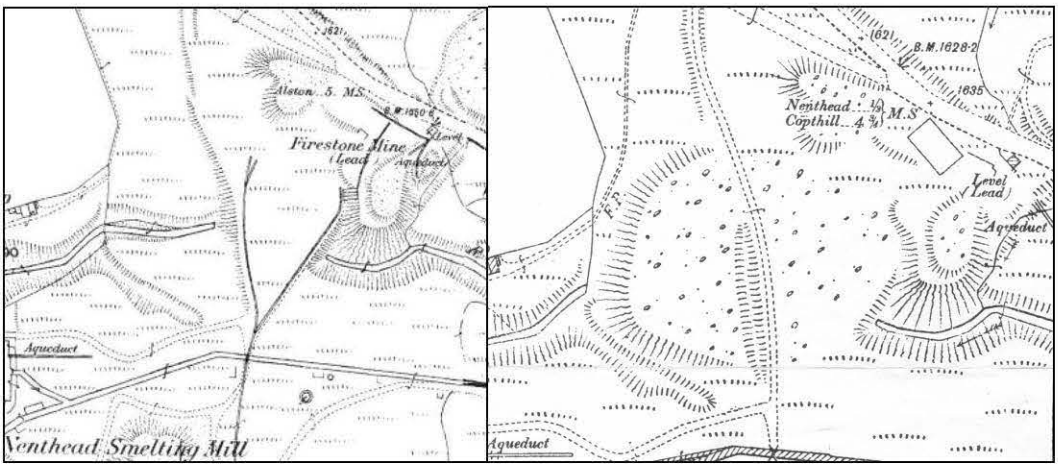

Plate 89: First Edition (1859) and Second Edition Ordnance Survey map (1899; © NMCS archive)

6.166 West of the level are a number of ruined drystone walls and waste heaps, which may form the remains of a small washing floor or other processing area. The dressing floor is clearly depicted on the First Edition Ordnance Survey mapping of 1859 (Plate 89), connected by a short waggonway from the portal, and depicted as a broad flat area, with a probable bouse team adjacent to the bank. This dressing floor is connect by a Y-shaped arrangement of waggonways which cut across Rampgill Burn, supported by a wedge of mine waste, under which the burn is culverted. The waggonways connect to Smallcleugh Dressing Mill, and it is probable that ore was being shipped from Firestone down this waggonway. It is also probable that mine waste was being dumped from the dressing floor at Firestone into the burn, and was also being transported northwards to this position from the Smallcleugh Dressing Mill, where the bulk of the waste is likely to have originated. By the late 19th century, the dressing floor and the waggonways leading from the mine are no longer depicted; the rectangular structure west of the portal entrance is a tennis court (now represented by a concrete platform). The burn is entirely obscured by a large, broadly oval, dump of dressing waste by this date (Plate 89).

6.167 Later editions of mapping show that the heaps remain unchanged until the mid-20th century. In the late 1950s, the dressing waste heaps were identified as containing abundant fluorite, and were reworked by Anglo-Austral Mines Ltd, who adapted the Krupp Gravity Mill in the centre of the village for the processing of fluorspar. It is probably at this date that the heaps were dug out, and the culvert was re-exposed. The reprocessing was, however, short-lived, and the company ceased its activities in 1961. It is interesting to note that the material removed for reprocessing appears to have lain directly over the line of the culvert, and was perhaps removed deliberately in order to expose the culvert, and as such limit the requirement for its maintenance.

6.168 The trackway over the eastern section of the culvert, and the culvert itself, was rebuilt around 1995 by Cumbria County Council (BHWB 1995, Appendix 1/9, 32), who installed a concrete pipe under the trackway.

Previous Investigations

6.169 Other than previous rapid identification surveys (summarised in BHWB, 1995, Appendix 1/9, 33-40) and more recently the Miner Farmer Landscapes Project survey (though it is not specifically mentioned in the report - Railton and Wooler 2012), no detailed survey or excavation work has ever been carried out on the culvert.

Description and Function of Features

6.170 The culvert comprises a single continuous structure **900**, which has a number of separate components, primarily dictated by its condition (Figure 14-15). The spoil heaps, underneath which the culvert runs are extensive, and apparently heavily contaminated with no vegetation growth; these appear to comprise fine crushed and washed dressing waste with larger deads exposed along the southern part of the area. The area is littered with dumps of rubbish, particularly along the edge of

the track, most of which appears to be 20th century in date. The rubbish includes: general household waste, including broken china and other rubbish with a dark humic soil (presumably decayed organics), probably early 20th century; and isolated dumps of large blocks of concrete, and other industrial materials, seemingly bull-dozed into position or tipped from lorries, and probably mid to late 20th century date (and relating to the systematic destruction of the lead mill and other sections of the site at this time). The whole of the area is described in all the surveys as '*toxic waste*' (BHWB 1995, Appendix1/9, 28), which, whilst dramatic, is probably true.

*Plate 90: view of Rampgill Burn Culvert **900**, facing west*

6.171 The culvert under the track was not examined in detail, as this lay outside the limitations of the survey, and could not be accessed due to health and safety reasons. This section of culvert is c.30m in length and abuts the large concrete pipe on its east side, which exits the bank within a rebuilt retaining wall. The western end of this section of culvert is now damaged and has collapsed for c.1m, but this appears to mark the end of the first phase of culvert (as depicted on the First Edition Ordnance Survey mapping of 1859), which supported the waggonways to Smallcleugh Dressing Mill. The culvert includes a well-laid floor of stone cobbles, which was not visible in other sections of the culvert. The walls are a maximum of 1.4m in height; a cursory examination of the interior suggests some sections of the side walls have collapsed further back in under the track, and are much shorter, down to 1m in places.

6.172 From the western end of this section, the culvert has fully collapsed for about 24m, with the eastern end of the north wall completely destroyed for 14m. Laminated layers of dressing waste are visible in section, above the natural clay. The base of the culvert is mostly obscured by rubble and stone washed down the hill, though sections appear to be flagged with large stone flags, laid in an irregular

pattern. The culvert has mostly been built upon the limestone bedrock, which forms a band across this area, and probably was a contributory factor in the location and construction of the culvert.

6.173 From this point, the culvert survives for a 40m stretch in good condition. The base of the culvert is largely obscured and choked by loose stone. The side-walls stand to between 1.4m (at the east end) and 1.5m in height (at the west end), and there are evenly spaced square recesses just beneath the springing line of the arching, where timber formers have been used. There are also gang-breaks along the entire length of the culvert, indicating that the culvert was probably built in sections, perhaps as the spoil heaps became larger. A further short, collapsed section, 7.5m in length, with side walls c. 1m in height on the south side (though much lower on the north side), leads to the final surviving section.

6.174 This section, comprising the final western component, measures 17m in length, with the side walls dropping to 1.7m at the western end, and including the same detail as the main section. The exit mouth of the culvert has collapsed for c.2.5m, but the culvert arching is in good condition. A short distance to the west is a fence line, which marks the end of the limestone outcrop. The water cascades down the hillside from this point into the burn.

Interpretation and Discussion

6.175 The culvert, which forms the subject of this study, comprises a single phase, reasonably uniform construction, approximately 90m in length, to allow the Rampgill Burn to flow underneath a series of large dumps of dressing waste. This waste has emanated from the dressing floors at Firestone, but for the most part was transported up to this point from the Smallcleugh Dressing Mill. The culvert east of this section is probably earlier, and supported the waggonways between Firestone and Smallcleugh; this section is notable for having a well-laid base, in comparison to the culvert under examination. The culvert has now been rebuilt and is abutted by a concrete pipe on its eastern side.

6.176 The main section of culvert has uniform arching and side-walls, the latter becoming taller as the culvert progresses westwards. Recesses for the arching formers are visible along the length of the culvert, and also gang-breaks, which suggests that the culvert progressed incrementally westwards, as the spoil-heaps expanded, though without significant changes to its form. The base of the culvert is flagged in places, but is mainly built on bedrock, and it would appear that the culvert was deliberately constructed on this, for stability; the culvert ends, on the west side, where the outcrop terminates. There are numerous collapsed sections along the length of this culvert, and the '*toxic waste*' is being washed out of the heaps at these points.

7.0 STATEMENT OF SIGNIFICANCE

7.1 The national significance of the Nenthead Mines is reflected in its status as a Scheduled Monument. The site is an important example of a well preserved, multi-phase, dispersed lead mine complex, retaining evidence of virtually all processes relating to the excavation and processing of ore. However, scheduling is based on a broad set of criteria, applicable on a country wide basis and, while aiming to protect the nation's historic monuments, does not take into account smaller details which contribute to a site's specific significance. Sites like Nenthead have a unique cultural significance derived from a wide range of varying values and perspectives encompassing not just the physical fabric of the site but also its setting, use, history, ecology, traditions, local distinctiveness and community value (Kerr 2012, 4). A successful management policy is dependent on the protection and balancing of all these various elements, while resolving any potential areas of conflict and future threats and issues.

7.2 The following section aims to consider what contributes to Nenthead's specific site significance and 'sense of place'. To do this, it considers five high level themes as set out in Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment (English Heritage, 2008b):

- **Evidential Values** - the potential capacity of the mine complex to yield primary evidence about past human activity (potential archaeological remains, levels of preservation, structural evidence etc).
- **Historical Values** - the potential of the mine complex to offer a connection between the present and the past through association with people, events and aspects of life.
- **Aesthetic Values** - the potential for people to derive sensory and intellectual stimulation from a place, through design, art, character and setting.
- **Community Values** - the potential for the mine complex to hold meaning for people to relate to it or whose collective experience or memory it holds (often closely related to Historical and Aesthetic values).
- **Ecological Values** - the potential for the mine complex to provide habitat for native flora and fauna; in particular protected species.

7.3 The overall significance of Nenthead Mines, based on these themes, is summarised in the table below. A more detailed assessment of significance on a site-by-site basis is included in the site inventory at the end of this report.

Table 1: Summary of heritage significance – in order of importance

Evidential	*1) The site is one of the principal lead-mining centres in the North Pennines, covering all stages of processing from extraction and dressing to smelting. The mines were the London Lead Company's main headquarters and production centre - one of the two main companies operating in the North Pennine orefield in the 18th and 19th century (the second being the Blackett-Beaumont Company). It is one of the few mines in the country to feature a Stagg Condenser, which was designed and built at the site. It is also the site where the desilvering of lead by means of the Pattinson Process was developed and then improved upon. The in-situ elements associated with these processes are, therefore, of exceptional significance.* *2) The site is a prime example of a large 18th to late 19th century lead mine and contains features relating to all stages of lead processing. It includes features associated with: gaining the ore (levels, shafts, powder stores), drainage (levels, leats, culverts), water management (leats, reservoirs, culverts), power transmission (wheel-pits, boilers, air compressors), transport (waggonways), dressing the ore (dressing floors, mills), storage (bingsteads), smelting of lead ore (hearths and furnaces, flue systems, chimney), reclamation of fume (flue, settling tanks, condenser) production of silver (Pattinson House, Rozan House) and waste management (spoil tips and tailings).* *3) The layout and arrangement of the various elements clearly illustrates process flow across the mine and the way in which the local topography was utilised to minimise the transportation of heavier material around the site and channel water to facilitate the dressing process.* *4) The mine was used for lead mining (1736 1882), zinc and lead production (1882-c1949) and, finally, for the reprocessing of heaps (c1949-c1970). The complex is therefore a multi-phase palimpsest of archaeological features relating to all three main periods, and, as such, provides an excellent opportunity to study the layout and nature of a mining landscape of this size and scale.* *5) The smelt mill complex is the focal point of the mine and is of exceptional significance in terms of both understanding the operation of the complex and contributing to the unique sense of place. The structure is relatively comprehensive and very important in terms of understanding the layout and workings of the mill, particularly when put together with the documentary evidence. Preservation of this structure has been attempted previously, however*

	sections of the structure are now in a precipitous state. *6) There is a high potential for the survival of good sub-surface archaeological remains associated with: the dressing floor immediately north of Rampgill Reservoir; the mine shop at Rampgill; the Smelt Mill; the flue chimney, the condenser and the Smallcleugh Washing Floor. There is the potential for the survival of archaeology associated with the underground working of the mine (Rampgill Horse Level) but this has not been assessed.*
Historical	*1) There is a considerable corpus of published material relating to lead mining and subsequent phases of extraction at Nenthead, but there remains no overarching publication on the site. The documentary material is quite comprehensive when compared with other mines in the district.* *2) There is some potential for further evidence to be gleaned from the documentary material in the light of information uncovered by the archaeological survey and future archaeological work.* *3) The site is important within the broader context of the development of mining across the North Pennines.* *4) The connection of the mine with the London Lead Company and the Vielle Montagne Zinc Company is of some significance. The London Lead Company was one of the largest and most significant lead mining companies operating in the country at that time. The operations of the Vielle Montagne Zinc Company are also of interest in the context of international mining.* *5) The connection with Joseph Stagg (inventor of the Stagg Condenser) and Hugh Lee Pattinson (inventor of the Pattinson Process) is of national importance.*
Aesthetic	*1) In terms of historic setting, the site is foremost in a group of industrial sites in the area (Killhope, Allenheads, Allen, Langley and so forth). It has an important group value as one of the North Pennines mines, and marks the western extent of the 19th century ore field.* *2) The industrial remains, set as they are within the wide expanse of the surrounding moorland, evoke a strong feeling of the passing of time and the transitory nature of human endeavour: a sense which echoes across some of the country's greatest and most popular archaeological sites. The topology of the valley also creates a sense of enclosure, of a 'hidden' discovery, clinging*

	onto the valley side. *3) Onsite, the smelt mill complex is intriguing to visitors. Visitors enjoy spending time walking around the edges of the complex and examining the detail of the workings as interpreted on boards, and in the workshop, where interactive features are available. Further up the valley, the Smallcleugh complex affords more adventurous visitors an opportunity to look at more dispersed mine buildings and dressing floors, which also carry interpretation boards. Both areas provide a rare opportunity to explore the 'workings' of a mine and are likely to have considerable appeal to those with a sense of discovery.* *4) The movement of water in and around the complex is another prominent feature of the landscape. The River Nent tumbles through the middle of the monument, dividing the mine complex in two, with most of the archaeological features lying on the north-eastern bank side. The river and its tributaries have been culverted, and extensively tapped for water to feed reservoirs by means of an extensive network of leats and launders. These in turn serve a number of complex motive and dressing functions.* *5) Views both from and around the site are key to the setting of the monument. In particular the long view along the River Nent and views across the monument from the viewing points at the Powder House. Views to the mine are also significant, particularly from the Killhope Road, and the road up over Fiddlers to Garrigill.*
Community	*1) The site is clearly visible from the Coast to Coast (C2C), which is a popular long distance Sustrans cycle route, and, as such, is believed to be of considerable significance in terms of enhancing the experience of those using the long distance path. Though the C2C does not directly access to the site, it is an important element contributing to the unique character of this section of the route. Cyclists make regular visits and use of the site during high season.* *2) There continues to be great interest in the underground working of the mine through the constant use of the site by mine explorers, and the opening of sections of the mine during 'high days' throughout the year by the Nenthead Mines Conservation Society, which attracts many visitors to the site during its open days.* *3) The site remains an important focus for the local community and is accessed on a daily basis by local dog-walkers and residents.*

Ecology	*The value of metalliferous sites is recognised at local and national levels, with their distinctive flora which includes uncommon species. This is being covered in the Management Plan (Countryside Consultants 2013).*

8.0 MANAGEMENT CONCERNS AND RECOMMENDATIONS

Introduction

8.1 The detailed results of the structural survey and conditions assessment, including a discussion on possible options to stabilise the site, are included in the Management Plan (Countryside Consultants 2013), and will not be discussed at length here. The following section summarises some issues and concerns highlighted during the survey. A site-by-site assessment of condition is included in the site inventory at the end of this report.

Statutory Requirements

8.2 Nenthead Mines is a Scheduled Monument as defined in the Ancient Monuments and Archaeological Areas Act of 1979. As such, any activity which might be construed to impact on a Scheduled Monument including demolition, destruction, repair or alteration in any way, must have prior written consent from the Secretary of State. Undertaking such activities without consent is a criminal offence. In addition, the setting of a Scheduled Monument is a material consideration in the planning process under the National Planning Policy Framework (NPPF). This has direct implications for those sites which lie outside the scheduling boundary. In terms of the guidance (NPPF 2012, 56), a monument's setting is defined as:

"the surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral."

8.3 As such, setting does not necessarily have to relate spatially to the monument but might be any element which affects our understanding of the heritage asset.

Threats to Evidential Significance

The condition of the standing remains

8.4 Despite a comprehensive programme of consolidation of a number of structures in the 1990s and 2000s, a number of the structures on the site are in now a semi-ruinous state, either through having lain abandoned for over 100 years, or through progressive failure of the consolidation works. Nevertheless, the crumbling nature of the industrial structures, set against the wildness of the landscape, is part of the intrinsic character and unique '*sense of place*' of Nenthead and this needs to

be taken into consideration in terms of the long-term management of the site – striking a careful balance between conservation and natural attrition. Given the significance of the monument, it is important to conserve the site for the enjoyment of future generations but the guiding principle should always be stabilisation, rather than any form of extensive reconstruction or rebuilding, which could have considerable detrimental impact on the character, identity and setting of the mine. Such an impact might, arguably, outweigh any potential benefits.

8.5 Management concerns relating to the selected survey areas have been described and discussed in the Management Plan (Countryside Consultants 2013); however, given the scale of the site, and the extent of the structural problems affecting particular areas, a solution to all the concerns raised is likely to be costly and therefore a balanced programme needs to be agreed, identifying areas of most need.

Plate 91: damage to the line of the flue caused by unauthorised track-side ditch clearance

Unauthorised maintenance work

8.6 As a Scheduled Monument, any maintenance work carried out on site which could cause any damage will require Scheduled Monument Consent (SMC). This includes any clearance of trackside drains (Plate 91), rubble clearance, propping or insertion of scaffold, or construction, and applies equally to the buildings and surrounding remains (dressing floors, earthworks etc.). No material should be removed, or any modifications made to the monument without prior written consent.

Erosion

8.7 The exposed nature of the mine means that the Nenthead Mines are at risk from erosion. Mostly this process seems relatively slow paced and the threat is considered to be low, though during heavy deluges, caused by increased rainfall and spring melts at certain times of the year, flood paths have been noted cutting into the upper dressing floors and the tracks above the smelt mill. The continual movement of water across the site means that water erosion is probably one of the main threats to the site. Most of the buildings are also under threat from the freeze/thaw activity in the winter, which causes the failure of mortar and the subsequent ingress of water to the structures. There are also issues with regards pollution getting into the water courses in Areas 8 and 9.

Threats to the Historic Significance

8.8 There are no perceived threats to the historic significance of the site. Most of the records are held in a secure facility at the mines by the Nenthead Mines Conservation Society, and a concerted effort of cataloguing is currently underway. Nevertheless, the NMCS only has limited funds, and long-term assistance with this process is recommended. The ultimate deposition of certain sections of the archival material with the Cumbria Archives Service should be encouraged.

8.9 There remains no comprehensive publication on the history and archaeology of Nenthead Mines. This is long overdue, would be a substantial benefit to the site and its future management, as well as public understanding and appreciation.

Threats to the Aesthetic Significance

Views

8.10 Given the nature of the surrounding landscape, and the current land-use, there is not perceived to be any immediate threat to any of the views or vistas associated with the monument.

Potential Setting Issues

8.11 Issues of setting are not bound only to visual aspects of the site, but might include other elements which could affect our understanding of the context of the mine as a heritage asset and its accessibility. This might include:

- Other industrial sites (the North Pennines mines and smelters etc)
- Transport routes
- Pattern of settlements
- Hydrology (becks, leats, dams etc)
- Built heritage (form, design, materials of the buildings within the wider regional context)
- Social/economic implications (development of community including the miner/farmer

relationship and the development of schools, churches, workers education, poor law administration etc)

8.12 Therefore, any new development, even if not directly visible from the mine complex, could potentially have an impact on its historic setting (NPPF 2012, 56).

Threats to Community Significance

Visitor Numbers

8.13 Visitors to the site are now relatively few. Low numbers mean the mine retains a sense of isolation and there is a sense of 'discovery', which is becoming a key element of the mine's appeal. However, in order for the mine to remain viable, a continued programme of outreach and development needs to be maintained. The NMCS continue to curate the site and open it for visitors, but will need continued assistance for the near future. Better links with other sites in the wider area would also be beneficial.

Health and Safety

8.14 Despite the relatively low visitor numbers, public liability and health and safety is a major concern at Nenthead. The Spine Wall is not easily accessible, but it can be reached from the track (despite the fence) and children have been noted playing on the top of it. There are no signs or warnings. The structural survey has shown that the condition of the wall is perilous and could potentially result in collapse. The fencing around the upper reaches of the Stagg wheel-pit is also in a poor state, and the wheel-pit is a considerable risk to anyone venturing too close to the edge. Methods to minimise public health and safety risks are discussed in the Management Plan (Countryside Consultants 2013). Signage needs to be erected as a matter of urgency.

Gaps in our Understanding – Further Research

8.15 Gaps in our understanding can have a marked impact on an assessment of a site's significance, with this in mind, the following work might be considered:

Documentary Research

8.16 In the light of the information resulting from the archaeological survey, further research might be undertaken into the mine's history as part of the development of outreach at the mines, assisted by members of the NMCS, through the Altogether Archaeology programme.

Targeted Excavation (subject to SMC)

8.17 Based on the current proposed programme of works, a small area of targeted excavation on the dressing floor at Smallcleugh, prior to the consolidation of the retaining walls, would be beneficial. The dressing floors are considered to be of considerable (regional) significance as an example of a well preserved 18th – 19th century lead dressing floor, forming part of the wider mining landscape.

The recording has established the considerable evidential value of the site which appears to be of a large extent and excellent quality of preservation, with considerable potential for the survival of material relating to all aspects of the dressing processes, including buddling, jigging and slimes, as well as crushing and sorting. Excavation could potentially reveal information on the nature of the dressing processes being employed, as well as assess their state of preservation.

8.18 The site has a considerable communal value with regards the level of interest inspired in the industrial history of the area, particularly mining. There are a number of local and regional industrial interest groups including the Nenthead Mines Conservation Society, and exploration groups and local history societies who are interested in the site and there is the potential to bring these elements together to advance a better understanding of the site and its surroundings. This could be undertaken as a community-based programme through Altogether Archaeology, supported by the Nenthead Mines Conservation Society.

Emergency Recording (subject to SMC)

8.19 It is recommended that the section of damaged flue east of the line of the track is cleaned back to stable archaeology and the layers and structures recorded, before any further damage occurs in this area. This could be undertaken as a community-based programme through Altogether Archaeology, supported by the Nenthead Mines Conservation Society.

8.20 The pits for the gearing to the east and west of the Stagg wheel-pit are starting to fail, and appear to have never been fully recorded archaeologically. Only basic outline drawings of these have been surveyed in. It is recommended that the pits are cleared out and fully recorded, and then lined with terram and filled in with a stable inert substance to support the structures and prevent further damage. Consideration should be given as to how best conserve the timbers and protect them from the elements. This could be undertaken as a community-based programme through Altogether Archaeology, supported by the Nenthead Mines Conservation Society, though there are clear Health and Safety issues which would need to be addressed.

Further survey

8.21 In light of the extensive archaeological record for most of the site, further survey is not likely to be required. However, it would be beneficial to produce further Digital Elevation Models (DEMs), particularly of the smelt mill, Smallcleugh dressing floor, and other areas, which could be used as a pre-intervention record of the areas prior to consolidation works commencing. The survey work on the latter could then be augmented by further detailed survey of the dressing floor, which could be undertaken as a community-based programme through Altogether Archaeology, supported by the Nenthead Mines Conservation Society. The results from the fieldwork could be fed back into the Miner Farmer Landscapes Project, being undertaken by English Heritage.

9.0 NENTHEAD MINES SITE INVENTORY

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
101	Rampgill Reservoir	378072, 543457	Pre-1850	Moderate Important in terms of understanding the transmission of power around the mine.	Generally stable, but affected by **102**, which is eroding and collapsing its bank.	The reservoir is depicted on the First Edition Ordnance Survey mapping of 1859. D-shaped in plan, with a dam on its eastern and western sides. The dam is a steep-sided flat-topped earth bank c. 2.5m high. There is no evidence of any internal lining to the dam structure. The south side of the reservoir is formed by a gently sloping natural bank and there is no trace of any artificial earthworks.
102	Main Sluice-Gate	378077, 543476	Pre-1850	Moderate Group Value with **101**.	Collapsed and no longer visible.	The northern sluice-gate is no longer visible and has collapsed, causing erosion of dam wall due to the movement of water through the wall at this point, which is visibly leaching out to the north, creating a boggy area. The sluice gate is depicted on the First Edition Ordnance Survey mapping of 1859.
103	Overflow Sluice-Gate	378048, 543452	Pre-1850	Moderate Group Value with **101**.	Structural sound, though sluice gate no longer in position. Silted up.	Stone-built sluice, rebuilt, located on the internal face of the western side of the dam of the reservoir. U-shaped, 1.4m wide, 4m long, and survives to a height of 1.5m. The slots into which the sluice gate fitted survive within the stonework. A culvert, now choked with silt, leads away to the west.
104	Capelcleugh Upper Level	378100, 543471	c.18th century	High Outside immediate survey area.	Generally less stable than **105**, but not a concern. Water issues constantly from this level, ponding to north of **101**.	Capelcleugh Level was originally known as Brigal Burn Level, and was driven before the 19th century into the Brigal Burn and Dowgang veins, possibly only as a drainage level. Probably this one. Stone-arched portal.
105	Capelcleugh Lower Level	378114, 543490	1819-1825	High Outside immediate survey area.	None, generally stable. Water issues constantly from this level.	The London Lead Company are recorded as driving a further level between 1819 and 1825 (Fairbairn 1993, 76). Probably this one. Stone-arched portal.
106	Leat	378081, 543479	c.18th century	Moderate Important in terms of understanding the transmission of power around the mine. Leat fed the dressing floor water wheel. Outside immediate survey area, could be affected by works.	Only sections survive, immediately north of reservoir, as earthwork leat (silted up). South course not traced.	Leat running due north from River Nent, across front of **101** (which presumably fed it).Circumvents the edge of the reservoir, cutting to the north-west, across a longer possible finger of spoil **108** and connects to a rectangular building, possibly a wheel-pit for a water-wheel powering a crusher (First Edition Ordnance Survey mapping of 1859).
107	Waggonway	378084, 543504	c.18th century	Moderate Probably part of the original mine layout. The track is significant in terms of understanding the operation of the mine, in particular transportation. Outside immediate survey area, could be affected by works.	Moderate Slow deterioration Feature is stable but waterlogged in places, which could threaten its survival.	The waggonways extend from the level **104** and end in a short spoil heap to the north, with a further north-east spur leading to a series of bouse-teams. Ephemeral evidence in the woodland, full course not traced.
108	Spoil Heap	378052, 543542	c.18th century	Moderate Spoil-heap likely to be solely comprised solely of deads, but supports other	Low/Moderate Slow deterioration In some areas there has been erosion, particularly	Long finger of probable spoil north of Capelcleugh Upper Level, probably related.

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
				important features	along the water's edge. Plantation on east side.	
109	Leat	378077, 543406	Pre-1850	Moderate Important in terms of understanding the transmission of power around the mine. Outside immediate survey area, could be affected by works.	Mostly an insubstantial earthwork, through a marshy area, could be damaged by constant water action	The leat appears to be carrying water spilling out from a line of shafts and subsidence hollows **111**, and is now quite swampy and difficult to trace.
110	Leat	378044, 543433	Pre-1850	Moderate Important in terms of understanding the transmission of power around the mine. Leat fed the dressing floor water wheel. Outside immediate survey area, could be affected by works.	Generally stable earthwork.	The leat is only visible as a very shallow earthwork, and appears to have been carried over a natural water-course to the west by a launder, though the course of this was not traced.
111	Shafts/Hollows	378094, 543417	Pre-1737?	Moderate Probably part of the original mine layout. Could relate to 18th century workings of Dowgang Hush. Outside area.	Generally stable, turfed over hollows.	Possibly early shafts or subsidence hollows along line of Capelcleugh Level.
112	Spillway	378056, 543469	1999	Low - modern construction	Stable	The breach in the north side of the dam is represented as a V-shaped cut c3m wide at the top and 2m deep. It is partially grassed over and moderately defined. In 1999 a new spillway was inserted, and later a bridge over (?2007-8). Stable and functioning.
201	Rampgill Horse Level	378162, 543513	c.1825	High One of the earliest and most important mining features on the site	Stable and in good condition (rebuilt in 1990s); issues with hanging gate pulling at stonework	The Rampgill Horse Level, in its current form, appears to originate between 1825 and 1859, and has been remodelled at least three times since it was first driven, probably in 1690, but certainly by the early 18th century. The level still includes a number of its original features, but was rebuilt in the late 20th century as part of consolidation works by the North Pennines Heritage Trust at the mine. The portal of the level **201**, which is 1.2m wide and 2m high, comprises walls of roughly coursed squared stone rubble set with a lime mortar. The level is roofed with flat stone slabs at the entrance for a short distance; beyond this the slabbed roof is replaced by stone arching, before being cut into solid rock. There is a small square recess in the west wall a short distance inside the portal. Gated.
202	Retaining Wall	378161, 543515	c.1825	Moderate Important in terms of understanding the layout of the buildings and operations in compound and mine. Feature is also key to the structural preservation of the area.	Collapsing along base.	Probably dates to same period as **201**, retaining wall between level and **205** mine shop. Originally held a ladder, and a number of functions took place to north, related to compound to south-east. made of random coursed and squared stone rubble, bonded with lime mortar.

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
203	Culvert	378160, 543512	19th or 20th century	Moderate Probably part of the original mine layout.	Generally stable structures but condition of slabs under car park not assessed.	The water from **201** flows into an underground culvert **203**, approx 2m wide and 0.3m high at its mouth, which is flagged with stone flags supported on iron rails. The course of this is not known, but it appears to follow a diagonal path westwards across the car park to a small aperture built into the retaining wall, on the north-east side of the river, from which a constant stream of water flows. It is possible this culvert utilises the line of the first level, driven in the early 18th century or earlier.
204	Leat	378134, 543544	19th century	Low/Moderate. Significance damaged as has been re-excavated though preserves original alignment	Generally stable earthwork.	Now largely inactive earthwork leat, may have connected to culvert **203**, running beneath the position of the mine shop.
205	Rampgill Mine Shop	378150, 543474	c.1818-20	High. Important part of the original mine layout, contributes to understanding of welfare and miner's life. High evidential value.	Demolished and heaped into a bank.	The exact date of construction of Rampgill Mine Shop is not known; on the mine plan c.1825 it is described as a 'smithy and shop'. Probably built 1818-1820. Demolished 1972. Originally had two storeys, the upper storey accessed on the south-east side by an external staircase. In 1995, the north wall of the building still survived, standing up to 1m high and built of roughly coursed squared stone rubble. A blocked recess, possibly a fireplace, was recorded at the western end of the wall with a small iron pipe projecting from the top. There are now no structural remains visible.
206	Building	378164, 543509	Pre-1825	Low/Moderate. Original building now subsumed into modern café building, only retains exterior features.	Stable.	Now incorporated into the former cafe at the Visitor Centre, but believed to have originally functioned as a stable or a smithy. This is the building marked as a 'shop' on the 1825 mine plan.
300	Smelt Mill Complex	378420, 543285	1737-1970	High. See sub-components below.	See below.	Group number for sub-elements below.
300 (SM)	Smelt Mill	378416, 543292	1737-1896	High. Site of 18th century smelt mill, used throughout 19th century.	Most walls robbed to foundation level. Consolidated, but consolidation now failing.	Three-celled rectangular building with a central wheel-pit and four hearths or furnaces (three survive). Wheel powered bellows originally, and the later a fan, which led air through a series of ducts to rear of furnaces. Working areas had fume hoods and were accessed via doors at each end.
300 (A)	Building A	378414, 543299	1820s?	Low/Moderate. Extensively damaged and now only survives as foundations. Most internal features destroyed. One surviving furnace. Modern hopper at NE end.	Stable	Long rectangular building accessed from doors to SW, a waggonway originally also accessed the building through one door. Probably originally held three furnaces, only one survives (position of other two inferred from air blast ducts). Large hopper at NE end built in 1961 by Rampgill Mine Company.
300 (B)	Building B	378430, 543284	1820s?	Moderate/High. Building mostly now demolished, but retains internal features and evidence of process.	Stable	Square building with openings on SE and SW sides. Cobbled and stone flag floor; cobbling may originally mark position of a furnace (refractory furnace). Position as line of heat-affected stone on Spine Wall. Accessed via double (cart) doors with original hinge points, stops etc. Modified C20 for coal storage with insertion of large square lowered area to floor to feed coal to Lancashire Boiler (Building H).
300	Pattinson	378399,	1839	High.	Stable, but SE wall in	Named after Hugh Lee Pattinson, who discovered in 1829 a process for

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
(C)	House	543279		Building mostly now demolished, but retains internal features and evidence of process. High Historical and Evidential Value.	collapsing state.	desilvering lead. Long rectangular building, multiple doors, for aiding air-flow to building. Recesses for Pattinson Pans evident in floor infilled with brick, with associated flues and a system of crane bases for lifting ladles. Later modifications - infilling when used as dormitory accommodation, then later insertion of machine bases and modern brick walls for 1960s reprocessing works.
300 (D)	Rozan House	378408, 543262	1882	Moderate. In good condition but all interior desilvering workings removed when converted to air compressor plant.	Generally declining, walls never consolidated and concrete bases of compressors now fractured by frost action.	Named after Luce and Rozan Process, introduced 1882 for desilvering lead. Building converted to steam plant c1901. Largely demolished in 1960s for reprocessing activity. No evidence of desilvering in interior now, remains only of steam plant in form of bases of air compressors and associated pipework, crane bases etc.
300 (E)	Robey Boiler House	378431, 543269	c.1900	Low/Moderate. Building mostly now demolished, but retains internal features and evidence of process.	Stable.	Building seemingly constructed for sole purpose of housing six Robey Boilers for powering steam plant in Rozan House. Long rectangular room to south, with corresponding doors to each boiler, equates to position of a coal store.
300 (F)	Building F	378416, 543278	c.1820	Low/Moderate. Building mostly now demolished, but retains internal features and evidence of process.	Consolidated but walls are now failing. Spine Wall is also failing.	Building with a series of openings on SE side, probably originally leading to yards, and at least one used for a waggonway; now bricked up by insertion of Lancashire Boiler in Building H, but leads through a doorway to passageway up side of Pattinson House. Interior flagged surface incorporates a machine base (later) and position of a furnace, now only marked by a brick flue in side of Spine Wall and an area of irregular flags.
300 (FB)	Building F-B	378422, 543281	c.1820	Moderate/High. Building mostly now demolished, but retains internal features and evidence of process. In situ remains of hearth, high evidential value.	Stable.	Small sub-square building, constructed with a space between buildings B and F. Excavations in 1999 uncovered remains of two hearths, preserved on site. Positions of these marked by heat affected stone work. Walls largely stable.
300 (H)	Lancashire Boiler House	378422, 543275	c.1900	Moderate. In situ remains of a base for a Lancashire Boiler, good example.	Poor, brickwork is failing, and chimney has now mostly collapsed.	Long rectangular building built solely to house a Lancashire Boiler, for powering plant in the Rozan House. Base of boiler survives, along with flues and position of an economiser, and a brick chimney. Important part of later phases of use of the mill.
300 (SW)	Spine Wall	378433, 543294	c.1802	High. Strong aesthetic appeal, forms main focus of smelt mill complex now.	Failing badly.	Large stone structure to support flue system, connected to Smelt Mill on NW side. Later connected to a series of flues from other buildings (B, FB, F), mostly via inserted brick flues or exterior flues of metal. Incorporates staircase at NE end and an unloading point for fume removed from flue to smelt mill. Large number of passageways through the structure.
300 (BS)	Bingsteads	378457, 543277	c.1820	High. Strong aesthetic appeal, forms main focus of smelt mill complex now.	Stable, some localised issues.	Series of six bingsteads, larger ones to SE probably last to be built. Loaded from top by side-tipping waggons, evidence of timber chutes survive. Extensively consolidated in 1990s and now stable.
400	Flue	378494, 543331	c.1802	Moderate. High Evidential Value.	Stable.	Section of flue to the track comprises low stone spreads, up to 0.5m high, with very few visible walls surviving, though these seem to be buried and presumably survive at foundation level. Where the return flue from the condenser **519** rejoins the main line of the flue, there are surviving walls on the north and south sides, corresponding to the outside walls of the flue itself, and just east of this point, a large heaped mound of stone, 1.5m in height, is located, which appears to be a section of inwardly-collapsed and undisturbed arching. The flue north of this point is visible as 2m wide section comprising

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
						three lines of walling, being the inner and exterior wall, and the interior baffle wall which ran down the centre, with gaps of 0.9m between each wall.
401	Flue	378552, 543347	c.1802	Moderate. High Evidential Value.	Stable, but visibly cut by modern track works along edge of track.	The three lines of walling east of the track and west of where cut through by the line of the Nent Hydro Scheme, which appears to have removed c.18m of the line of the flue.
402	Flue	378578, 543355	c.1802	Low/Moderate. Moderate Evidential Value.	Stable.	The three lines of walling visible east of the line of the Nent Hydro Scheme.
403	Dumps	378607, 543363	20th century	Low	Stable.	Extensive dumping across its surface of flue probably as a result of **404.**
404	Track	378624, 543360	20th century	Low	Stable.	A track bull-dozed through the line of the flue just east of the dumps **403**, clearly not recently. The track has now been blocked by a modern soil bund.
405	Flue	378683, 543359	c.1802	Low/Moderate. Moderate Evidential Value.	Stable, some erosion from track usage on north side, south side collapsing slightly into a shaft.	Three lines of walling, at c.5m in width, and a series of bitumous deposits and timbers are visible on the baffle wall east of bulldozed cut. North side of the line has now been partly subsumed into a modern track, which is using the stone spreads as a firm base for driving vehicles on. South wall of this section survives well.
406	J. Wallace's shaft	378683, 543349	18th century	Low/Moderate. Shaft now run in.	Stable.	Shaft mound, survives as a large-water filled shallow shaft of uncertain date.
407	Bridging Point.	378745, 543351	c.1802	Low. Ex-situ structural detail.	Stable.	A series of large ex-situ slabs lie adjacent to a leat where flue crosses its line. Presumably supported the side walls of the flue at the crossing.
408	Settling Tanks	378775, 543334	c.1850	Low/Moderate. Earthwork now only survives.	Stable.	The settling tanks, visible as a large rectangular building built onto the south side of the flue in early photos, comprise a large rectangular area c.25m square, surrounded by rubble banks up to 1m in height. There are stone spreads and lynchets within the interior, which appear to include a dividing wall running north-south down the centre, dividing the square structure into two rectangular areas. There are large spreads of rubble located to the south and west of this structure, the latter being revetted back from filling the feeder leat by a series of boards and upright reused lengths of rail.
409	Cisterns	378794, 543322	c.1850	Low/Moderate. Earthwork now only survives.	Stable.	A group of cisterns abutting the east side of the settling tanks **408**, probably related to cleaning process to extract lead from accretions to the flue lining. Broadly rectangular and aligned north to south, the cisterns comprise two water-filled ponds c.2m wide and 8m long with low walls around the edges and one dividing pond.
410	Connecting Flue	378798, 543335	c.1850	Low/Moderate. Earthwork now only survives.	Stable.	The connection between the flue and settling tank; water was presumably flushed down the flue into these tanks to assist the cleaning process.
411	Flue	378959, 543248	c.1850	Low/Moderate. Earthwork now only survives.	Stable.	Flue runs up the hillside as a wide earthwork trench for 300m, c.2m wide with low turf flanking banks, entirely turfed over with little or no structural evidence visible, apart from a few sections of low walling surviving to c.0.50m in height within the base of the trench.
412 (A-D)	Flue	379052, 543129	c.1850	Moderate. High Evidential Value.	Mostly stable, some collapsing sections.	Four surviving sections of arching within a 55m stretch of flue. Each section of surviving arching measures 2m to 3m in length, the open ends of each section having sloping banks of turfed over collapsed material sloping down into the interior, which is 1.5m lower than the top of the banks. The bases of the flue sections are covered in rubble, and in only one case is there any evidence of the baffle wall surviving. Apart from the first arched section, which retains approximately 0.8m of soil above, most of the arching is only covered by a

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
						very thin deposit of soil and turf. In several places this has worn thin, and small collapses are evident.
413	Flue	379127, 543052	c.1850	Moderate/High. High Evidential and Aesthetic Value.	Mostly stable, some collapsing sections.	Best preserved section of flue, on the brow of the hill, 75m in length, with the arching mostly intact. Retains its baffle wall in various states of decay, but in some sections it extends nearly to the ceiling.
414	Flue	379207, 542971	c.1850	Moderate. High Evidential Value.	Collapsing, and fragile.	A small section of arching, less than 2m wide and very close to collapse.
415	Chimney Base	379348, 542925	c.1850	Moderate/High. High Evidential and Aesthetic Value.	Broadly stable but with collapsing sections which require attention.	The chimney only survives as a short stubby base 4.5m by 4.5m in plan. Has several phases of construction, and this implies it has fallen down and been rebuilt at least once. Wide exterior stone walls, with an interior wall, which appears to be later. The interior wall supports large flags straddling both the interior and exterior walls; this in turn supports remains of the brick chimney, which originally stood supported on the flags. The inner wall encloses a chimney flue, square in section and 0.6m wide, which runs up from a segmental arch on the west side, connecting the chimney to the main flue. The arch comprises two rows of fire bricks, supported on a large stone capping lintel over the main entrance, with stone infill above. The use of bricks and capping stones in both arching and the chimney suggest this is a later addition to the earlier, outer stone walls, which presumably supported an earlier phase of chimney (probably stone).
416	Collapsed Chimney	379344, 542919	c.1850	Moderate. High Evidential Value.	Stable.	The collapsed brick chimney, fallen in a broadly south-west direction, and largely destroyed by its fall. The use of six iron straps, pulled tight onto a series of (originally vertical) timber boards, and mostly still in situ, has preserved some of the arrangement of brick courses, but no faces of the chimney stack now survive.
417	Position of Chimney	379288, 542937	c.1850	Moderate. High Evidential Value.	Stable.	Position of an earlier chimney, c.6m by 6m, devoid of vegetation which suggests a high toxic content. Detailed examination of this area failed to identify any evidence for a chimney, though a high concentration of toxins is reasonably certain.
500	Stagg Main Bearing Wall	378458, 543355	c.1843	High. High Historical Significance and Evidential Value.	Stable, some of the central stones in the upper courses of the south-facing elevation have fallen away, base of wall may have issues where timbers for wheel shroud built in, now rotting.	The main bearing wall 11m in length, and 1.8m in width at base, tapering to 1.2m at the top of the wall. The wall stands to 4m in height and is topped by eight massive stone blocks, which give the appearance of crenulations. The blocks are paired, with a 0.34m wide slot that runs across the whole thickness of the wall between each block, and fixing points for the rocker beams are visible astride the gaps between the pairs of blocks on the wall top. The fixing points comprise 0.60m square recesses, and in the base of each are four paired square bolt-holes and four paired round bolt holes with in-situ iron bolts The position of the fixing points indicates that the wheel-pit operated four beams, two pairs on each side of the main wheel-pit. Between the two main sets of pairs is a 1.45m gap, aligned with the centre of the wheel-pit. The two main elevations of the bearing wall contain four pairs of rectangular niches (each pair 0.5m apart), in an approximate horizontal line, 1m above ground level. The niches align with the fixing points for the rocker beams in the stone bearing blocks. The north-facing elevation also contains a further horizontal line of four niches at a height of approximately 3.45m. These niches are slightly offset from the line of the beam slots. A further line of four

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
						niches is also visible within this face, midway between the two rows, at 2.4m.
501	Stagg Wheel-pit	378458, 543364	c.1843	High. High Historical Significance and Evidential Value.	Stable, some very minor issues with stone work.	A 2.0m wide curved recess forms the start of the arc of the wheel-pit, which extends down 9.3m to the arch of the tail-race, which itself stands 1.75m in height. The wheel-pit measures 15.85m in length, 1.95m in width and is 8m deep. The east and west-facing elevations are formed of coursed, squared stone, with no obvious openings or recesses (though the east elevation now incorporates a drain for a leat tapping the water of the old launder which originally fed the wheel). The south-facing wall of the wheel-pit is also gently curved, to accommodate the wheel. The curves form arcs of a circle and were clearly constructed in order to closely fit and follow the circumference of the wheel itself, which fits with the supposed diameter of the wheel. The wheel-pit has a flagged base, now partially obscured by debris.
502	Stagg Gearing Pits	378462, 543361	c.1843	High. High Historical Significance and Evidential Value.	Less stable, stonework has started to fail in the pits and the timbers are visible collapsing.	On each side of the wheel-pit, south of the mid-point of the wheel-pit, are a pair of north-south aligned rectangular pits **502** and **503**, now partly infilled but seemingly with similar squared rubble coursed walls. The walls support a network of large timber baulks, all with a square profile of approximately 0.40m, with in-situ iron bolts projecting from their upper surface. The beams and pits clearly held the gearing for the pistons attached to the rocker beams, with pistons projects from each pit to the rocker beams above. The timbers around the pits extend and connect to the large timbers around the wheel-pit which presumably originally held the shroud.
503	Stagg Gearing Pits	378455, 543360	c.1843	High. High Historical Significance and Evidential Value.	Less stable, stonework has started to fail in the pits and the timbers are visible collapsing.	See **502**.
504	Condenser House	378457, 543344	c. 1843	High. High Historical Significance and Evidential Value.	Stable.	The condenser house has been entirely removed, and is now represented by little more than low rectangular mound of rubble, surrounded by a sub-rectangular depression with low rubble banks, c.20m long and c.10m wide, defining the edge of the depression. No definite evidence of walling can be seen, though this clearly survived into the 20th century.
505	Flue	378455, 543326	c.1843	High. High Historical Significance and Evidential Value.	Stable.	The line of the flue leading to the condenser house is visibly raised above its position by at least 2m. The flue comprises three lines of rubble, 0.6m wide and 1.2m apart, corresponding to the sides and inner wall of the structure, with walling only intermittently visible; a very small standing section of walling on the east side may relate to this structure, but no more than four courses of walling now exist. On the main flue is what appears to be a dividing wall, which may relate to the junction with this flue, and a rectangular structure also survives on the south-east side of the main flue, perhaps related to this junction. The junction is now partly obscured by new dumps of stone from recent consolidation works.
506	Leat	378444, 543336	c.1843	High. High Historical Significance and Evidential Value.	Stable.	A timber leat now entirely filled with soil and loose stone. Its course is just discernible and timbers project out over the edge of the position of the settling tanks.
507	Settling Tanks	378434, 543326	c.1843	High. High Historical Significance and Evidential Value.	Stable.	A sub-rectangular area comprising: remnants of short stone retaining walls; timber frames infilled with fire-bricks and other timber structures; and areas of greyish silt.

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
508	Flue	378495, 543356	c.1851?	Low/Moderate. Earthwork now only survives.	Stable.	Flue, 0.5m wide, probably constructed to improve flow from the main flue. It is shown on late 19th century photographs connecting to a settling tank at its junction with the main flue. The line of this flue is visible extending east from a position adjacent to the bearing wall, as a sunken earthwork approx 1m wide and 0.5m deep.
509	Flue	378490, 543340	c.1843	Low/Moderate. High Historical Significance and Evidential Value, but damaged.	Stable.	Earlier flue, with wide arching and a central dividing wall. This section has now been entirely robbed away and only exists as an earthwork.
600	Culvert	378750, 542874	c.1820 with later phases	Moderate Of some significance in terms of understanding the operation of the mine and the transportation of water across the floors.	Stable but collapsing in sections.	The culvert is not a single phase construction, but has been extended at least three times. The main central section measures approximately 16m in length, and is constructed of large rectangular sandstone rubble blocks. The section has an almost oval profile, the arching springing very close to the base of the side walls. Along the eastern side of the culvert, a deliberate plinth or walkway has been left, seemingly cut out from the bedrock on which the arching rests. The central section has been extended northwards by approximately 7m, with slightly finer and narrower stone rubble blocks, which appear to have side-walls which are more vertical. The culvert exits north-westwards by means of a low flattened arch, which is failing on its western side. This appears due to the fact that the arching has been constructed off-centre, and that has put undue strain on the western side of the arch. At the south-eastern end of the culvert, the structure has been extended twice. The first extension is approximately 2m in length and is made of large roughly dressed rectangular blocks, broadly evenly coursed, and with vertical side-walls. The second extension is of much finer stonework, and includes three evenly-spaced square recesses which presumably accommodated the timber formers for the arch, which were used during its construction
700	Powder House	378523, 543034	c.1872?	High Important in terms of an understanding of the form and function of the complex, as well potential public interpretation. Structure is also visually important as part of the industrial landscape and has historic significance as one of only two powder stores on the site.	Collapsing, urgent repairs needed.	The powder store measures c.3.20m by 3.5m, and is constructed of coursed squared sandstone rubble. The building is unroofed, and now has a cement cap to the wall tops, but the original roof was of a single pitch, running down to the east. The walls are bonded with a light grey lime mortar, which may be original; there is evidence of cement repointing. The doorway is centrally placed in the east wall, and measures 0.95m wide by 1.7m high. The edges of the wall and doorway include roughly dressed sandstone quoins at the corners, and a large flat stone lintel forms the top of the doorway, which is 1.20m in width. The remains of a timber door-frame forms the entrance to the building, however only the southern upright and lintel survive, with a few pieces of metal sheeting around the frame. There are no longer any doors in situ. The wall exteriors are featureless, apart from the west wall, which has a recess which originally housed a curved ceramic pipe, perhaps a vent. Set within the faces of each interior wall are two rows of timber battens, the upper of which has now been replaced with modern timber in the north and east walls. The remainder of the battens have now completely rotted, and the collapsing walls have compressed them to little more than a thin line of decayed wood. When surveyed in 2005 still held wooden dowelling pegs within some of the original timbers, which would have held a frame covered

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
						with timber cladding to cover any hard surfaces and so reduce the risk of sparks. The interior wall base of the west and east walls includes are four sockets for timber joists, with two on each side of the door indicating that the building had a wooden floor.
800	Retaining Wall	378586, 543065	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Good Slow deterioration No obvious, immediate threats but there are signs of gradual decline.	This is the first and northernmost of three sets of retaining walls revetting the western edge of the dressing floor. Wall comprises a large wall of thirteen courses of squared rubble and standing up to 2.5m high, splaying out at its base. The northern end is built onto, and supported by, the outcropping limestone.
801	Retaining Wall	378590, 543047	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Moderate More rapid deterioration and obvious, immediate threat and signs of decline.	The retaining wall comprises a 1.4m high retaining wall built of similar random coursed stone, built further down the slope. The wall is c. 20 courses in height at the south end, diminishing to c. 10 courses at its northern end, where it has collapsed and has become buried by fine dressing waste.
802	Retaining Wall/Chute	378592, 543044	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Moderate More rapid deterioration and obvious, immediate threat and signs of decline.	A short length of later wall retaining a number of timber planks and may be the base of a chute, though this is not clear. The wall has been constructed in front of one of the (rebuilt) retaining walls which extend south from this point.
803	Settling Tanks	378593, 543050	c.19th century?	High The dressing floors are very important in terms of understanding the layout and operation of the mine. Evidence from many aspects of the dressing process are represented and well preserved. The area is of considerable significance in terms of public interpretation and a key visual element.	Stable, but eroding out. Timbers will start to rot.	Several parallel timber structures, some buried to c .1m, possibly representing the remains of settling tanks or catch-pits.
804	Launder support	378598, 543051	c.19th century?	High The dressing floors are very important in terms of understanding the layout and operation of the mine. Evidence from many	Stable.	A small square stone, perhaps the base of a launder

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
				aspects of the dressing process are represented and well preserved. The area is of considerable significance in terms of public interpretation and a key visual element.		
805	Timber Revetment	378585, 543045	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Stable, but eroding out. Timbers will start to rot.	A series of retaining planks recorded just above the crest of the bank over the river, and associated with a large deposit of very dark dressing waste tipping down the hill from the corner of a building, which has been washed out by later water action.
806	Timber uprights (chute)	378590, 543061	c.19th century?	High The dressing floors are very important in terms of understanding the layout and operation of the mine. Evidence from many aspects of the dressing process are represented and well preserved. The area is of considerable significance in terms of public interpretation and a key visual element.	Stable, but eroding out. Timbers will start to rot. One timber upright has recently been pulled out, socket only remains.	Two pairs of squared upright timbers, broadly 7.5cm across, which appear to have acted as the upright supports for chute, from which waste was tipped over the edge of the wall.
807	Tailings	378582, 543059	c.19th century?	Moderate Variation in aggregate size as tailings progress down the site is an important indication of the various processes taking place.	Unstable, evidence of rabbit and water erosion.	Waste from position of chute **806** represented by a large tailing dump of fine dark grey silt, which has been heavily disturbed by rabbits.
808	Stone Revetment	378580, 543066	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Good Slow deterioration No obvious, immediate threats but there are signs of gradual decline.	Wall **800** sits upon a crude c .3m high sloping stone revetment.
809	Timbers (Buddle)	378590, 543067	c.19th century?	High The dressing floors are very important in terms of understanding the layout and operation of the mine.	Stable, but eroding out. Timbers will start to rot.	Two planks exposed within level area defined by **810**, which appear to be structural, probably a buddle.

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
				Evidence from many aspects of the dressing process are represented and well preserved. The area is of considerable significance in terms of public interpretation and a key visual element.		
810	Retaining Wall	378593, 543071	c.19th century?	High Important in terms of understanding the layout of the mine and the construction of the dressing floors. Feature is also key to the structural preservation of the area.	Good Slow deterioration No obvious, immediate threats but there are signs of gradual decline.	A retaining wall defining the north and east sides of a rectangular working area which may have housed a series of Brunton buddles or similar, fed by material from the elevated area to the east . The wall holds back a substantial bank of dressing waste, and does not appear to be part of a building, but rather defines. The surface of this area is covered in fine crushed material, which is being eroded by water action.
900	Culvert	378583, 543448	c.1830 with later phases	Moderate Of some significance in terms of understanding the operation of the mine and the transportation of water across the floors.	Stable but collapsing in sections.	The culvert comprises a single continuous structure, which has a number of separate components, primarily dictated by its condition. The spoil heaps underneath which the culvert runs are extensive, and apparently heavily contaminated with no vegetation growth; these appear to comprise fine crushed and washed dressing waste with larger deads exposed along the southern part of the area. The area is littered with dumps of rubbish, particularly along the edge of the track, most of which appears to be 20th century in date. The rubbish includes: general household waste, including broken china and other rubbish with a dark humic soil (presumably decayed organics), probably early 20th century; and isolated dumps of large blocks of concrete, and other industrial materials, seemingly bull-dozed into position or tipped from lorries, and probably mid to late 20th century date (and relating to the systematic destruction of the lead mill and other sections of the site at this time). The culvert under the track was not examined in detail, as this lay outside the limitations of the survey, and could not be accessed due to health and safety reasons. This section of culvert is c.30m in length and abuts the large concrete pipe on its east side, which exits the bank within a rebuilt retaining wall. The western end of this section of culvert is now damaged and has collapsed for c.1m, but this appears to mark the end of the first phase of culvert which supported the waggonways to Smallcleugh Dressing Mill. The culvert includes a well-laid floor of stone cobbles, which was not visible in other sections of the culvert. The walls are a maximum of 1.4m in height; a cursory examination of the interior suggests some sections of the side walls have collapsed further back in under the track, and are much shorter, down to 1m in places. From the western end of this section, the culvert has fully collapsed for about 24m, with the eastern end of the north wall completely destroyed for 14m. Laminated layers of dressing waste are visible in section, above the natural

ID No	Name	NGR	Date	Significance	Conditions Issues	Description
						clay. The base of the culvert is mostly obscured by rubble and stone washed down the hill, though sections appear to be flagged with large stone flags, laid in an irregular pattern. The culvert has mostly been built upon the limestone bedrock, which forms a band across this area, and probably was a contributory factor in the location and construction of the culvert. From this point, the culvert survives for a 40m stretch in good condition. The base of the culvert is largely obscured and choked by loose stone. The side-walls stand to between 1.4m (at the east end) and 1.5m in height (at the west end), and there are evenly spaced square recesses just beneath the springing line of the arching, where timber formers were used for the arching. There are also gang-breaks along the entire length of the culvert, indicating that the culvert was probably built in sections, perhaps as the spoil heaps became larger. A further short, collapsed section, 7.5m in length, with side walls c. 1m in height on the south side (though much lower on the north side) leads to the final surviving section. This section, comprising the final western component, measures 17m in length, with the side walls dropping to 1.7m at the western end, and including the same detail as the main section. The exit mouth of the culvert has collapsed for c.2.5m, but the culvert arching is in good condition. A short distance to the west is a fence line, which marks the end of the limestone outcrop. The water cascades down the hillside from this point into the burn.

10.0 GLOSSARY OF LEAD MINING TERMS

ADIT or LEVEL	A level tunnel (usually driven into a hillside) in order to give access to a mine, and used for drainage or the hauling of broken ore. Deeper adits did not necessarily connect to surface, and were used to carry water back from distant workings to a pumping shaft.
ASSAY HOUSE	A building in which ores were assayed (tested) for lead and other metal content, and lead for silver content.
BARYTES	The mineral Barium Sulphate (BaS04)
BARGAIN	A contract between the mine owner and the miner or partnership of miners to undertake any of the work in the mine, i.e. level driving, shaft sinking, raising, ore production, etc. Miners could be paid either by the weight of ore produced or by the amount of concentrate produced from the ore.
BINGSTEAD	Stone storage bunkers used for storing lead ore after processing for transportation to the smelt mill
BING	Processed lead ore which has gone through the dressing process and is ready for smelting. Also standard weight of material, often applied to lead concentrate, usually 8 cwt (407 kg).
BOUSE	Unrefined lead ore mixed with waste materials
BOUSE TEAM OR ORE BIN	A storage place for bouse. Usually arranged in bays or storage hoppers.
BUCKING	The breaking down of mineral ore on an anvil to about 10mm in diameter using small hammers, after which the ore was separated from the waste by hand.
BUCKER	A broad flat-headed type of hammer used for manually breaking or crushing ore.
BUDDLE	A device for concentrating lead ore. In the mid-19th century these most usually took the form of a circular pit with rotating brushes; the ore from the crusher was fed into the centre or side of the pit and was graded by gravity, concentrating the heavy ore near the inlet point. These were often mechanically worked. Earlier buddles were trapezoidal in shape, and manually operated. A variation used in tailings works to treat sands and slimes was the Round Frame: a free-standing, all wooden, mechanically-actuated buddle, whilst a further variation was the dumb buddle or dumb pit, which was not mechanically operated. Named after John Buddle (1773-1843).
CHIMNEY	The word is used in its normal sense. Smelter chimneys are normally free-standing and fed by a flue, whereas engine house chimneys are normally attached to the building.
CONCENTRATE	Dressed lead ore ready for smelting.
CONDENSER	A small building erected in a flue and filled with wet brushwood to condense any lead fume in the gases leaving the furnaces.
CROSS CUT	A tunnel driven usually at right angles to strike the vein in the shortest distance.
CRUSHER	A mechanised device for crushing ore similar to a mangle. In practice normally the timber frame for the crushing rollers only survives.

CRUSHING CIRCLE	A horse-powered crusher, consisting of an edge-runner stone running on a circular stone or iron bed.
CRUSHING MILL	A building containing mechanically-powered crushers.
CULVERT	A small tunnel constructed to carry a channel of water.
DAM	The word is used in its normal sense.
DEAD GROUND	Any ground which was unproductive, which might even be the vein itself.
DEADS	Waste material either from the mine or the dressing floor.
DRESSING FLOORS	An (often extensive) surface area on a mine where the various processes of concentration of ore took place - these consisted of crushing or stamping to attain a uniform size range, sizing (particularly on later mines), separation of waste rock, concentration (generally mechanically and hydraulically), the removal of contaminant minerals (by calcination, flotation, magnetic separation), and finally drying and bagging for transportation to the smelter. Dressing floors in particular were generally laid out down a slope to reduce mechanical or manual handling between stages in the process.
DRESSING MILL	A building containing an integrated array of mechanically-powered ore processing devices.
DRESSING WASTE	The residues from ore-processing operations; intact tips may preserve considerable evidence on the processes used.
ENGINE BED OR MACHINE BASE	The solid stone or concrete base on which an engine or machine was mounted; may give considerable information on the form of the engine.
ENGINE SHAFT	A shaft for winding or pumping by mechanical means.
FATHOM	The nominal mining measurement of length, 6 feet or 1.85m.
FINGER DUMP OR TIP	A linear dump of waste material from a mine or quarry, flat-topped to allow material to be barrowed or trammed along it, and often equipped with a temporary tramway track.
FLAT	A horizontal ore-bearing vein or the replacement of country rock by mineralisation.
FLUORSPAR	The mineral fluorite, calcium fluoride (CaF2). widely used as a flux in blast furnaces and as a source of fluorine in the chemical industry. Also used for special glasses and ceramics. Many lead mines were later worked for the fluorspar content.
FLUE	A near-horizontal chimney or passage designed to take the poisonous fumes away from the smelting mill and to create a draught for the furnace. Can be of considerable length.
FURNACE	The term used in a broad sense for any form of smelting furnace or hearth.
GALENA	Lead sulphide, the lead mineral normally mined (PbS).
GANGUE	The waste material in a vein, from which the lead minerals have to be separated, and which are usually dumped near the mine. Since the gangue minerals include

	fluorspar and barytes, many spoil heaps have since been reworked.
GRATING	Sometimes bouse was raked over a grate in a stream of water to wash and clean it for further dressing. The small particles would run to the slimes pit in readiness for buddling.
HOTCHING (TUB)	A concentrating device used to separating the lead ore from the gangue material, by repeated suspension and settling in water. Also known as a jig.
HUSH	A method of working by which water is ponded up and then released along a prepared downward route to effectively strip the top soil and overlying rocks to reveal the lead vein. Often an early indicator of mining. Also often used for prospecting.
JIG	A large mechanically or hand-operated sieve set in a tank of water and agitated to separated out lead ore from waste. Sometimes constructed in groups within jigging houses.
KIBBLE	A large, strongly-constructed, egg-shaped, iron container used for ore and rock haulage in earlier shafts.
KNOCK-STONE	A stone or platform on which lumps of ore were manually broken to size, often with a bucker.
LAUNDER	A wooden or steel trough used to carry water or other liquids; often used to feed water or finely-divided material in suspension around a dressing floor.
LEAT	An open watercourse (normally horizontally graded and following the contours) carrying a water supply for power or washing use. Often simply dug as an earthwork channel although may have stone sides.
LODE (VEIN)	A linear area of mineralisation underground. Sometimes referred to as a VEIN. Generally vertical or near-vertical, and often extending for considerable distances along its strike.
MINE SHOP	Dormitory-type accommodation for workers not living permanently on site. Often two storey, with accommodation above and smithy, workshops and/or stables below.
MIDDLINGS	An intermediate product of dressing, which normally contained sufficient lead mineral to make re-dressing worthwhile.
OPENCUT OR OPENCAST	An open working on a vein or other mineralisation, not worked by water.
ORE HEARTH	A method of smelting lead, similar to a blacksmith's hearth.
PEAT HOUSE	A purpose-built building used to store peat as fuel for smelting. Often open sided or well ventilated to allow the stored peat to dry.
PIG	A solid bar of smelted lead.
POWDER HOUSE	A purpose-built building used to store gunpowder or other explosives, often at some distance to the mine. Also magazine store.
ROASTING HEARTH	A furnace for heating lead concentrate in contact with air before smelting, to drive off sulphur and improve physical characteristics.

ROYALTY	The payment of a certain stipulated sum on the mineral produced from an area of land.
SETTLING TANK	A tank in which sediments were deposited from waste waters, for reprocessing.
SHAFT	A vertical or near-vertical tunnel sunk to give access to the extractive areas of a mine.
SIEVING	A method of dressing by repeated suspension and settling in water, using a hand-held box fitted with a grid of wires or rods.
SILVER REFINERY	A building used for the extraction of silver from smelted lead, by cupellation, Pattinson's process, or other method.
SLAG	The liquid waste product resulting from smelting.
SLAG HEARTH	A furnace for re-smelting ore-hearth slag to extract further lead.
SLAG TIP	A tip of slag from any form of smelter.
SLIMES	The finest material treated in dressing. Difficult to deal with but, by using the right techniques, could be successfully huddled to produce lead concentrate.
SMELTER OR SMELT MILL	A site where metallic lead was extracted from ore. Process include the bole-hill, the ore-hearth, the roasting furnace, the reverberatory furnace, and the slag hearth. Associated processes such as silver refining were also undertaken on some sites.
SPOIL HEAP	A tip of waste rock discarded directly from the mine without further processing. Spoil collars encircle shafts.
STAMP MILL	A building or structure containing a set of mechanically-powered stamps for pulverising ore.
STOPE	Excavated area produced during the extraction of ore-bearing rock. Often narrow, deep and elongated, reflecting the former position of the lode. Where open to the surface, these are termed openwork.
TAILINGS	The waste sand and slime from a mine dressing floor, not containing workable quantities of mineral.
TAILRACE	The channel along which water flows after having passed over or under a water-wheel and is then generally returned to the water course.
TUB OR WAGGON	A waggon on rails for transporting ore, deads, and materials required in the mine.
VEIN	Mineral body in a horizontal, vertical or angled position.
VIRGIN GROUND	Unworked area.
WASHING FLOOR	An often terraced area, on which a range of ore processing operations was carried out, often open to the elements. See also Dressing Floor.
WATER BLAST	The means of inducing ventilation by discharging water down a pipe in a shaft.
WATER-WHEEL	Wheel fitted with buckets or paddles around its periphery, and driven by the weight or force of a stream of water directed onto them. Housed in a wheel-pit.

WHEEL HOUSING	A structure built to house a water-wheel, often excavated and stone-lined, but sometimes free-standing.

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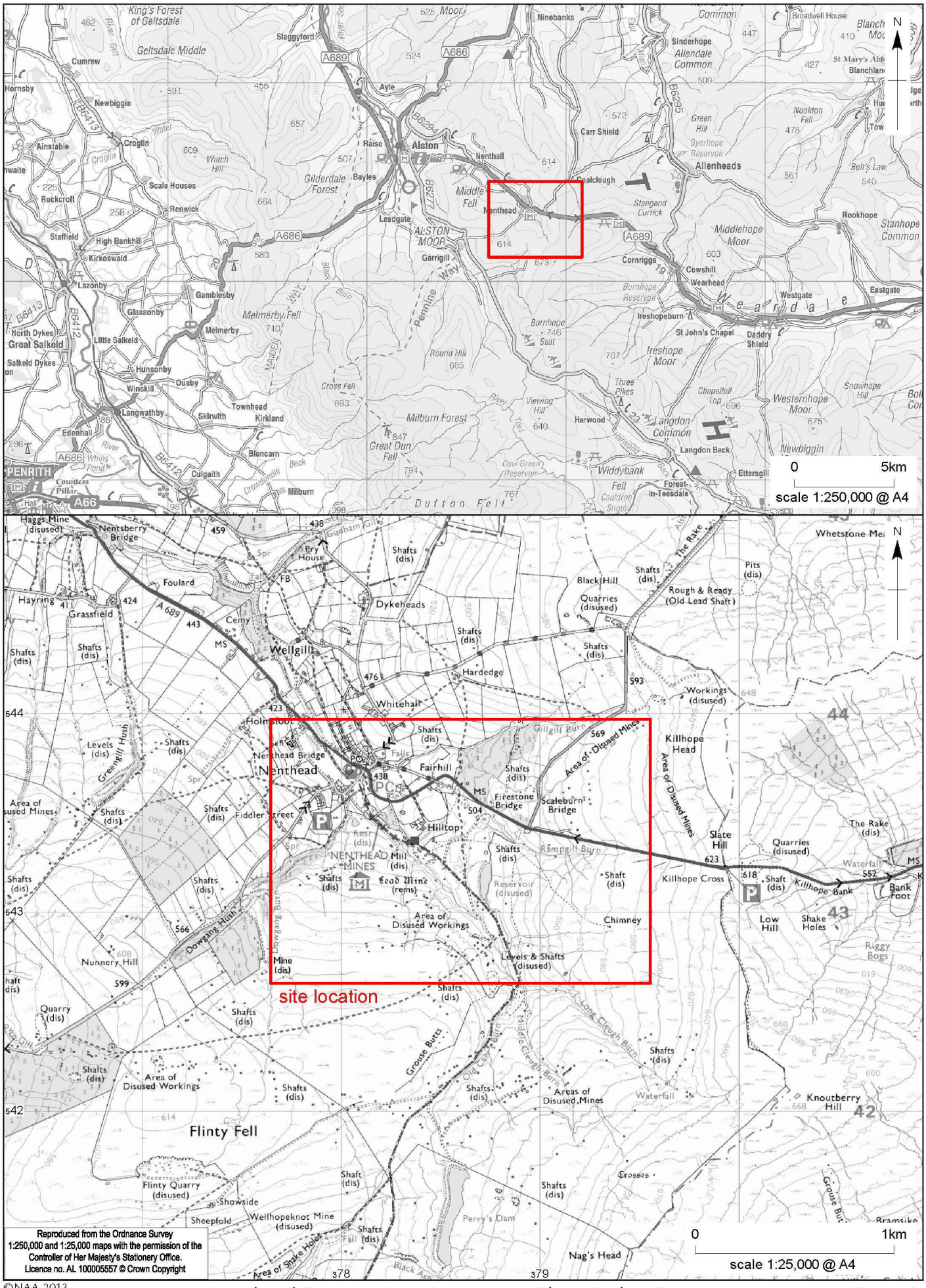
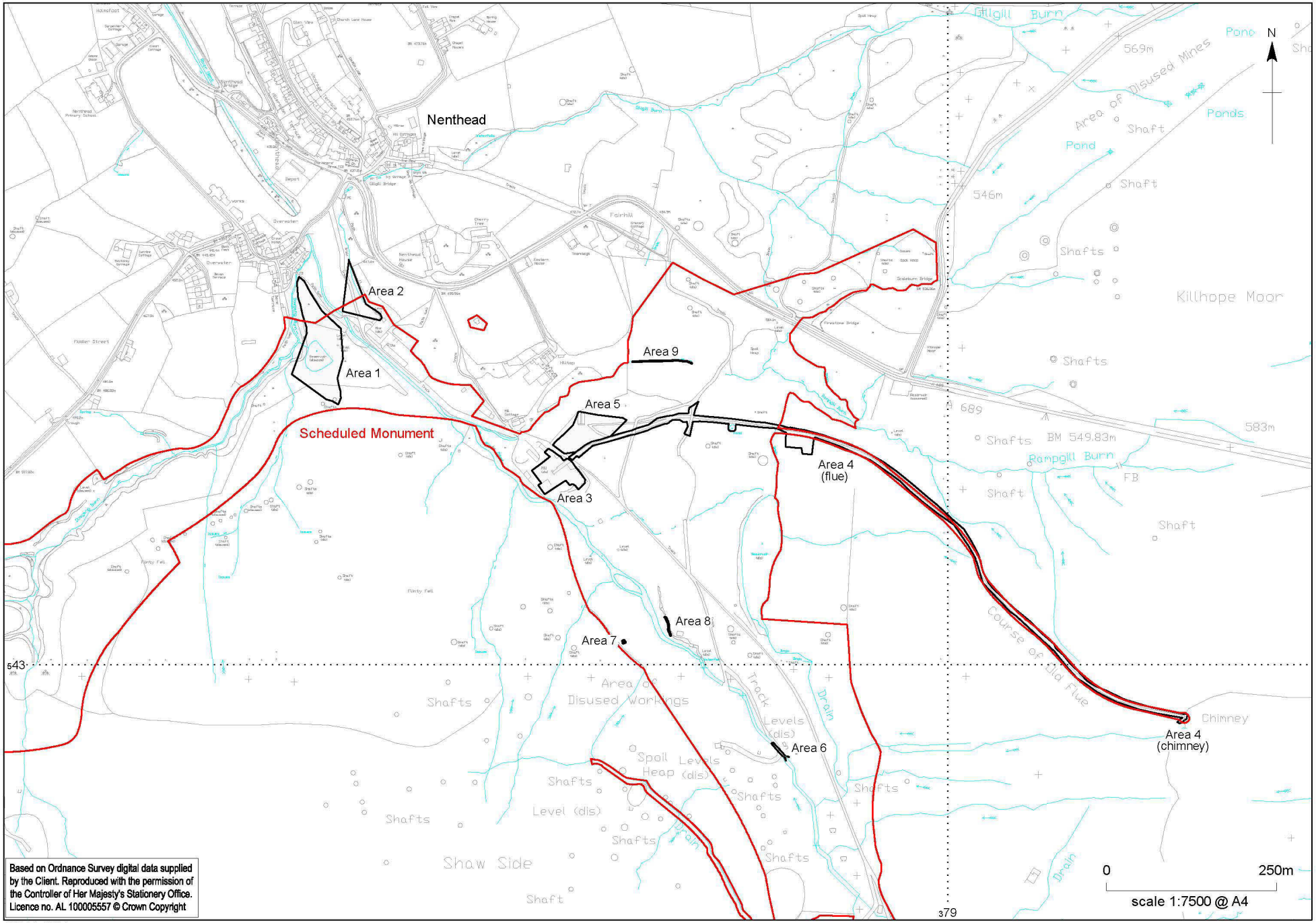
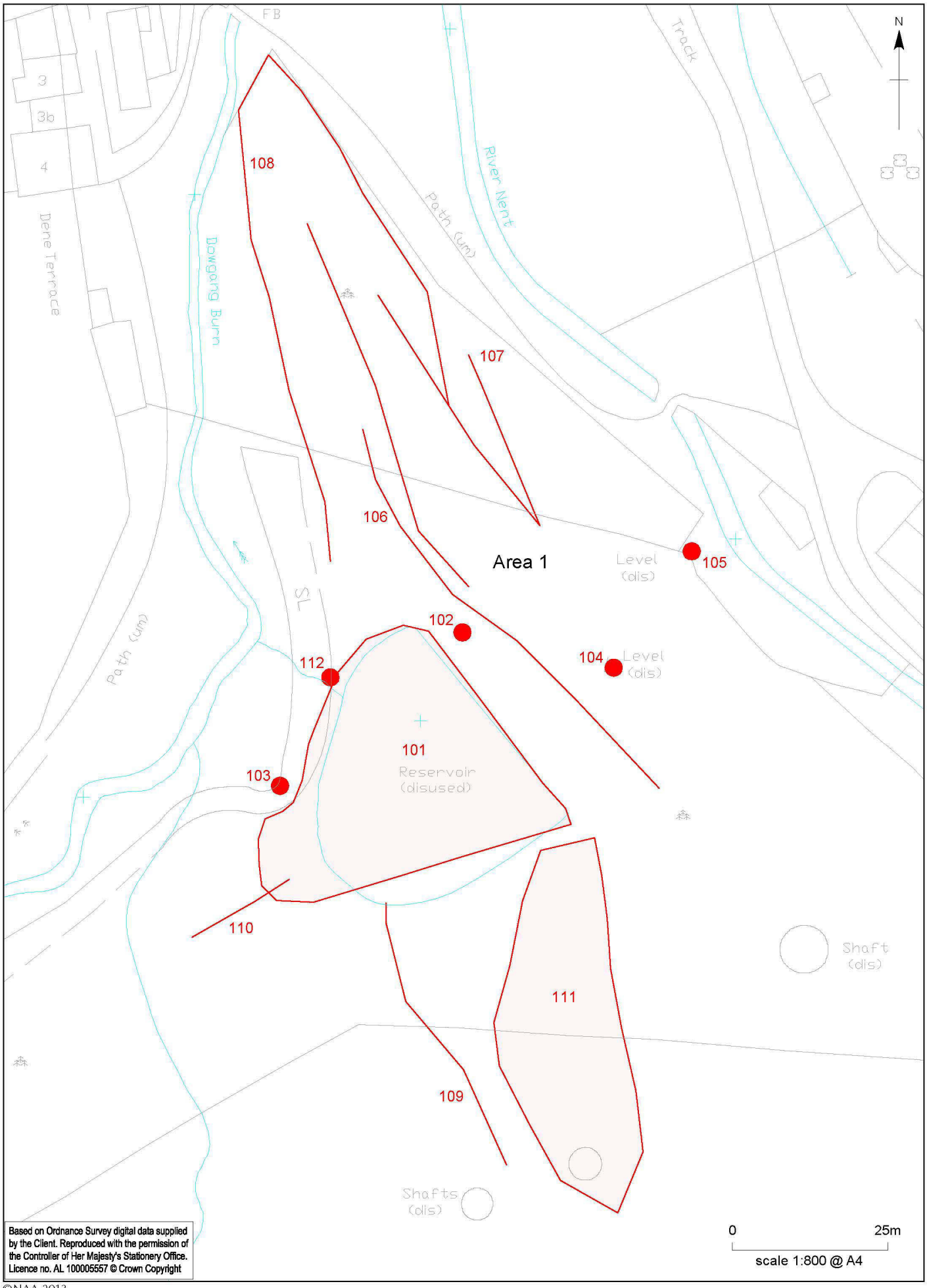


Nenthead Conservation Management Plan: site location *Figure 1*



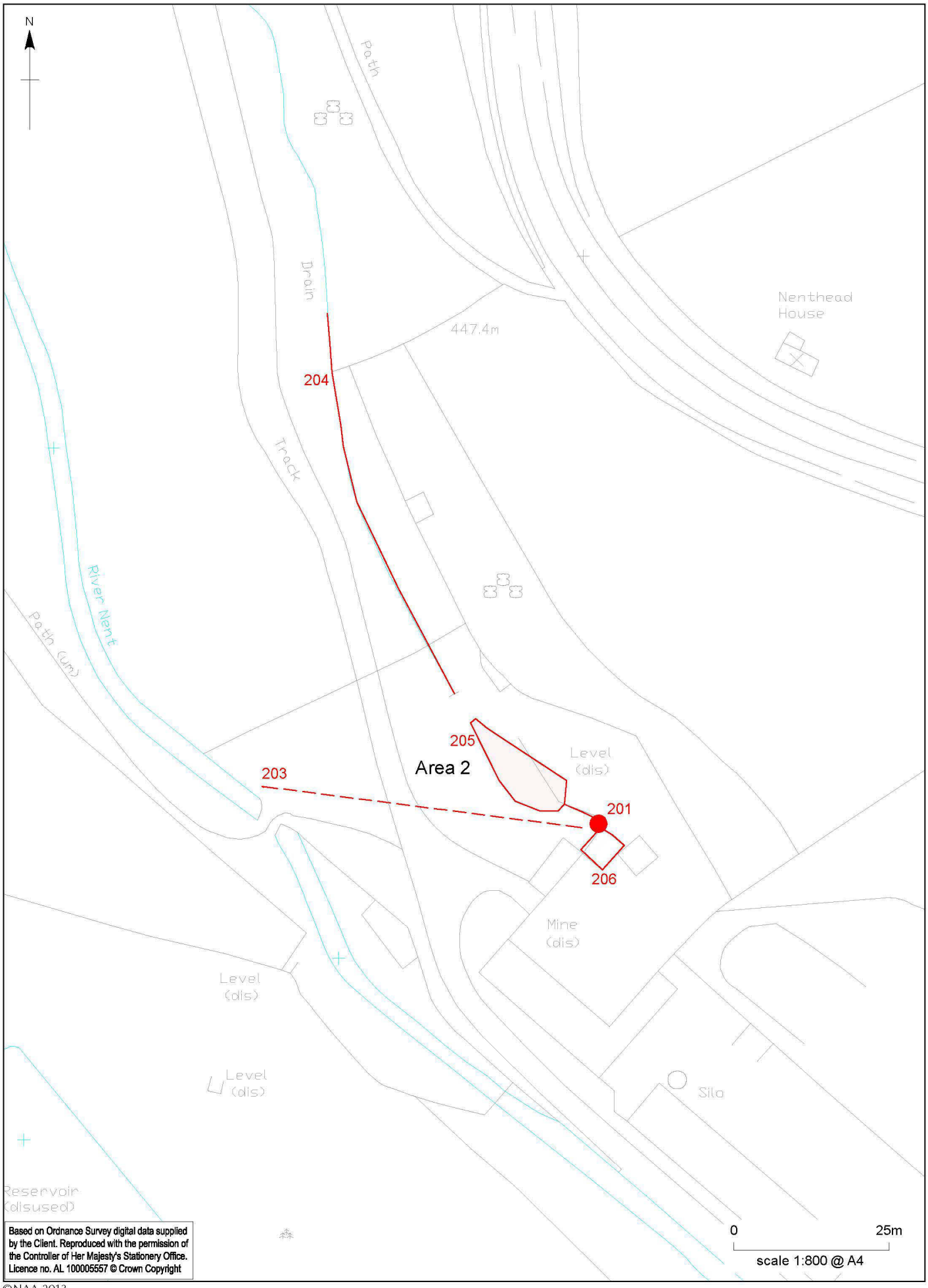
Nenthead Conservation Management Plan: location of survey areas

Figure 2



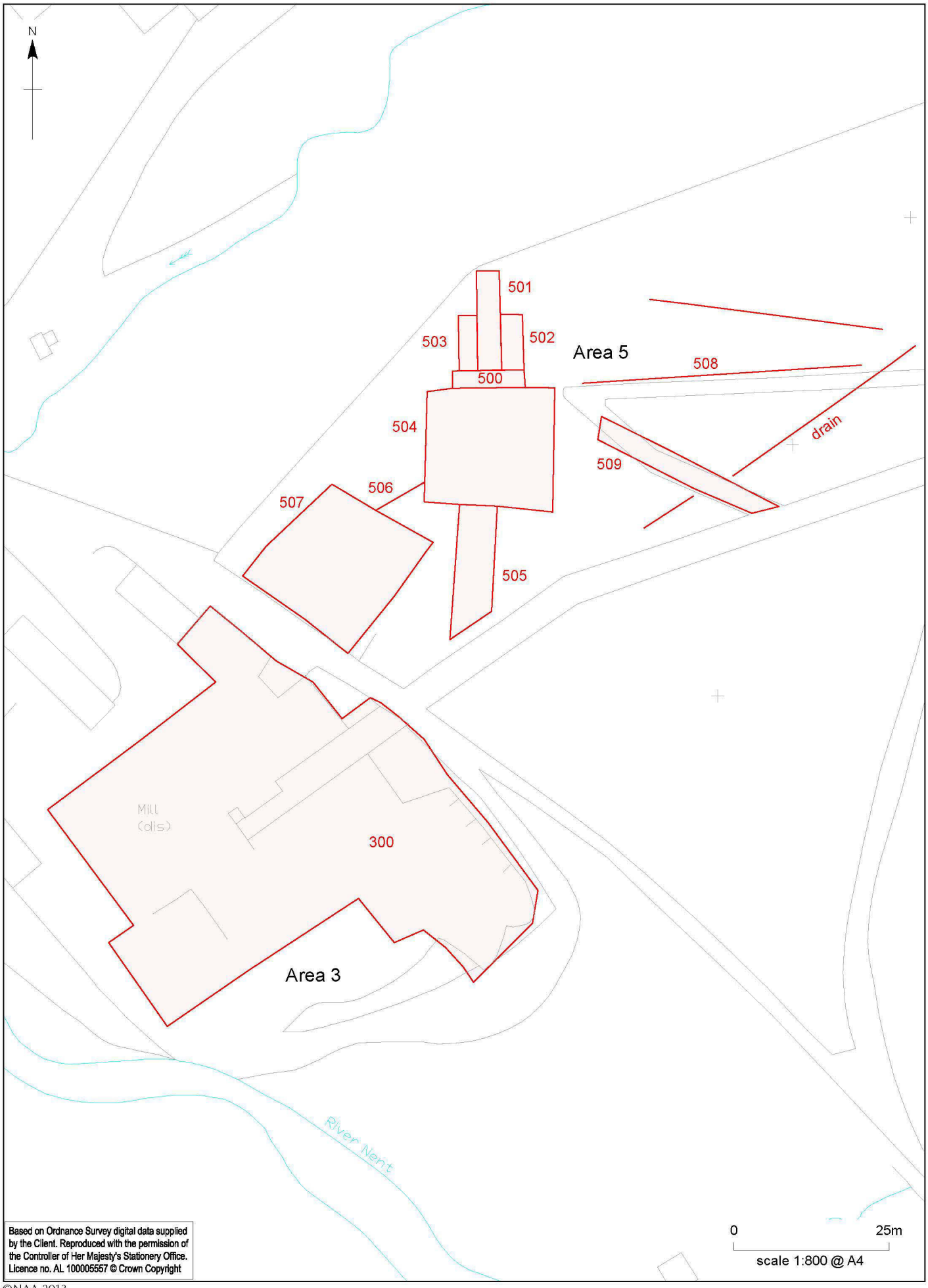
Nenthead Conservation Management Plan: Rampgill Reservoir (Area 1), location of surveyed features

Figure 3



Nenthead Conservation Management Plan: Rampgill Horse Level (Area 2), location of surveyed features

Figure 4



Nenthead Conservation Management Plan: Nenthead Smelt Mill (Area 3) and Stagg Condenser (Area 5), location of surveyed features

Figure 5

KEY
position of hearth or furnace
machine base
spine wall
area referred to in text

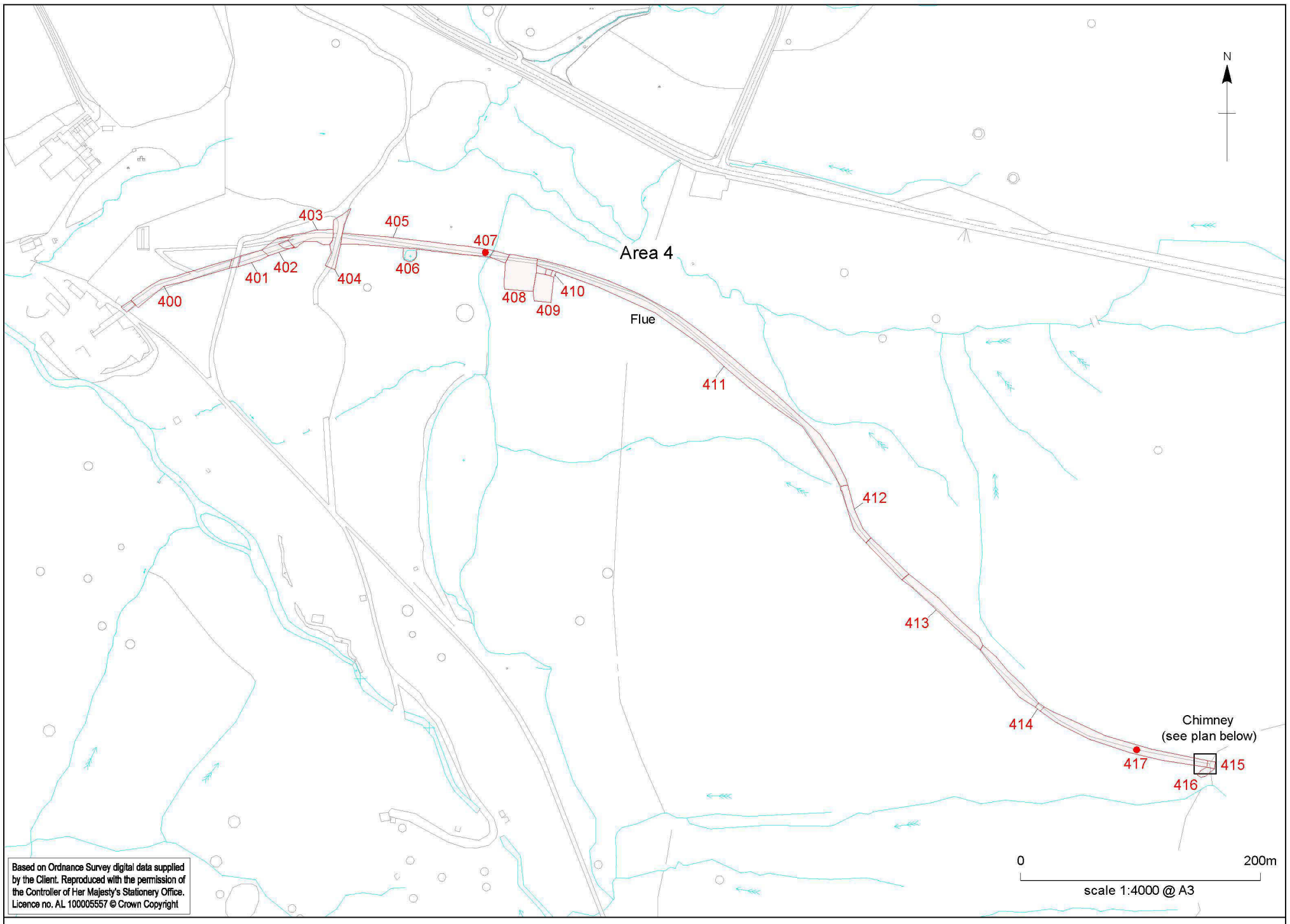
N

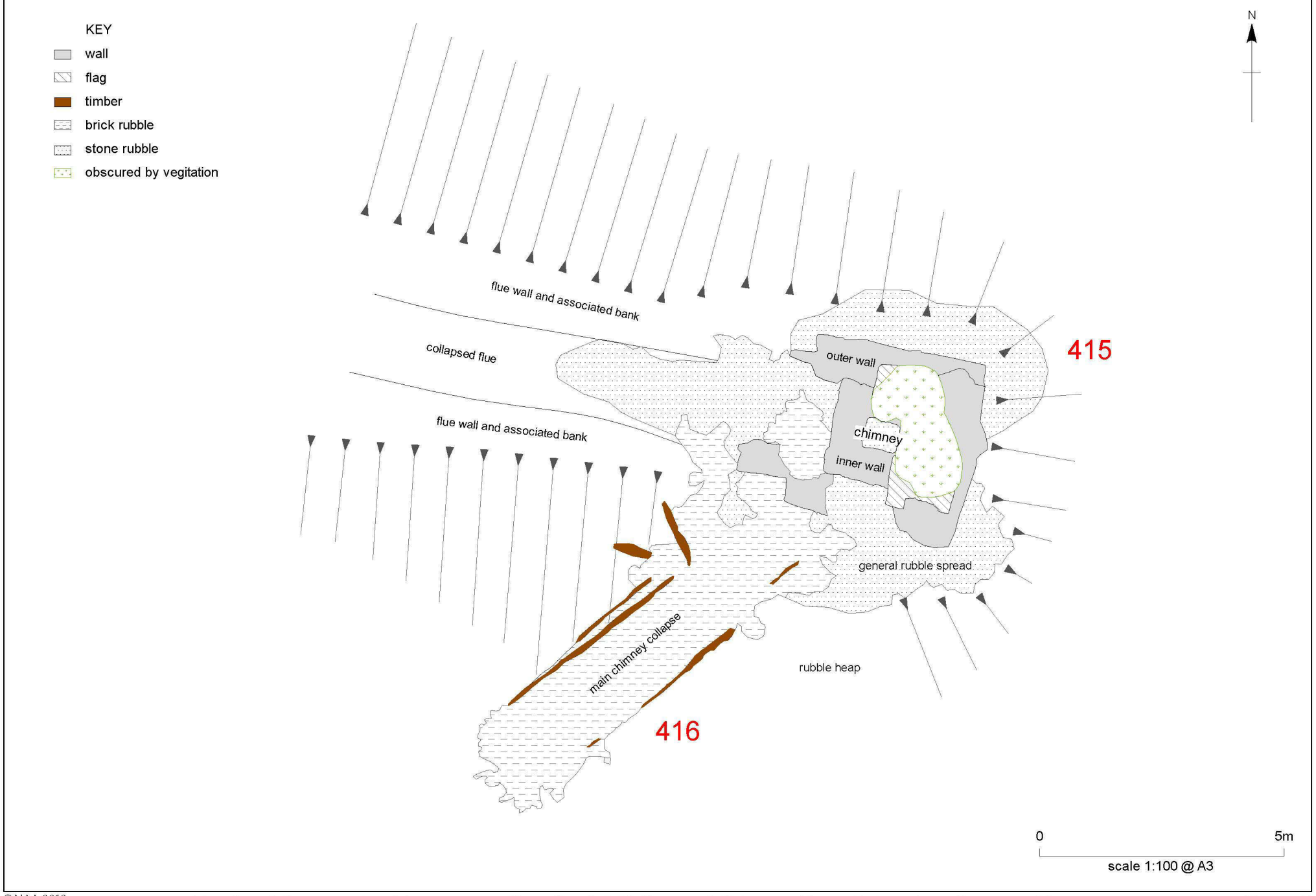
hopper
A
SPINE WALL
2013 test pit
wheelpit
flues
SMELT MILL
B
loading bay
FB
BING STEADS
C
F
infilled pan bases
economiser
Lancashire boiler
H
E
engine bases
D
chimney
air compressor bases

0 10m
scale 1:250 @ A3

Nenthead Conservation Management Plan: plan of Smelt Mill complex

Figure 6





Nenthead Conservation Management Plan: Smelt Mill Flue and Chimney (Area 4), location of surveyed features and Smelt Mill Chimney plan

Figure 7

north facing elevation

east facing elevation

south facing elevation

west facing elevation

0 1m

scale 1:40 @ A4

Nenthead Conservation Management Plan: Smelt Mill Chimney elevations (rectified)

Figure 8

A: north-west facing elevation

B: south-west facing elevation

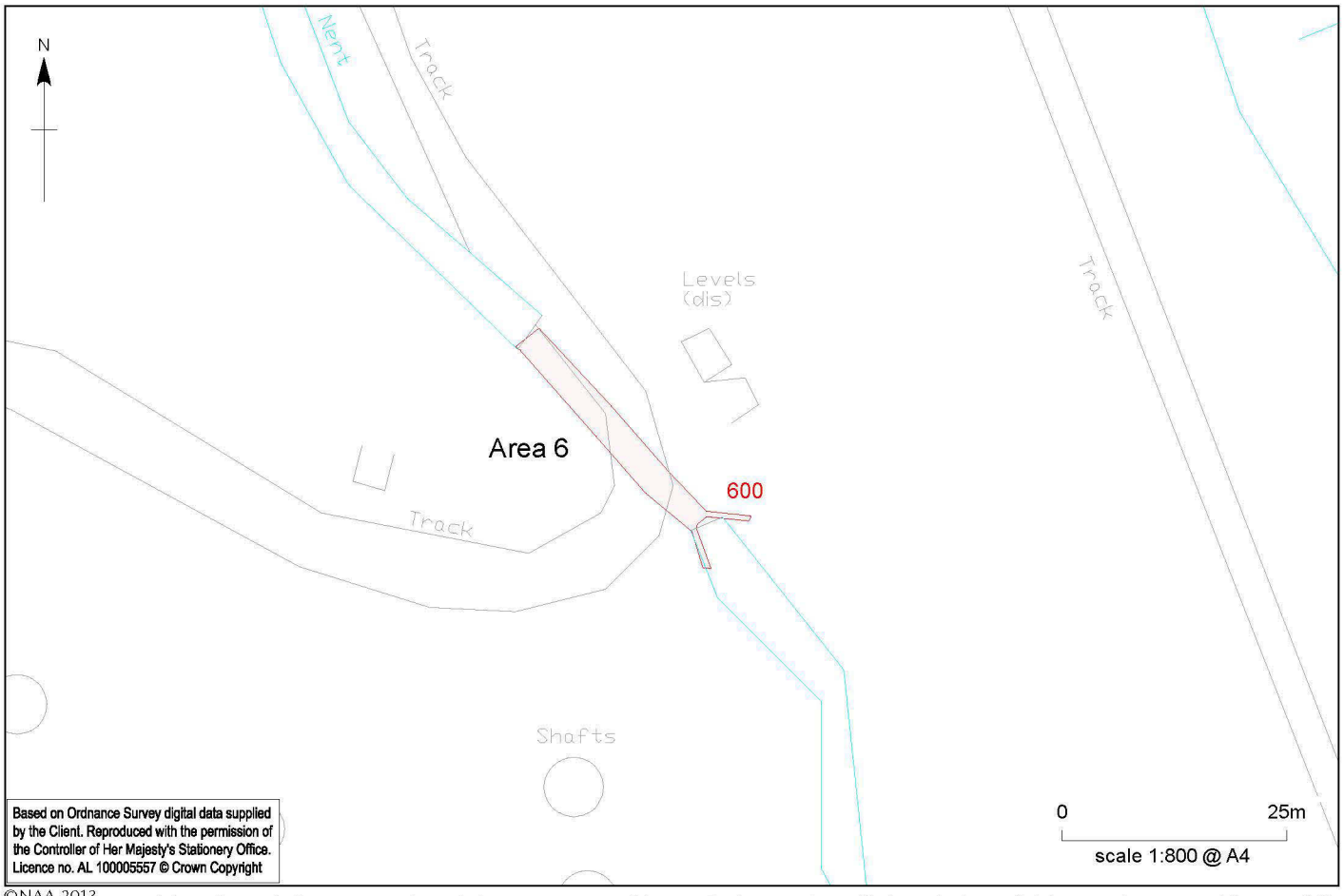
0 1m

scale 1:40 @ A4

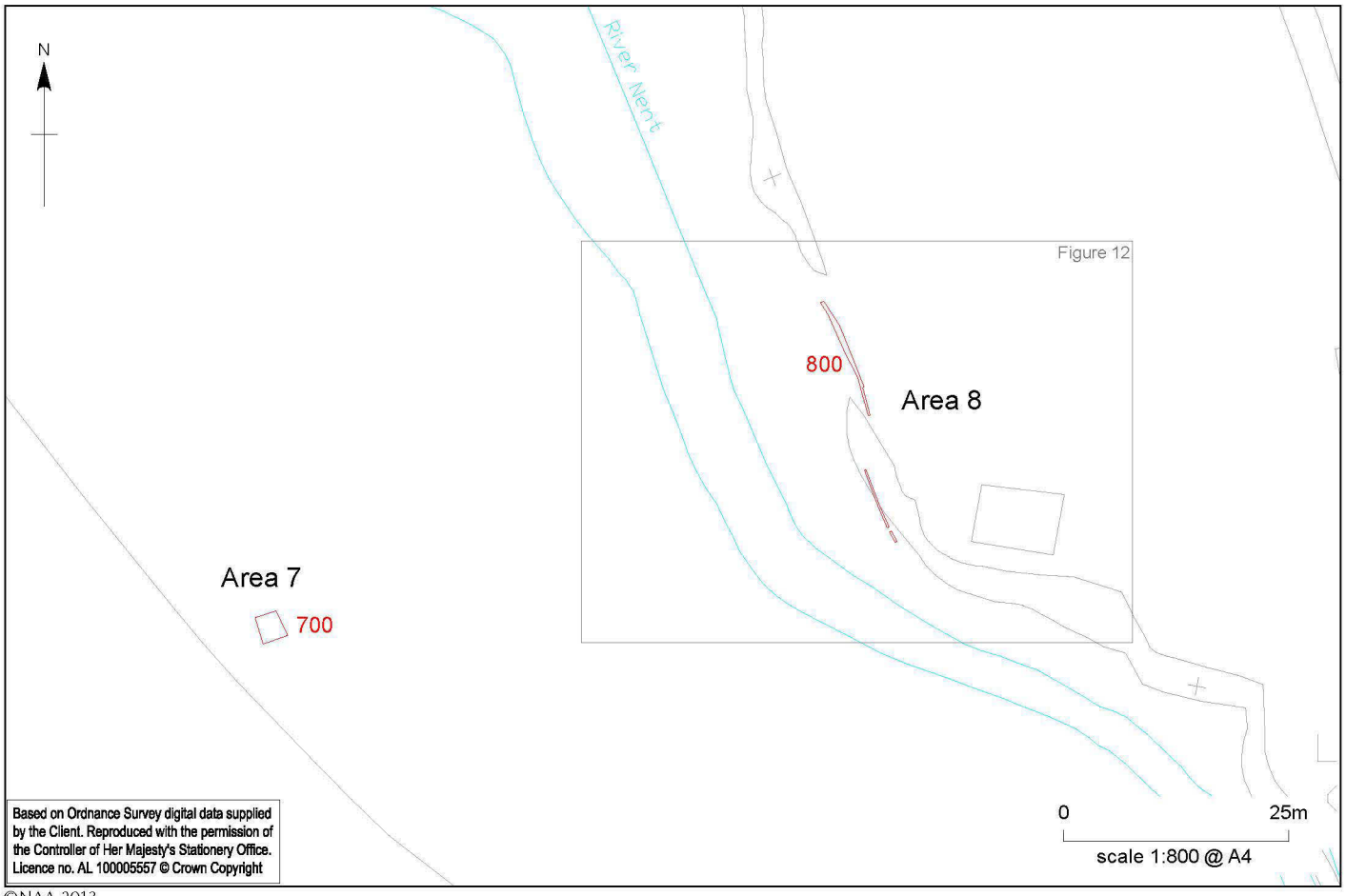
C: south-east facing elevation

Nenthead Conservation Management Plan: Smelt Mill collapsed chimney plan (orthophoto) and elevations (scaled)

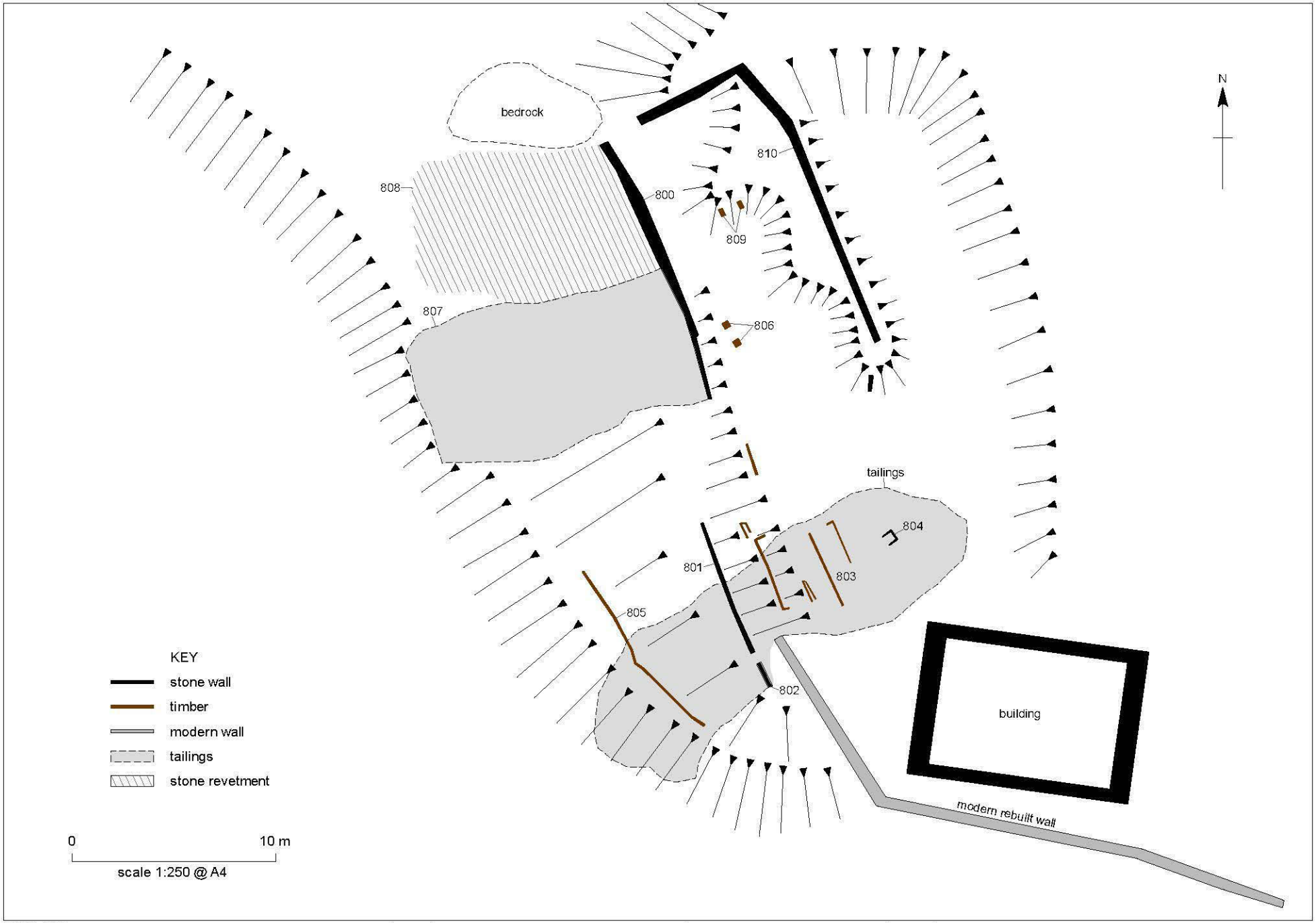
Figure 9



Nenthead Conservation Management Plan: Culvert, Smallcleugh Level (Area 6), location of surveyed features *Figure 10*

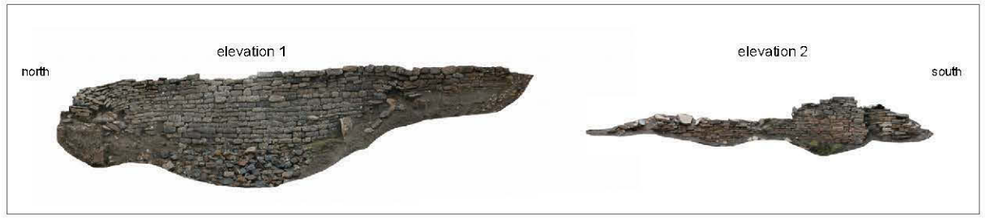


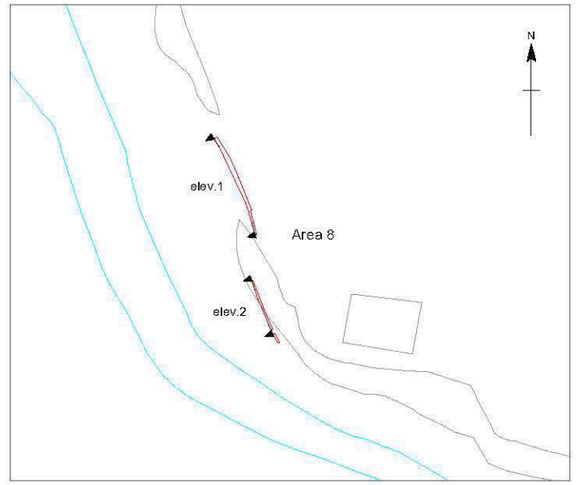
Nenthead Conservation Management Plan: Powder House (Area 7) and Retaining Walls at Smallcleugh (Area 8), location of surveyed features *Figure 11*



Nenthead Conservation Management Plan: Area 8 - Dressing Floor plan

Figure 12



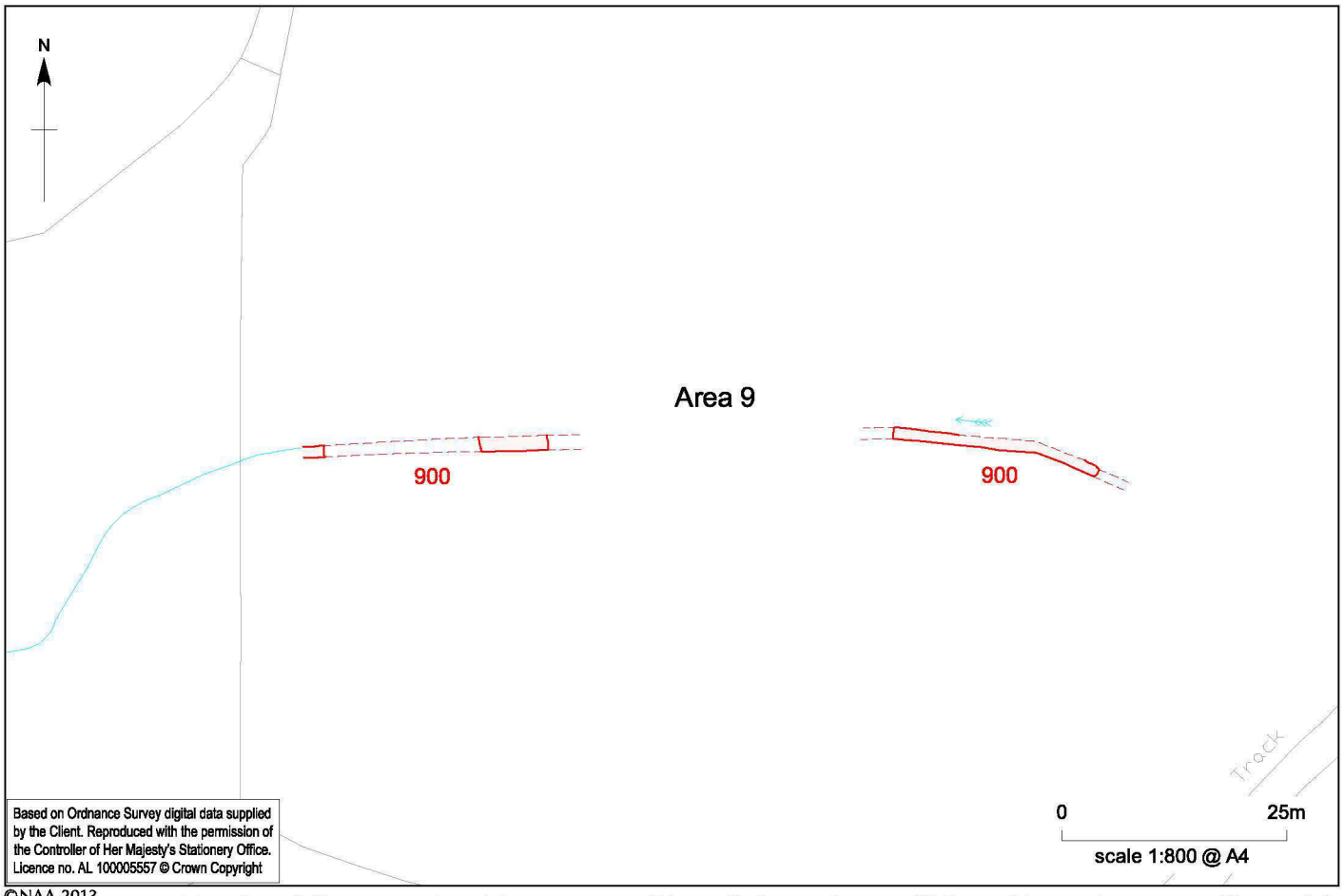


0 2m

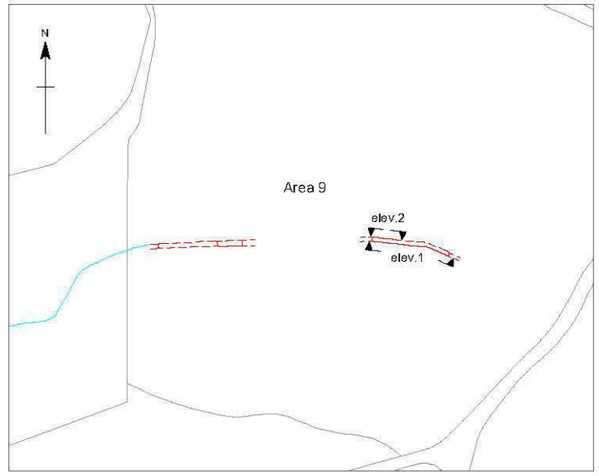
scale 1:40 @ A3

Nenthead Conservation Management Plan: Area 8 - Retaining Walls elevations (orthophotos)

Figure 13



Nenthead Conservation Management Plan: Culvert, Rampgill Burn (Area 9), location of surveyed features *Figure 14*



elevation 1a

elevation 1b

elevation 2

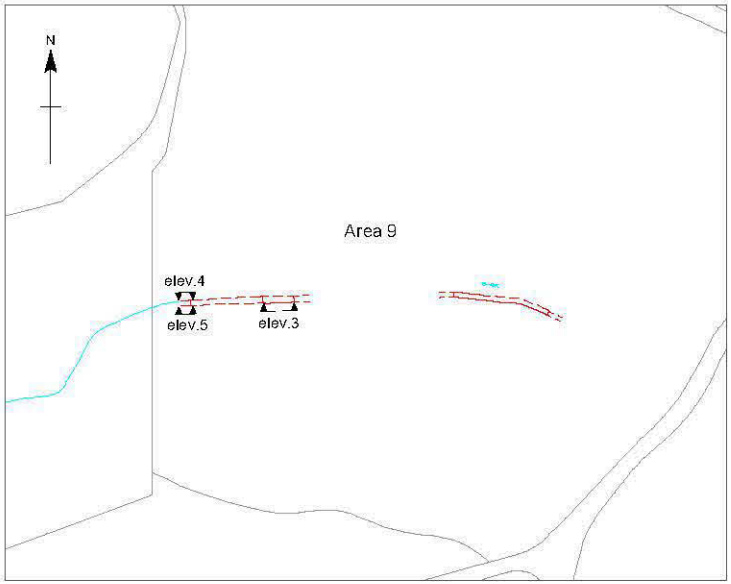
0 2m

scale 1:40 @ A3

Nenthead Conservation Management Plan: Area 9 - Culvert, Rampgill Burn elevations 1 and 2 (orthophotos)

Figure 15

elevation 3



0 2m

scale 1:40 @ A4

elevation 4

elevation 5

Nenthead Conservation Management Plan: Culvert, Rampgill Burn elevation 3 (orthophoto), 4 and 5 (rectified) *Figure 16*