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WOODHEAD TUNNELS

SURFACE STRUCTURES

prepared for

NGC

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Summary

The disused Woodhead Tunnels lie beneath the Pennines, between Dunford Bridge (SE 15600225) and Woodhead (SK 11409990), approximately 32km to the west of Barnsley (Figure 1). They lie on a section of railway which formerly connected Manchester and Sheffield and comprise a pair of mid 19th-century single line tunnels located slightly to the north of a modern double line tunnel built by British Rail in 1954. None of the three tunnels now carry railway traffic and all three are owned by the National Grid Company (NGC).

The earlier tunnels have been used since 1968 by the Central Electricity Generating Board (CEGB), now NG, to house and maintain 400kV electricity cables which formed part of the Macclesfield-Stockbridge and Stalybridge-Thorpe Marsh circuits. These cables recently reached the end of their design life and have been replaced by cables running through the 1950s tunnel. As a result of the cable being rerouted, both of the Victorian tunnels are now redundant and need to be sealed and made safe. As part of this process the former ventilation shafts on the moor above the tunnels also require consideration in relation to their remediation. At present there are three surviving shaft-head structures, all three being located above former Construction Shafts later used for ventilation. Two of these (shafts 2 and 5) relate to the construction of the Victorian tunnels, the third being associated with the creation and ventilation of the 1950s tunnel.

The positions of the five Victorian Constructions Shafts are shown in a section drawing produced by one of the engineers involved with the original tunnel scheme, Wellington A Purdon. The positions of each of these were transcribed onto a modern base-map and were subsequently located in the field with a hand-held GPS system which permitted navigation to the recorded locations at which point the remains of the former structures were more or less obvious on the ground. Only one Construction Shaft was employed in the 1950s and this shaft-head lies just to the south of the central (shaft 3) Victorian shaft-head and is still used for ventilation purposes. The structures were examined, photographed and a preliminary record made. The presence or absence of ancillary buildings at each location were noted along with a brief record of any adjacent earthwork features that may relate to the original construction scheme, and any available means of access and egress that might facilitate the remediation of the structures.

Neither of the two remaining Victorian shafts survives in its original form; the westernmost survivor (shaft 2) was enlarged, and its ventilation tower created after 1912, the easternmost example (shaft 5) was intercepted as part of the 1950s construction programme and used to ventilate this later tunnel, its architecture being reflective of this period rather than the mid-1800s. So far as can be ascertained, the shaft-head and ventilator tower for the British Rail tunnel is still used for ventilation purposes.

All three ventilation towers are prominent landscape features, but their heritage value is low since none represent features that relate to the original construction programme for the Victorian tunnels. Only one of the shafts(shaft 2) still ventilates this earlier tunnel system, and that shaft was itself enlarged post-1912. The second Victorian shaft-bore (shaft 5) is substantially more original, but it was also modified in the 1950s. It has also been partially blocked, and the ventilation tower is clearly not original.

As they exist, all three shafts present considerable health and safety issues in providing potential access routes to tunnels situated around 150m+ below the present ground surface. The towers surmounting the original shaft positions are deteriorating and will require remediation works to be undertaken in the near future. Such procedures could usefully incorporate proposals designed to seal the potential access routes to the redundant tunnels, and groundworks associated with such procedures could be achieved with minimal disturbance to the landscape surrounding each shaft if appropriate measures are undertaken.

Prior to any remediation works occurring it is recommended that a programme of topographic survey be undertaken in order to record the surviving shaft-head structures within their immediate archaeological environment and that a programme of standing building survey is implemented to record the form and fabric of any structure that might require repair, alteration or demolition during remediation works.

All construction works should be seek to avoid damaging any of the surviving earthwork features that may represent original elements of the construction programme undertaken in the 1840s and 1850s; use existing trackways as means of access and egress; aim to restrict the working area to a minimum by undertaking preparation works (such as concrete mixing) off site wherever possible, and be undertaken under archaeological supervision in order to record any original features exposed during construction works.

A Written Scheme of Archaeological Investigation to this effect should be prepared, and submitted to, and agreed as a suitable scheme of works with the Peak District National Park Archaeological Officer in advance of any remediation works occurring.

1.0 INTRODUCTION

1.1 This report presents the results of an Cultural Heritage appraisal of surface structures associated with the construction, and use, of the Woodhead tunnels undertaken by Northern Archaeological Associates for National Grid (NG) in connection with an on-going programme of remedial work.

1.2 The disused Woodhead Tunnels lie beneath the Pennines, between Dunford Bridge (SE 15600225) and Woodhead (SK 11409990), approximately 32km to the west of Barnsley (Figure 1). They lie on a section of railway which formerly connected Manchester and Sheffield and comprise a modern double line tunnel built by British Rail in 1954 and two earlier mid 19th-century single line tunnels which are located slightly to the north. All three tunnels are owned by the National Grid Company (NGC).

1.3 The earlier tunnels have been used since 1968 by the Central Electricity Generating Board (CEGB), now NG, to house and maintain 400kV electricity cables which form part of two circuits (Macclesfield-Stockbridge and Stalybridge-Thorpe Marsh). These cables recently reached the end of their design life and have been replaced by cables which have been re-routed to run through the 1950s tunnel. The railway line running through this tunnel was closed to all rail traffic in 1981; the tunnel was acquired by CEGB in 1993. The decision to run the new cables through this later tunnel was taken as a result of several occurrences in the older tunnels, including collapses and a major fire, raising concerns about the safety of their continued use.

1.4 As a result of the cable being rerouted, both of the Victorian tunnels are now redundant and need to be sealed and made safe. As part of this process the former ventilation shafts running across the line of the tunnels at surface level will similarly require consideration in relation to their remediation. At present there are three surviving shaft-head structures, all three being located above former Construction Shafts later used as ventilation, two of which relate to the construction of the Victorian tunnels, the third being associated with the creation and ventilation of the 1950s tunnel. All three are situated amongst complexes of spoil-heaps and other structures arising from the former construction works.

1.5 An archaeological appraisal, followed by a detailed historical and archaeological survey have already been undertaken for the Victorian tunnels (NAA 03/119 and NAA 05/48 respectively), both of which concentrated on the subterranean aspects of the railway route. This report considers the above-ground elements of the same complex, and should be used in conjunction with these two earlier reports.

1.6 The fieldwork forming the basis of this study was undertaken on the 15th April 2013, the surveyor being accompanied by NGC's Project Engineer for the scheme.

2.0 HISTORICAL BACKGROUND

2.1 To many commentators the two 19th century Woodhead Tunnels represented the most impressive engineering feat of the Sheffield, Ashton-under-Lyne & Manchester Railway, which was the first railway to be constructed directly through the Pennines between Sheffield and Manchester. To others it was "….a story of heroic savagery, magnificent profits and devout hypocrisy" (Coleman 1965, 115). Between 1838 and 1852 two tunnels or bores were constructed between Dunford Bridge and Woodhead at the summit of the line, although initially only the southern tunnel (the down line) was constructed. The first tunnel measured 3 miles and 22 yards in length and was the longest in the country when it opened in 1845.

2.2 An account of the construction of the southernmost tunnel was written shortly after its completion by Wellington A Purdon, and was published in the Transactions of the Institution of the Civil Engineers of Ireland in 1849. Purdon was employed as assistant engineer and surveyor on the Sheffield Ashton-under-Lyne & Manchester Railway, working under Charles B Vignoles, who was the engineer who originally designed the scheme, which was eventually constructed under the supervision of Joseph Locke, a well respected railway engineer, who had designed an alternative scheme for the tunnel which had been rejected by the shareholders of the railway company. Vignoles encountered serious difficulties with the board of directors of the scheme, both on a personal and financial level, and resigned, but Purdon's services were retained, and he alone was the only engineer to stay on the scheme for the six years it took to complete the first tunnel (*ibid* 117). Purdon himself acquired a significant degree of notoriety and was summoned before the Commons Select Committee in 1846 to answer accusations of dangerous working practices during the construction of the tunnel (*ibid* 124).

2.3 The original scheme was always for the provision of two parallel tunnels but it was decided to economise by constructing a single line tunnel in the first instance, later known as the Woodhead Down Line, with the option for the construction of the second tunnel when the volume of traffic using the line warranted it (Purdon 1849, 98). The initial phase of construction started in October of 1838 and comprised the construction of cart roads to move coal and materials over the moors, and the erection of accommodation for the men and horses working on the project, magazines for the storage of gunpowder, to be

used for blasting the rock, and reservoirs (Purdon 1849, 102). Construction did not begin in earnest until September 1839 in the vicinity of the western portal at Woodhead after which excavations commenced. The tunnel was constructed by working from each end towards the centre and by means of five vertical shafts excavated between Pikenaze Moor and Dearden Moss. These last ranged between 138 yards (126m) to 196 yards (179m) in depth and were 10 feet (*c*.3m) in diameter (*contra* NAA 2003 and 2005). Water was pumped from each shaft using 8 inch pumps powered by a 25 horse-power steam engine (Purdon 1849, X).

2.4 The workers, which numbered up to 1500 at one time, were poorly treated. Initially no accommodation was provided for them at all, and Vignoles had to struggle to get tents provided for the 400 men who were initially engaged to dig the first shaft at the western end of the scheme. Things did not improve much throughout the project, the navvies themselves resorting to building *ad-hoc* dry-stone shelters around the shaft-heads (Coleman 1965, 116)

2.5 Some eight million tons of water were pumped out of the workings over the six years of construction. Initially driftways or pilot headings were cut between the shafts and the portals and once these were linked the tunnel was driven by two contractors in two sections. It is estimated that the total volume of excavated material taken out of the tunnel amounted to 273,000 cubic yards and that about half of this was brought up the shafts.

2.6 When finished, the tunnel had a maximum height of 18 feet (5.49m) between the track-bed and a span of 15 feet (4.57m) at the level of the track-bed. The arch was semi-elliptical in shape with its springing some 10 feet (*c*.3m) above rail level. Two open side channels 2 feet (0.46m) deep were cut at the base of the side walls for drainage and throughout the length of the tunnel 25 side arches were cut into the northern side at approximately 200 yard intervals to facilitate the construction of a second tunnel were this to be required. Castellated stone portals were constructed at the two ends and sections of the tunnel where it was driven through more friable strata were lined in stone. The finished tunnel, which was officially opened on Saturday 20th December 1845, had a constant gradient from of 1:203 and was perfectly straight.

2.7 Construction works on the second, northernmost, tunnel began in spring 1847, under the new ownership of the Manchester Sheffield & Lincolnshire Railway, formed by the amalgamation of the Sheffield, Ashton-under-Lyne & Manchester Railway, the Grimsby Docks Company and three other railway companies in the same year (Simmons and Biddle 1997, 188). In comparison to the construction of the first tunnel, the building of the second was relatively straightforward and simply involved extending the side-arches to form cross-

headings into the northern tunnel with spoil being removed through these and loaded into wagons in the southern tunnel for disposal (Coleman 1965, 135). The new up-line tunnel was opened on the 2nd February 1852 and it was virtually identical to its neighbour other than that it was lined with masonry throughout.

2.8 From the first instance, the tunnels appeared to be unpopular with their users, and maintainers, largely due to problems of ventilation (*ibid* 137). As a result of the construction shafts, which were later pressed into service as ventilation shafts, being placed over the centre line of the pair of tunnels, they did not directly vent into the tunnels themselves and it appears that shafts 1 and 2 had been blocked by debris by 1911 anyway (Ball 1916, 306) The cross-passages also permitted the sideways movement of air, and smoke, between the tunnels whenever trains moved through one or the other, and the construction/ventilation shafts caused downdraughts rather than exhausting fumes upwards, this being especially true of shaft 3 (*ibid* 307). This may, in part, have been a result of the quantity of water that flowed down the shafts drawing cold air down with it. Attempts to operate a signal box in the tunnels in the late 1800s were abandoned as a consequence of the difficulties encountered by train drivers in actually seeing the signals in the tunnels, and the decreasing number of individuals prepared to work in the signal box itself. In an effort to improve the situation, shafts 1 and 2 were re-opened, and shaft 2 was subsequently enlarged from 10 feet to 16 feet in diameter between the years of 1912 and 1915 (*ibid*). Shaft 1 appears to have been backfilled again once shaft 2 had been brought back into service.

2.9 The erosion of the fabric of the tunnels, and their linings, caused by smoke and steam was also a major problem, requiring constant attention which interrupted smooth traffic flow through the system. In order to remedy the erosion problem at source, the decision to electrify the line was made in 1936, but this was never implemented as a result of the Second World War, and the continued dilapidation of the tunnels afterwards. Attempts to repair the tunnels in the post-war years resulted in closures of one or other of the bores for protracted periods and ultimately the decision was made to construct a new, double-track tunnel, 77 feet to the south of the original pair. This was designed as an electrified railway from the outset and construction works began in February 1949. Only one Construction Shaft was sunk for this tunnel this being in the vicinity of the 1840s Construction Shaft 3. Unlike the 1840s shafts, the 1950s shaft was constructed a further 26 feet south of the centre-line of the new tunnel in order to separate lifting activities from general construction works more effectively. The tunnel was initially driven from the two faces at the bottom of the shaft, and one at either end of the tunnel, although this approach was later modified.

2.10 Despite many unforeseen setbacks, such as major collapses, tunnelling operations were completed in October 1953 and the facility opened with electric trains running through the tunnel by June of the following year. Whilst smoke was not an issue in this tunnel, the construction shaft was re-used for ventilation, and a further connection made to Construction Shaft 5 for the same purpose.

2.11 The two redundant tunnels were acquired by the Central Electricity Generating Board (CEGB) a short time after January 1964, in order to place an underground section of a trans-Pennine electricity cable between Stalybridge, near Manchester, and Thorpe Marsh Power Station, near Doncaster. It was intended to run the new cable through the northernmost tunnel only, but before this was possible a programme of renovation works were required, during which the CEGB were permitted to run a temporary cable overland between Dunsford Bridge and Woodhead (Goulty 1969, 172). As part of the remediation works, all of the former Victorian Construction Shafts were sealed and backfilled, with the exception of shafts 2 and 5. Shaft 2 had previously been enlarged in 1912 and was further improved and retained by the CEGB for continued ventilation purposes, and shaft 5, which had previously been incorporated into the ventilation system of the electric railway tunnel, was backfilled to a level below the interconnection of the shaft and the new tunnel. The new cables running through the northern tunnel were completed in 1969 and the overhead line recovered (http://www.forgottenrelics.co.uk/tunnels/woodhead.html).

2.12 It was during this period that the findings of the Beeching Report, published in 1963, began to be make its mark upon the British Railway network. Despite the fact that the passenger service between Sheffield and Manchester via Woodhead was not identified as being a candidate for closure within this report (British Railways Board 1963a, 112 and 121), the route between the same destinations through the Hope Valley was. The then Minister of Transport refused to ratify this latter recommendation and, as a compromise, the line through Woodhead tunnel, which served fewer communities than that through the Hope Valley, was subsequently proposed for closure. After a Public Enquiry this decision was upheld and the Woodhead route closed for passenger services in 1970. Freight trains, particularly those used in the movement of coal, which had always amounted to a considerable volume of rail traffic over the route, continued until July 1981 when the line was closed altogether.

2.13 The CEGB (although electricity privatisation began in 1990, the CEGB continued to exist until the Central Electricity Generating Board (Dissolution) Order came into force in 2001) acquired the remaining tunnel not already in their possession in 1993 after a number of occurrences in the Victorian tunnels raised concerns about their safety, and viability as a cable duct beneath the

Pennines. The existing 1960s cables were reaching the end of their design life and required replacement and rerouting them through the third tunnel was clearly a preferred option. Before this option was implemented, National Grid (responsible for power transmission) sought advice from the Department for Transport about the likelihood of a reinstatement of the railway link through the Woodhead tunnel and received a negative response. Construction works on the replacement cable link commenced in 2008 and is currently nearing completion.

3.0 RESULTS

3.1 A total of five Construction Shafts, two additional air-shafts and four Observatories were identified on Purdon's section drawing. The Construction Shafts and Observatories were numbered 1 to 5, and 1 to 4, respectively, from west to east, the two air-shafts were not numbered. The positions of each of these were transcribed onto a modern base-map and the National Grid Coordinates for each feature noted. These positions were subsequently located in the field with a hand-held GPS system which permitted navigation to the given coordinates to an accuracy of ±3m, at which point the remains of the former structures were more or less obvious on the ground.

3.2 In addition, a number of concete pillars, seemingly observation pillars, were noted at the time of the site inspection survey. These were situated in positions that do not equate with any location given by Purdon, and, as a result of their relatively low height, were intervisible at ground level whereas the sites of the observation towers were not.

Construction Shafts

3.3 The positions of five Constructions Shafts are given by Purdon, their locations being chosen in order to bring all of the tunnel construction headings to completion at a similar time, this opinion being based upon professional judgement (Purdon 1849, 99). This judgement was flawed and the headings tunnelled from the shaft bases met at various times from September 1842 to March 1845 (*ibid* 123). The shafts were set out in a line equating with the centre line of the intended tunnel pair, and were sunk into the 17 feet of rock separating the two bores, each being 10 feet in diameter. The southern tunnel was constructed first, and Headings (a 4 foot square drift excavated along the top of the intended tunnel) and Lower Driftways (6 foot square, at the bottom of the tunnel) were then driven in a line parallel to the line described by the bases of the shafts, some 16 feet to the south of each. Once these met their counterparts, the full bore of the tunnel was excavated (*ibid* figure 2). The

Construction Shafts were also used as a means to remove spoil to the surface, and to de-water the excavations before the lower driftways met and permitted natural drainage to occur towards the west. They were later used in an attempt to ventilate the tunnels, although, being sited between the two bores, were not particularly effective at doing so.

3.4 Each construction shaft was provided with its own 25 horse-power steam engine at the surface, and various pumping and winding apparatus. Spoil was raised from each shaft and dumped locally, water was routed into artificial drainage channels which vented into nearby watercourses to drain naturally. There would have been a series of ancillary shaft-head buildings to accommodate engines, pumps etc, and each shaft was serviced by a cart road for the supply of coal etc. A navvy settlement, built by the navvies, was established at each shaft-head. The buildings constructed by these workers were informal, dry-stone structures, roofed in heather, representing little more than bivouacs (Coleman 1965, 116)

3.5 Purdon numbered the Construction Shafts, 1 to 5, from west to east, and that order and nomenclature has been preserved here for consistency.

Shaft 1 (SE12306 00438)

3.6 The remains of Construction Shaft 1 are located within a disused quarry, *c.* 1060m to the north-east of the western tunnel portal, and the shaft is relatively difficult to identify on the basis of its surviving structure alone.

3.7 The quarry is identified as being Greystone Edge Quarries on Ordnance Survey mapping of 1881 suggesting that these were active subsequent to the construction of the original pair of tunnels. The quarries are further identified as being disused on the Ordnance Survey issue of 1989. The shaft head is represented by a small, but neat, cairn of broken sandstone fragments containing a few pieces of engineering brick. Part of a small 'kerb' of dressed sandstone blocks remain visible on the north-western side of the cairn, probably representing masonry of the lip of the shaft, otherwise there is little in the surviving structure to differentiate it from the numerous smaller heaps of quarry debris within this area.

Plate 1 The remains of Construction Shaft 1 from the west

Plate 2 Fugitive remains of the lip of Construction Shaft 1

3.8 There was no surviving evidence for the engine or boiler house that would have once been associated with this shaft, the evidence for these presumably having been removed during later quarrying activities. Similarly there was no surviving evidence for an access track to the shaft-head. The spoil heaps from the sinking of the shaft, and the construction of the tunnel, have similarly been subsumed by quarry debris.

3.9 Construction Shaft 1 was 186 yards (*c.*170m) deep, took 3 years and 1 month to sink and was bottomed on the 29th October 1843. The shaft was clearly used as a ventilation shaft for the original tunnels and is identified as such on a number of historic issues of the Ordnance Survey. The presence of brick within its destruction debris is suggestive of repair and/or modification over time (see Construction Shafts 3 and 5) and its presence is noted on 1954 Ordnance Survey mapping for Derbyshire.

3.10 The shaft's demolition was undertaken by the CEGB post-1964 when it was backfilled and sealed.

Shaft 2 (SE12790 00814)

3.11 Construction Shaft 2 is located *c.*754m to the north-east of shaft 1 and the superstructure of the air-shaft into which it was converted survives intact as a circular tower approximately 4m high.

3.12 The construction shaft was excavated in an elevated position on the eastern slope of one of the two highest points of the route as it descends towards a valley originally containing two brooks. The courses of the brooks have become rather less distinct as a result of later activity, particularly the spoil bund resulting from the excavation of the only 20th-century tunnel construction shaft.

3.13 The air-shaft tower was constructed of cement-mortared, coursed gritstone blocks of various shapes and sizes and sits upon a concrete ring-beam which is eroding, predominantly on its western side. As a consequence of this erosion, the masonry of the structure has cracked in several places, and in at least one case, the crack extends through the blocks of the masonry rather than through the bonding. Some baulks of timber have also been incorporated into the structure at low level, these now being in poor condition.

3.14 The tower sits amidst a complex of spoil-heaps, predominantly situated to the south and east of the tower, which undoubted contain the remains of ancillary structures such as the engine house which are difficult to definitively identify on the surface.

Plate 3 Ventilation tower, Construction Shaft 2 from the south-east

Plate 4 Spoil heaps and possible structural remains associated with Construction Shaft 2

3.15 No shaft-head structures survive as they would have been removed in order to construct the ventilation tower. Access to this construction site would have been from the surviving trackway which approaches from the west, there being no obvious means of connecting the site to shaft 3 over the boggy ground from the east other than the meandering route which hugs the valley contours to the north of both today.

3.16 Construction Shaft 2 was 192 yards (175.5m) deep and took 4 years and 5 months to excavate and was bottomed on the 31st March 1844. The shaft was subsequently used as a ventilation shaft for the railways and is identified as such on historic mapping. The shaft was enlarged to a diameter of 16 feet in the early decades of the 20th century, the present superstructure of the shaft belonging to this period. The shaft was the subject of a programme of further improvement and maintenance by the CEGB in the mid 1960s.

Shaft 3 (SE13488 01100)

3.17 The remains of Construction Shaft 3 are located 590m to the east of shaft 2 in an area that has been significantly remodelled during the construction of the 1950s tunnel, the only shaft that was needed for the construction of the latter being situated within the immediate vicinity. The remains of Construction Shaft 3 comprise a low mound of destruction debris containing fragments of brick, timber and a section of former railway line.

3.18 The mound sits within a patch of waterlogged ground, in the vicinity of a former brook, to the west of a scarp that was once surmounted by Observatory 3. The shaft is surrounded by a number of reworked and ill-defined earthwork features, some of which are likely to be of natural origin. There are no obvious indications of former ancillary structures, or former spoil heaps, these probably having been cleared during construction works associated with the later rail tunnel.

3.19 The sole construction shaft for the 1950s railway is located off the line of the 19th-century works, approximately 55m to the south, and its surface remains are represented by a single, square, brick ventilation tower constructed in English Garden Wall bond.

Plate 5 Unconsolidated backfill in Construction Shaft 3

Plate 6 Ventilation tower on site of 1950s Construction Shaft, from the north.

3.20 The structure is approximately 6m square, its walls being capped with sandstone ashlar coping stones, one having been displaced. The spoil heap for this tunnel is vast in comparison to the dendritic spoil-heaps of the 1800s and comprises a well defined and deliberately shaped, level, platform of debris measuring some 240m north-west to south-east by 120m north-east to south-west. It would seem likely that the majority of the spoil from the earlier phase of construction, and the remains of any associated buildings, have been 'tidied up' and incorporated into this later heap.

Plate 7 View of 1950s spoil heap from 1840s spoil heap at Construction Shaft 2, from west

3.21 A single bicameral flat-roofed brick-built structure, which almost certainly relates to the 1950s tunnel, survives about 95m to the north-east of the later shaft, its function being unclear.

3.22 Access to the 1950s works was by a trackway leading south-eastwards to Goddard Lane. There is a further track leading eastwards, up the scarp towards Construction Shaft 4, it would seem unlikely that this was the principal route used for coaling or otherwise supplying shaft 3 as a consequence of the slope involved. As noted above, there is no easy means of access from shaft 2 in the west, and a former supply route leading from Goddard Lane in the 1840s would seem probable.

Plate 8 1950s ancillary building from north-west

3.22 Access to the 1950s works was by a trackway leading south-eastwards to Goddard Lane. There is a further track leading eastwards, up the scarp towards Construction Shaft 4, it would seem unlikely that this was the principal route used for coaling or otherwise supplying shaft 3 as a consequence of the slope involved. As noted above, there is no easy means of access from shaft 2 in the west, and a former supply route leading from Goddard Lane in the 1840s would seem probable.

3.23 Construction Shaft 3 was 165 yards (151m) deep and took 2 years and 7 months to sink and was bottomed on the 30th April 1842. It latterly functioned as a ventilation shaft and is identified as such on issues of the Ordnance Survey up until the 1950s, whereupon the later shaft is annotated as such. The original shaft is recorded as having been backfilled and sealed by the CEGB sometime after 1964, but the structure may have been demolished prior to this, possibly in the 1950s. It is evident that the backfilling of this shaft has only been achieved rather more untidily than elsewhere, resulting in a 'doughnut' of rubble surrounding a distinct hollow containing a mass of unconsolodated debris.

Shaft 4 (SE14805 01439)

3.24 Construction Shaft 4 was located some 648m to the east of shaft 3 on gently eastward sloping ground. The remains of the shaft are represented by a tidy sub-circular cairn of sandstone rubble bounded to the south-east by a well preserved complex of dendritic spoils-mounds.

Plate 9 Cairn sealing Construction Shaft 4 from north

3.25 The foundations of a number of stone-built ancillary buildings survive to the north of the shaft, and a number of architectural fragments are scattered around the complex, including a substantial sandstone bearing-block (without its bearing) from a former machine.

3.26 Access to the shaft seems to have been by a track leading from Construction Shaft 5, to the east, and this track extended westwards to Observatory 3 situated on the crest of a scarp between shafts 4 and 3, whereupon it descended the scarp to shaft 3. A second track now loops southwards over somewhat boggier ground to intersect Goddard Lane, although it is uncertain if this track was part of the original communications network or represents a later feature.

Plate 10 Remains of ancillary building to the north of Construction Shaft 4

Plate 11 Former bearing-block adjacent to Construction Shaft 4

3.27 Construction Shaft 4 was 196 yards (180m) deep, took 2 years and 3 months to complete and was finished on the 31st Dec 1841. It too acted as a ventilation shaft once the tunnels were complete and appears to have been backfilled by the CEGB sometime after 1964.

Shaft 5 (SE14676 01769)

3.28 Construction Shaft 5 was the easternmost of the original shafts required by the 1840s engineering scheme. The position of the shaft is marked by a short ventilation tower, *c*.2m in height, constructed of brickwork surmounting the remains of an earlier sandstone-built structure which only survives to a maximum of four courses in height, for part of the circumference of the structure. The fabric brick tower, built in English Garden Wall bond, preserves evidence of a former doorway, now blocked, and the uppermost five courses are recent replacements of the original engineering brick.

Plate 12 Blocked doorway in ventilation tower, Construction Shaft 5

3.29 The southern half of the tower has been painted white and bears a mural depicting an electric locomotive in British Rail electric blue livery. This is possibly a crude depiction of a Bo-Bo Class EM1 (also known as Class 76, predominantly used for freight) locomotive, or a Co-Co Class EM2 (alternatively Class 77, predominantly used for passengers) locomotive, it being difficult to distinguish just how many wheels are depicted in the mural. Both classes were

designed for use on the 1.5Kv Woodhead line, the Bo-Bo essentially being a pre-war design upon which the Co-Co class was later based. Of the latter, seven were built by Metropolitan-Vickers in 1953 and it seems that only one of these was ever painted in the blue livery, standardised as British Rails' corporate colour in 1965. The use of this mural, in this livery, on a ventilation shaft originally associated with steam locomotives is, therefore, perhaps inappropriate.

Plate 13 Mural on ventilation tower, Construction Shaft 5

3.30 The spoil-heaps for this shaft lie to the south-east, these having the appearance of being secondarily quarried, and the low turf covered foundations to the north of the shaft which probably equate with former ancillary structures. A drystone enclosure wall extends eastwards from the area of the shaft before turning south-eastwards along the line of a brook to return westwards and disappear amongst the spoil heaps. The enclosure, so far as can be defined, measures 125m by 95m (maximum) but its purpose is unclear. It seems likely that the enclosure pre-dates the shaft, since none of the other shafts are similarly enclosed, and that its former function was agricultural.

3.31 Access to the site appears to be have been by a track leading southwards to Goddard Lane, which also loops westwards to connect shafts 5 and 4.

3.32 Construction Shaft 5 was 138 yards (126m) deep and was the first shaft to be completed. The shaft was bottomed on the 30th October 1841 after 2 years and 1 month's excavation work.

Observatories

3.33 Purdon provides the positions of a series of four observation towers, or 'Observatories' employed on the tunnel construction scheme and, being a surveyor, exhaustive descriptions of their purpose, how their positions were arrived at, and their manner of operation (*ibid* 103-109).

3.34 The primary purpose of the Observatories was to maintain an uninterrupted line-of-sight between the two tunnel portals and each Construction Shaft head, and to ensure a perfectly straight line was maintained between each component of the construction scheme. It follows that the Observatory towers were built along this line-of-sight, and each was used to house an optical instrument, a 'transit', mounted along the axis of the construction line. The transit was only permitted to rotate in the vertical plane in order to remove any potential for horizontal angular error in the creation of the tunnels, although they could slide from side to side to permit offsets to the construction line to be achieved.

3.35 Each tower was between 20 and 40 feet in height, and placed in positions which permitted intervisibility between adjacent towers which could not have been achieved at ground-level as a consequence of the undulating topography of the moorland surface. Each was circular, thirteen feet in diameter, housing a circular concrete pillar upon which the transit was mounted. No other part of the building was constructed in contact with the pillar to avoid any deflection in the survey station should the rest of the building settle. The tower was roofed, with windows in the structure permitting the use of the instrument.

3.36 Purdon numbered the Observatories 1 to 4 from west to east, this system again being employed in the following discussion.

Observatory 1(SE 11528 99983)

3.37 Observatory 1 is the westernmost of the four observatories towers identified by Purdon. It was located about 156m to the east of the western tunnel portals on the edge of a scarp descending steeply to the valley of the River Etherow. Furthermore, Purdon illustrates this position as being approximately halfway between the then Turnpike Road (now followed by the A628) and an 'Old Road' which was presumably its precursor, which ran over Woodhead Pass at a slightly greater elevation, and eventually joined Goodard Lane where the latter now intersects with the A628). This tower is identified as 'Observatory (Air shaft)' on the 1881 Cheshire Ordnance Survey map sheet, and subsequently as an air shaft on the 1923, 1948 and 1958 issues for Derbyshire. This is a

misidentification, the Observatory was never an air shaft, although a forced ventilation shaft, identified by Purdon as an 'Air Shaft' used during construction works, did exist immediately to the west, at a distance of about 70m from the portals.

3.38 The tower has been razed, and there is very little evidence for its former position on the ground. The demolition of this structure must have been undertaken after 1901 as the tower appears on a photograph (L2376, Record Office for Leicestershire, Leicester and Rutland) of Woodhead Station which has been attributed this date.

Observatory 2 (SE12364 00467)

3.39 As with Construction Shaft 1, the remains of Observatory 2 are located within the former Greystone Edge Quarries, and are similarly difficult to identify by their structural remains alone, although once located, it comprises the most obvious example of this class of structure. The tower now consists of a heap of sandstone rubble, in excess of 2m high, surmounting a promontory which juts into the void of the quarry. This perhaps suggests that it was still extant while the quarry was active. The observatory could have been accessed and serviced in the same manner as Construction Shaft 1 which was in the same vicinity.

Plate 14 The remains of Observatory 2 behind a later concrete pillar, from south

3.40 The remains of the tower lie immediately adjacent to a concrete pillar, one of several encountered during the course of the fieldwork, which are discussed below.

Observatory 3 (SE13682 01213)

3.41 Observatory 3 was situated at the top of a scarp leading downwards to Construction Shaft 3 some 230m to the west. The remains of the tower are now represented by a barely perceptible circular, grassy, mound of containing some large sandstone fragments. The mound is surrounded by a circular ditch and has a small flat cairn built upon its top which presently appears to be being used for some other form of moorland survey.

Plate 15 The remains of Observatory 3

3.42 It was serviced from the track running eastwards from Construction Shaft 4, and its position corresponds with a slight kink in the track. There is now a further track descending the scarp to shaft 3, but it seems unlikely that this would have been used for anything other than foot traffic, if it actually existed at the time of the construction of the tunnels.

Observatory 4 (SE14505 01672)

3.43 Observatory 4 was not convincingly discernible during the site inspection survey. Its position, as given by Purdon, corresponds with a deviation in the

access track between Construction Shafts 4 and 5, and a platform of sorts was identified on the ground at this point. The remains of the observatory should be approximately 465m east of shaft 4 and 220m west of shaft 5, and situated on ground that gently sloped downwards to the east. The tower would have been serviced from the track between them.

Air Shafts

3.44 The positions of two forced ventilation shafts are given by Purdon, one at either end of the construction route and *c.*70m from the entrance portals, both of which were intended to ventilate the construction of the tunnel, not its use. Neither site was inspected as part of this survey and it is assumed that both were abandoned and filled shortly after the tunnels were completed. The Air Shafts employed a furnace to draw air through the tunnel entrances and up the shaft as a means of ventilation, whereas ventilation of the Construction Shafts was achieved by running a pipe up to the exhaust of each steam engine to achieve the same effect.

Pillars

3.45 A series of concrete pillars, set along the line of the original construction transit, were identified during the course of the site inspection survey. These were relatively low structures, and superficially resembled Ordnance Survey triangulation points in terms of shape and dimension. They were more numerous than the original Observatory towers (the precise number originally being constructed being unknown at present).

3.46 However they were all surmounted by an iron fitting, which survived differentially between each example, and were constructed from a coarse, pebbly, concrete mixture akin to the 'economy' concrete employed in various Defence of Britain structures during the Second World War.

3.47 The pillars were constructed upon rectangular concrete plinths made of the same material, but were not always centrally placed upon these plinths suggesting that the approximate route of the pillars was established first, the positions of the pillars being set-out more accurately by detailed survey. The pillars were not spaced equidistantly, but were generally intervisible with the exception of where the line of sight passed through the superstructure of shaft 2. The westernmost pillar, which appears to have been built upon peat, is now displaced and in poor condition.

Plate 16 Concrete pillar in open ground between Construction Shaft 4 and Observatory 3

Plate 17 Detail of top of pillar

Plate 18 Pillar between Construction Shaft 1 and Observatory 1

3.48 'Pillars' are noted on Ordnance Survey issues from the late 1970s, but not on issues originating in the 1950s suggesting that they were constructed between these two map editions rather than being directly related to the construction of the any of the railway tunnels at Woodhead. The fact that they are intervisible, but set at a low level, suggests that they represent some form of temporary survey stations.

4.0 DISCUSSION

4.1 Of five original Construction Shafts employed during the construction of the Woodhead tunnels in the 1890s, none survive in their original form. Construction Shaft 1 appears to have been filled with rubble prior to 1911 and shafts 3 and 4 seem to have been sealed and backfilled sometime after the CEGB acquired the Victorian tunnels in the mid 1960s. Shaft 2 was modified and enlarged between 1912 and 1915, and received further attention at the hands of the CEGB who retained this particular shaft for ventilation purposes in the 1960s and shaft 5 was intercepted for use as a ventilation facility during the construction of the third railway tunnel in the 1950s, and partially backfilled by the CEGB thereafter (http://www.forgottenrelics.co.uk/tunnels/woodhead.html). The surviving shaft-head structures relate solely to the use of their respective

shafts as ventilation structures, and there is no surface evidence for the shaft-head gear used during the construction of the tunnels, although copious evidence for the spoil-heaps resulting from this activity survives at the sites of shafts 2, 4 and 5. It is likely that some subsurface remains relating to the use of the shafts as Construction Shafts will survive at all of the sites, with perhaps shafts 1 and 3 having the lowest potential for the good survival of such remains.

4.2 There is also evidence to suggest the partial survival of subsurface remains of ancillary structures and buildings associated with the construction of the tunnels at shafts 2, 4 and 5, these being particularly obvious at the site of shaft 4. The remains of the ancillary structures at the site of shaft 1 have been substantially re-worked or removed by later quarrying activity, the remains of the shaft itself being difficult to differentiate from the small piles of quarrying debris that predominate in this area. Any remains in the vicinity of shaft 3, including the former spoil heaps, are likely to have been cleared and tidied up during the construction of the third tunnel in the 1950s. The spoil heap relating to this period of construction is substantially larger, and more orderly, than those relating to the earlier tunnels, and undoubtedly incorporates earlier debris. There is some potential for the remains of former ancillary structures in this area to be preserved beneath bog deposits which will have accumulated in the vicinity since the mid 19th century, especially if these originally lay to the north of the shaft, as they did around shaft 2

4.3 The remains of the navvy settlements formerly located at the shaft heads were not readily identifiable. These were insubstantial structures and were probably cleared when the tunnelling work was completed. There are some surviving dry-stone structural remains to the west of shaft 3 but it would be speculative to associate these with a former navvy settlement as they are constructed on spoil which could have originated from the later construction programme. They could equally have been constructed by recreational users of the moorland, either as shooting butts or informal bothies.

4.4 The Observatories have all been razed and only fugative remains of these structures survive at their former locations. Observatory 2, situated in a quarry, may retain more evidence of its former structure than the remainder.

4.5 Many of the tracks that were built to service the shafts and observation towers survive in reasonable condition and appear to be receiving some level of maintenance for the recreational use of the moorland. The track between Construction Shafts 5 and 4, and Observatory 3 is particularly well maintained, probably for use by shooting parties for access to a number of butts that line the northern edge of the track.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 At present it is proposed to seal the remaining open Construction/Ventilation Shaft (shaft 2) to the Victorian tunnels completely for safety reasons. The tunnels have now been vacated by NG and there is no further need to ventilate these, and the shaft is redundant but could still provide potential access opportunities for (extremely bold) trespassers.

5.2 The 1950s tunnel appears to be ventilated through two shafts; the original Construction Shaft 5, and the 1950s shaft located to the south of Construction Shaft 3. Construction Shaft 5 was intercepted to connect with the electric railway tunnel in the 1950s, and backfilled to a level below this interconnection in the 1960s by the CEGB, and so far as it can presently be determined, this facility is still being used. The centre-line of the 1950s shaft is situated 26 feet to the south of the centre-line of its tunnel, and again, still appears to be in use. These two shafts could potentially provide access opportunities into the 1950s tunnel.

5.3 Although the superstructure of Construction Shaft 2 relates to the enlargement of the shaft in the first decades of the 20th century, it is still a prominent landscape feature. It is, however, beginning to show signs of instability. In sealing the shaft, the tower would have to be dismantled and this could provide an opportunity to rebuild the structure in order to retain its cultural heritage value. The superstructure of Construction Shaft 5 almost certainly dates from the 1950s, when the shaft was incorporated into the ventilation system of the third Woodhead tunnel, or later, when the CEGB undertook to partially backfill the shaft. Despite the fact that the structure has been decorated with a mural of an electric locomotive, its value as a Cultural Heritage Asset is questionable, given that it is the shaft bore itself that relates to the construction of the 1840s tunnels, not the tower. The loss of this latter tower may, therefore, be considered an acceptable element of the of the remediation programme.

5.4 A programme of archaeological works should be undertaken in the vicinity of every shaft-head targeted for remediation works in advance of the construction programme in order to record any original structures and features relating to the construction and use of the Woodhead tunnels irrespective of period. This might reasonably include;

- A programme of topographic survey in order to record the surviving shaft-head structures within their immediate archaeological environment
- A programme of standing building survey to record the form and fabric of any structure that might require repair, alteration or demolition during remediation works

5.5 Any construction work involved in sealing the remaining shafts should;

- Seek to avoid damaging any of the surviving earthwork features that may represent original elements of the construction programme undertaken in the 1840s and 1850s
- Use existing trackways as means of access and egress
- Aim to restrict the working area to a minimum by undertaking preparation works (such as concrete mixing) off site wherever possible
- Be undertaken under archaeological supervision in order to record any original features exposed during construction works
- Prepare a report on all of the archaeological works to be submitted to the Peak District National Park Historic Environment Record, and the National Monuments Record
- Prepare a short report for publication in an appropriate journal

5.6 A Written Scheme of Archaeological Investigation should be prepared, and submitted to, and agreed as a suitable scheme of works with the Peak District National Park Archaeological Officer in advance of any remediation works occurring.

5.7 The recommendations made in the earlier appraisal and assessment reports (NAA 2003 and NAA 2005) should be reviewed, especially with respect to the provision of on-site interpretation and information panels, and implemented where possible.

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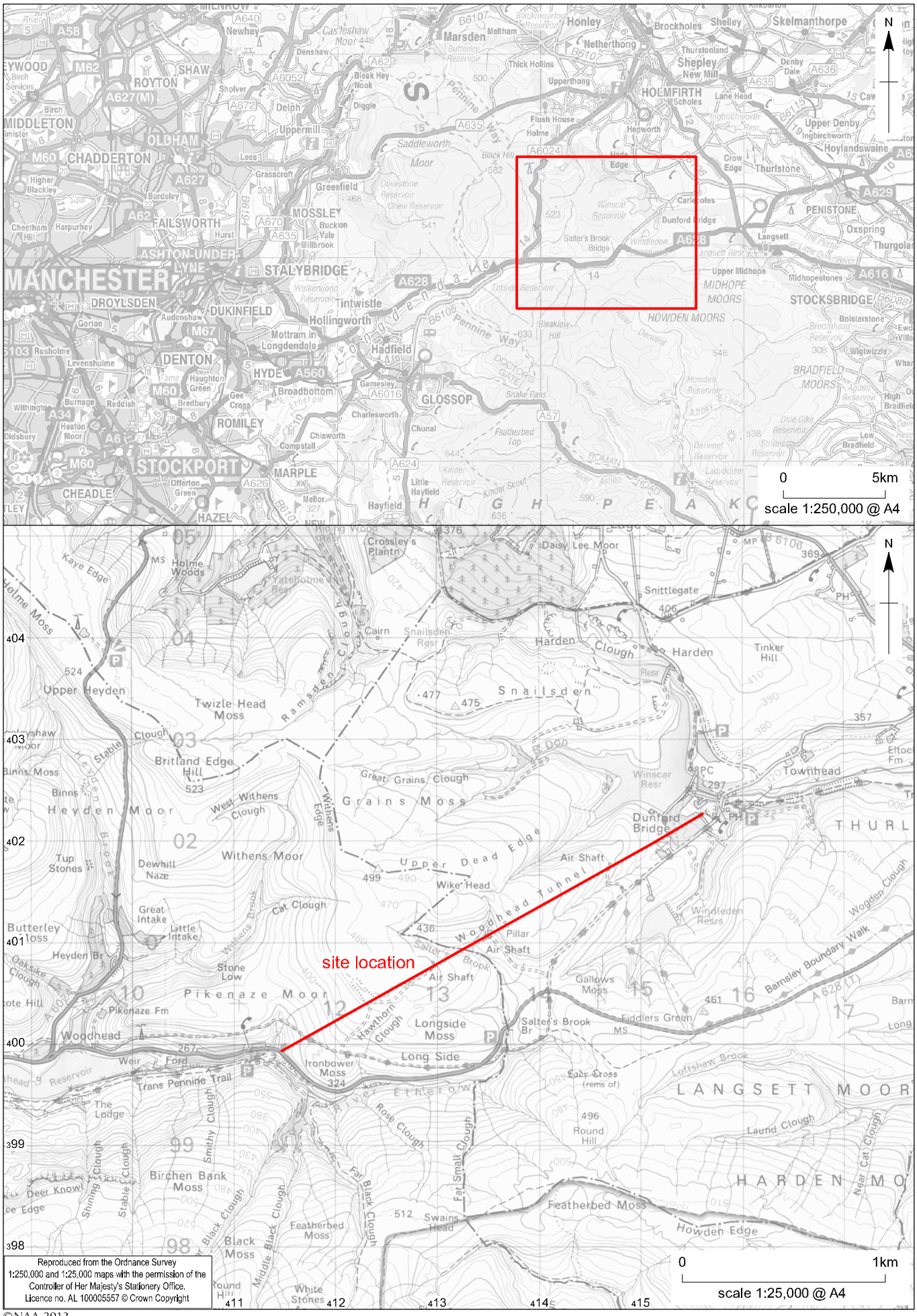

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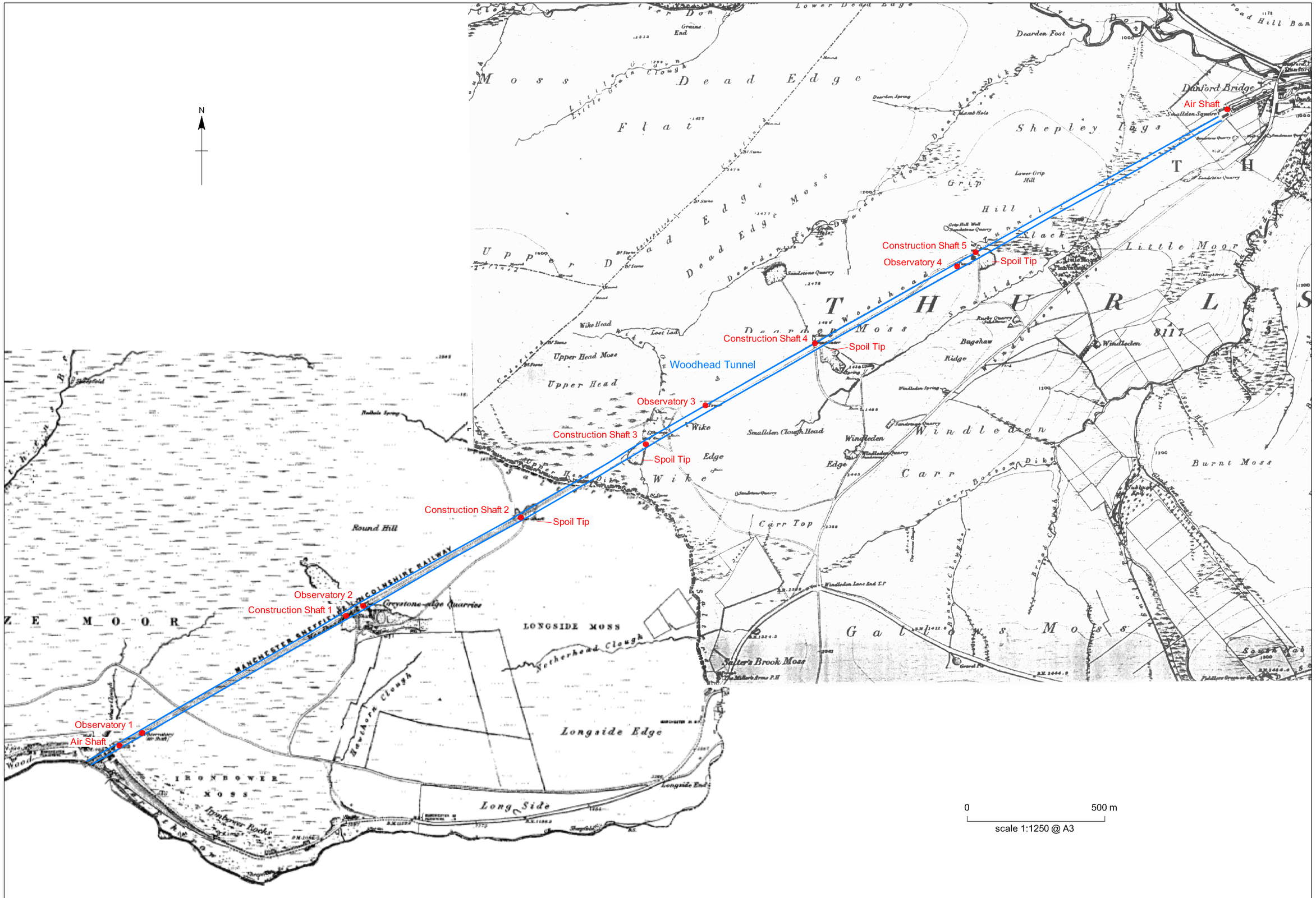
Woodhead Tunnel: site location *Figure 1*



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Woodhead Tunnel: 1st Edition Ordnance Survey maps (1855), Cheshire Sheet 5 and Yorkshire Sheet 280

Figure 2

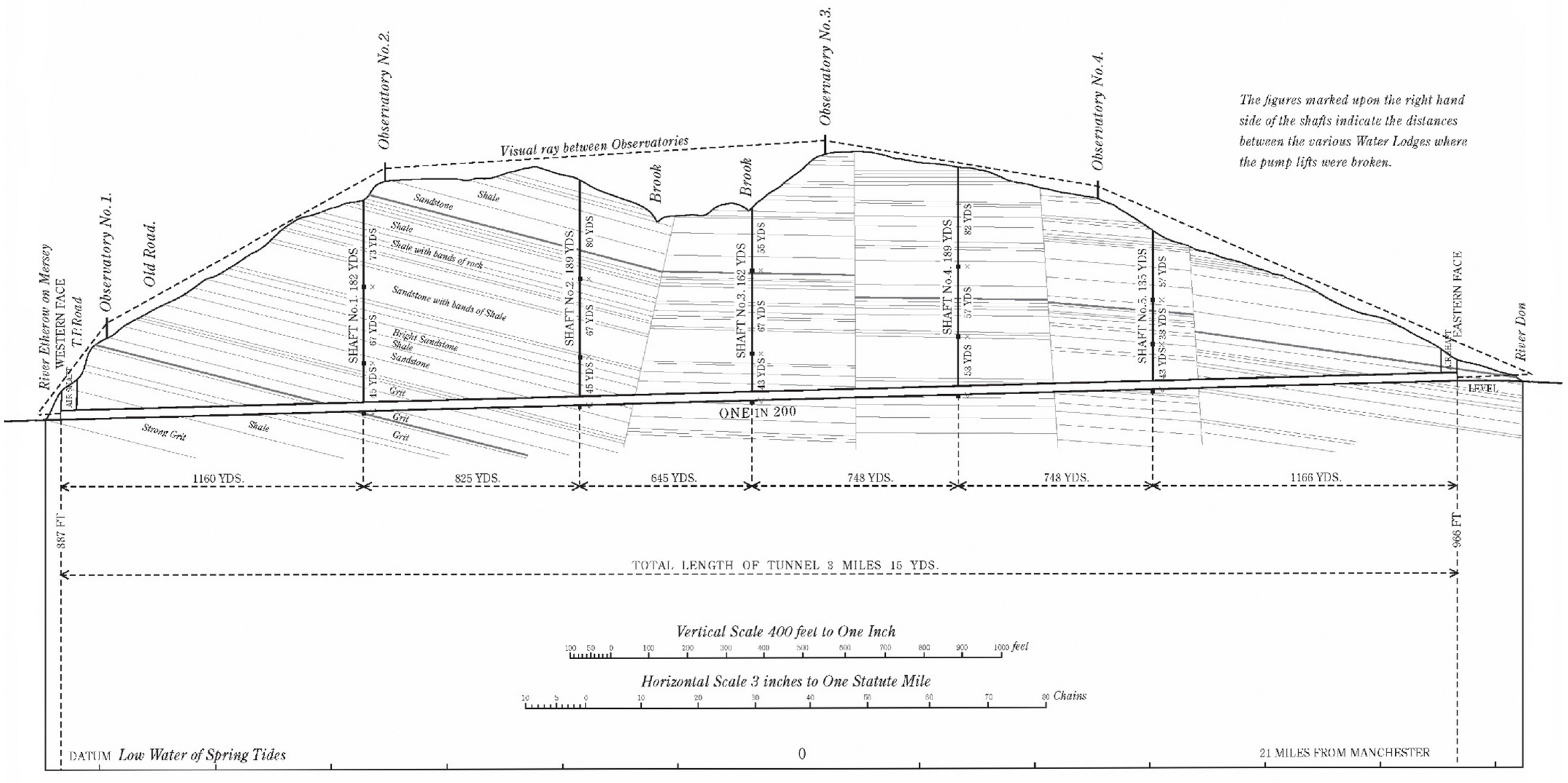
Reproduced from 'Trans. Ins. C.E. Ireland. Vol. III'.

SECTION OF THE SUMMIT ROCK AT WOODHEAD
ON THE LINE OF RAILWAY BETWEEN

MANCHESTER AND SHEFFIELD

SHOWING THE STRATIFICATION OF THE MEASURES PERFORATED AND
THEIR RELATION TO THE VARIOUS LINES OF THE TUNNEL, SHAFTS &C. 1839.

By W.A.Purdon C.E.



The figures marked upon the right hand side of the shafts indicate the distances between the various Water Lodges where the pump lifts were broken.

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Woodhead Tunnel: section through Woodhead Tunnel

Figure 3