SKANSKA COSTAIN STRABAG Working in partnership with HS2

1MC03 Main Works – Contract Lot S1

Heritage Agreement Method Statement (HAMS) - Intrusive Site Investigations (Coring) at Camden Winding Vaults

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1 Introduction

1.1 Project context – Schedule 18: Listed buildings

1.1.1 Under the provisions of Clause 1 of Schedule 18 of the High Speed Rail (London – West Midlands) Act 2017, the requirement to obtain listed building consent for certain works to heritage assets affected is disapplied. It is replaced by a requirement for HS2 to enter into Heritage Agreements with local planning authorities and Historic England.

1.1.2 HS2 has entered into a Heritage Agreement with the London Borough of Camden and Historic England concerning the Schedule 18 listed buildings within the borough.

1.1.3 Clause 2.1 of the Heritage Agreement permits HS2 (or its contractor, in this case SCSjv) to undertake works to the listed structures in Schedule 18 subject to agreement of a Heritage Agreement Method Statement (HAMS) with the relevant local planning authority, in consultation with Historic England where required.

1.1.4 This HAMS relates to the Camden Incline Winding Engine House, a listed structure which is identified in Table 2 of Schedule 18. Works authorised by the HS2 Act are limited to alteration or extension works carried out in exercise of the powers under the Act, for heritage or monitoring purposes only.

1.2 Purpose

1.2.1 The Camden Incline Winding Engine House(referred to thereafter in this HAMS as the Camden Winding Vaults) is a Grade II* listed structure in the London Borough of Camden. A preliminary Ground Movement Assessment (GMA) of the Vaults has indicated a high (category 5) risk of settlement-related damage, caused by the boring of the HS2 tunnels beneath them. The high damage category predicted is mainly caused by the current assessment of the vaults, their geometry and load combinations (including train loads). The condition (assessed as poor) of the vaults relies on some assumptions used to develop upper and lower boundary scenarios. If the structure was in good condition and working with comfortable factor of safety for the train loads, it would have potentially accommodated the HS2 tunnels with minor movements and cracking and without the risk of loss of stability and strength.

1.2.2 In order to refine the assumptions and to understand more fully the structural nature and condition of the Vaults, and thus the potential impacts of the predicted settlement, it is necessary to carry out a programme of non-intrusive and intrusive investigations. The purpose of this HAMS is to set out details of the proposed investigations, to show why they are necessary for the long-term asset management of the listed structure, and that they will not harm unnecessarily the significance of the Vaults.

1.3 Scope

1.3.1 This HAMS covers the Winding Vaults and the immediately associated Coal and Horse Tunnels which are, for the purpose of this HAMS, considered to form part of the listed building (see Figure 9).[1]

1.3.2 The HAMS relates to the proposal for non-intrusive and intrusive investigative surveys which are required to understand the structural make-up and condition of the vaults, to assist in the development of proposals for monitoring and mitigation of the predicted settlement that will occur when the tunnel-boring machines (TBMs) pass below.

1.3.3 Further HAMS will be produced to cover the monitoring and mitigation works.

1.4 Engagement

1.4.1 Pre-submission consultation with the London Borough of Camden and Historic England on the intrusive survey proposals occurred on 31 January 2024. In many cases, Schedule 18 consent for investigative works are not required. However, in this case and given the Grade II* listing of the Vaults, the London Borough of Camden Senior Planner advised that a HAMS for the proposals should be submitted for Schedule 18 consent.

1.4.2 Advice received from the Camden conservation team on the proposals has informed the methodology for the survey works and the content of this HAMS.

1.5 Assumptions and limitations

1.5.1 Access to the Winding Vaults is limited and difficult, and conditions inside them are poor, so the GMAs and this report have had to rely on very brief visual inspection. In addition, although there are some older Network Rail reports and surveys, there are no up to date or detailed laser surveys. Historical drawings and plans are also limited and restricted in their coverage.

It is for this reason that the GMAs have erred on the side of caution in their assumptions. The purpose of these surveys is to provide a better understanding of the nature and condition of the Winding Vaults to enable assumption to be refined.

2 Definitions and abbreviations

Table 1 – List of abbreviations and definitions used in this document

Abbreviation	Definition
HAMS	Heritage Agreement Method Statement

[1] This is a conservative assumption, particularly in relation to the Horse Tunnel, which is not mentioned in the list description and was never functionally related to the Winding Vaults.

Abbreviation	Definition
GMA	Ground Movement Assessment
GPR	Ground Penetration Radar
DH	Design House
RBG	Robert Bird Group
SURF	Survey Request Form

3 Responsibilities

3.1 Management and design

3.1.1 HS2 is responsible for considering how harm to third party property assets can be avoided or minimised in advance of tunnel construction and is making arrangements for appropriate surveys, monitoring and remedial works in advance of, during or following construction.

3.1.2 Asset Protection activities within each SCS contract area are the responsibility of the SCSjv Area Technical Lead, supported by the Asset Protection core team, including the SCSjv Heritage Technical Lead.

3.1.3 Technical design specialists provide additional support:

- GMA by Design House - Phase 3 Ground Movement Assessment Report - Network Rail Assets Camden Winding Vault - Euston Tunnels S1 - 1MC03-SCJ_SDH-GT-REP-SS02_SL01-000076
- GMA by RBG - Phase 3 Ground Movement Assessment Report – Network Rail Assets Camden Winding Vault and Horse Tunnel - 1MC03-SCJ_RBG-ST-REP-SS02_SL01-000005
- Survey Request Form – Camden Winding Vaults Building Intrusive Structural Survey – Euston Tunnels S1 (1MC03-SDH-GT-FRM-SS02_SL01-000001) prepared by Design House
- Survey Request Form – Camden Winding Vaults Building Intrusive Structural Survey – Euston Tunnels S1 (1MC03-SCJ ABX-FRM-SS02-Sl01-000001) prepared by Alan Baxter Ltd

4 Understanding the asset: Camden Winding Vaults

4.1 Introduction

4.1.1 The Camden Winding Vaults are located beneath the current West Coast Mainline, to the north of Fitzroy Bridge which carries the railway over the Regents Canal. The large brick vaulted underground structure was built to house two winding engines and associated equipment, used to haul trains up Camden Bank from Euston by means of a continuous rope. The system was originally planned to serve two tracks for the Great Western Railway (GWR) and two for the London and Birmingham Railway (LBR), however in the event the GWR terminated at Paddington rather than Euston and thus the former was never used. The winding engines only operated from 1837 to 1844.

4.1.2 Virtually all above ground evidence of the vaults along with the engines and associated equipment have been removed, however the underground vaults were first listed at Grade II in 1990, upgraded later to Grade II* status in 2007. The remaining structures are within the ownership of Network Rail.

4.2 Summary History

Development of the London and Birmingham Railway

4.2.1 In September 1830 the firm George Stephenson & Son were commissioned to conduct initial work for a new line to obtain an Act of Parliament. Robert Stephenson (1803-1859) took charge of the project, becoming Engineer-in-Chief.

4.2.2 The obtained Act authorised the construction of a railway from Birmingham as far as Camden, on the north bank of the Regent's Canal and close to the recently-created Regents Park.

4.2.3 An extension from Camden to Euston was authorised by a second Act of July 1835, enabling the line to terminate at a new passenger station on the Euston Road.

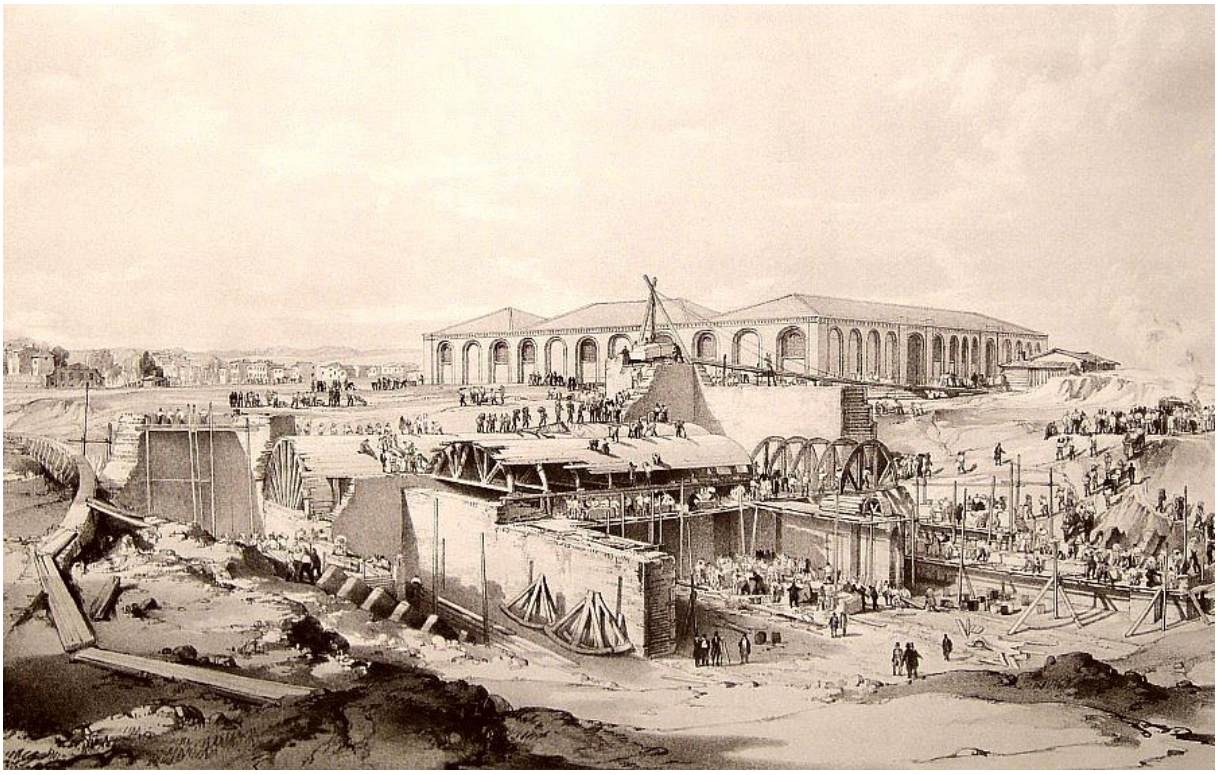
The Euston Extension and Camden Incline System

4.2.4 To minimise visual impact to the nearby, newly developed residential areas, the railway was sunk into a cutting, necessitating the excavation of London clay and building of large retaining walls.

4.2.5 The building of a steeply graded railway line was unavoidable. To avoid noise and pollution from locomotives assisted engines, Stephenson provided a rope-worked incline system powered by stationary steam engines. A model for this was the system by George Stephenson for the incline from Edge Hill to Liverpool's Lime Street passenger terminus.

4.2.6 Whilst at the Edge Hill summit the engines were housed in a pair of prominent buildings near the passenger station, with drive machinery contained in sunken stone vaults, at Camden both engines and machinery were housed in brick vaults below track level, flanked by open-topped boiler enclosures (Fig.1).

Figure 1 - Building the Stationary Engine House, Camden Town, J C Bourne

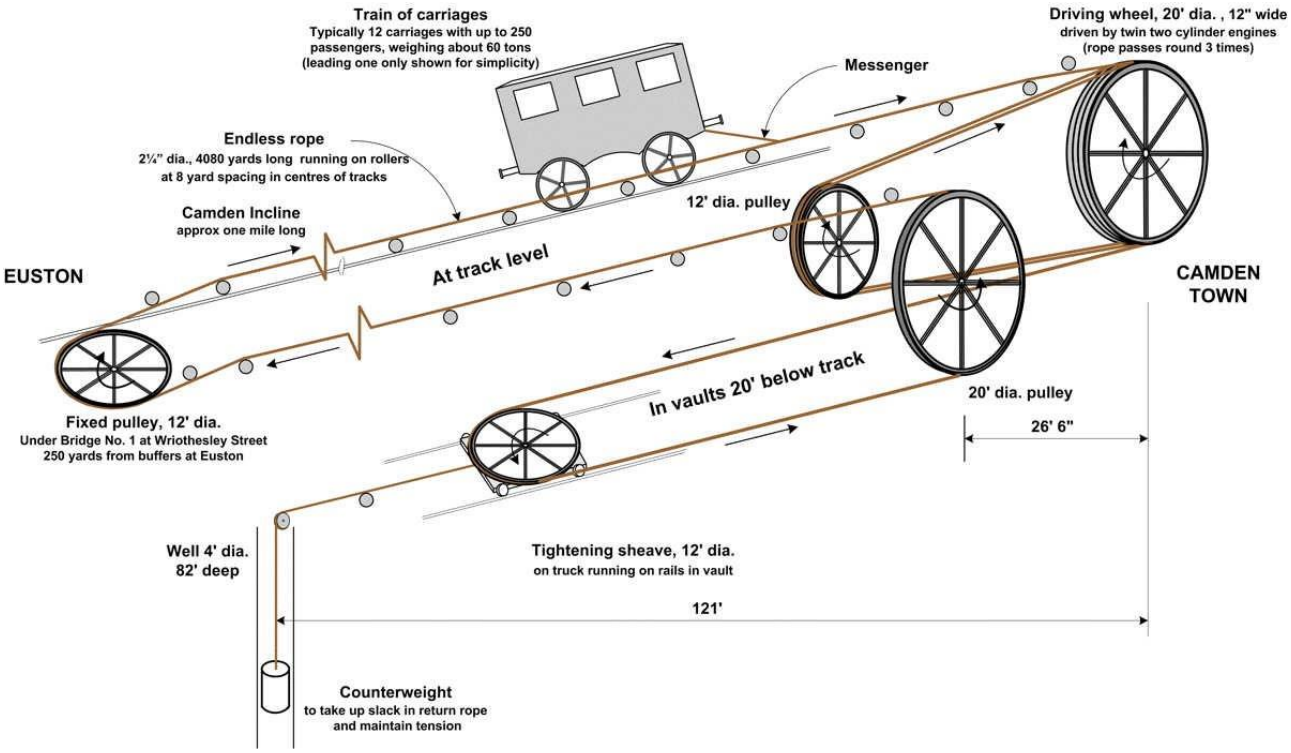


4.2.7 The core of incline operation was the continuous rope, resting on a line of iron sheaves (rollers) placed at intervals between the rails. At the top the rope passed round a driving wheel powered by the engine, returning around a free wheel at the bottom, held in tension by a third, sliding wheel, mounted on rails set at right angles to the rope, with a counterweight immersed in water (Fig.2).

4.2.8 At the foot of the incline, outward trains were attached by a short rope tied onto the main rope, which was hooked over the coupling hook of the first vehicle. A signal was sent via pneumatic telegraph to trigger operation which took around 3½ to 5 minutes depending on the weight of the train. At the top, the messenger rope was cast off, allowing the train to coast clear of the incline before being united with its locomotive.

4.2.9 Incoming trains would stop short of the incline head for their locomotive to be detached. before being propelled over the incline, the pace controlled by a brakeman and van.

Figure 2 - The Winding mechanism (Peter Darley, 2013)



The Design and Layout of the Vaults

4.2.10 The two winding vaults were conceived as operating independently for the LBR and GWR but were symmetrical in layout.

4.2.11 Steam power was produced by a pair of boilers located in open-topped pits on the eastern and western side of the vaults. Two 40m chimneys carried smoke far from the site (Fig.3).

4.2.12 Between the two boiler pits lay the brick vaults, accessed from steps leading down between the two pairs of railway tracks (Fig.4). The largest area within the vaults was the 30 feet wide engine room between the boilers. A pair of engines was provided in the eastern half of the room only. These low pressure engines were coupled to the 6m diameter driving wheel.

4.2.13 Parallel to the engine room lay a second vault, subdivided into a central passageway and two sheave rooms, where other pulleys were located. To the south of this, the central passageway continued as a groin-vaulted corridor flanked by the 24m long tunnel-vaulted rooms housing the rope tensioning system. These were in turn flanked by a pair of tunnel-vaulted coal stores, with access into the boiler rooms.

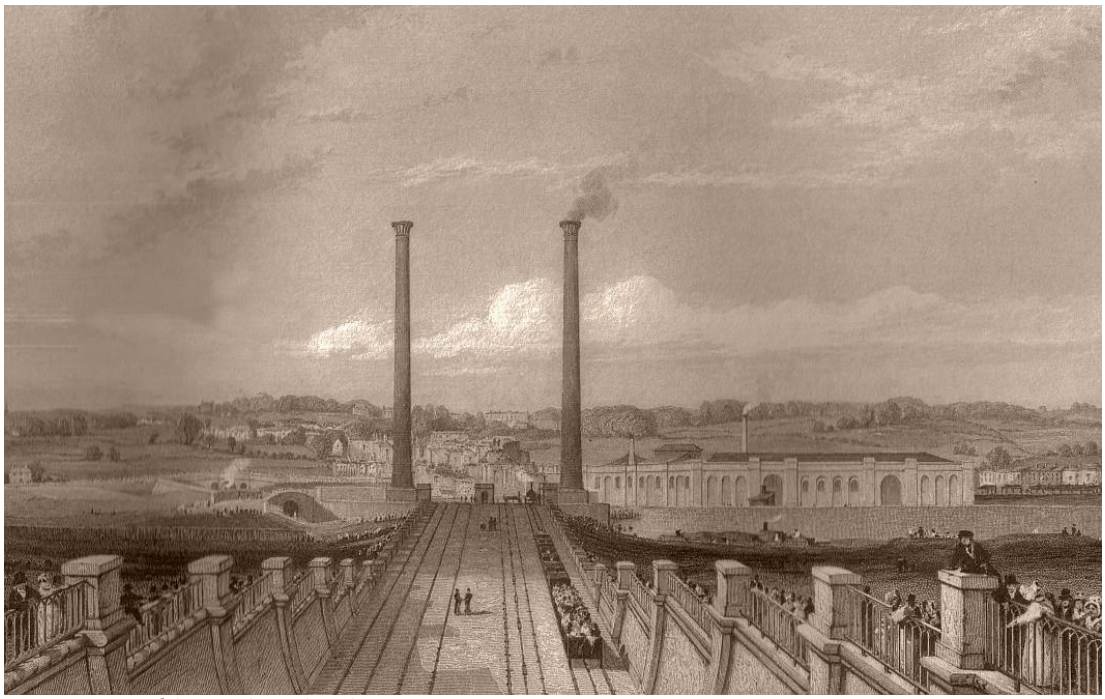


Figure 3 – View of the Camden Incline chimneys; J.C. Bourne

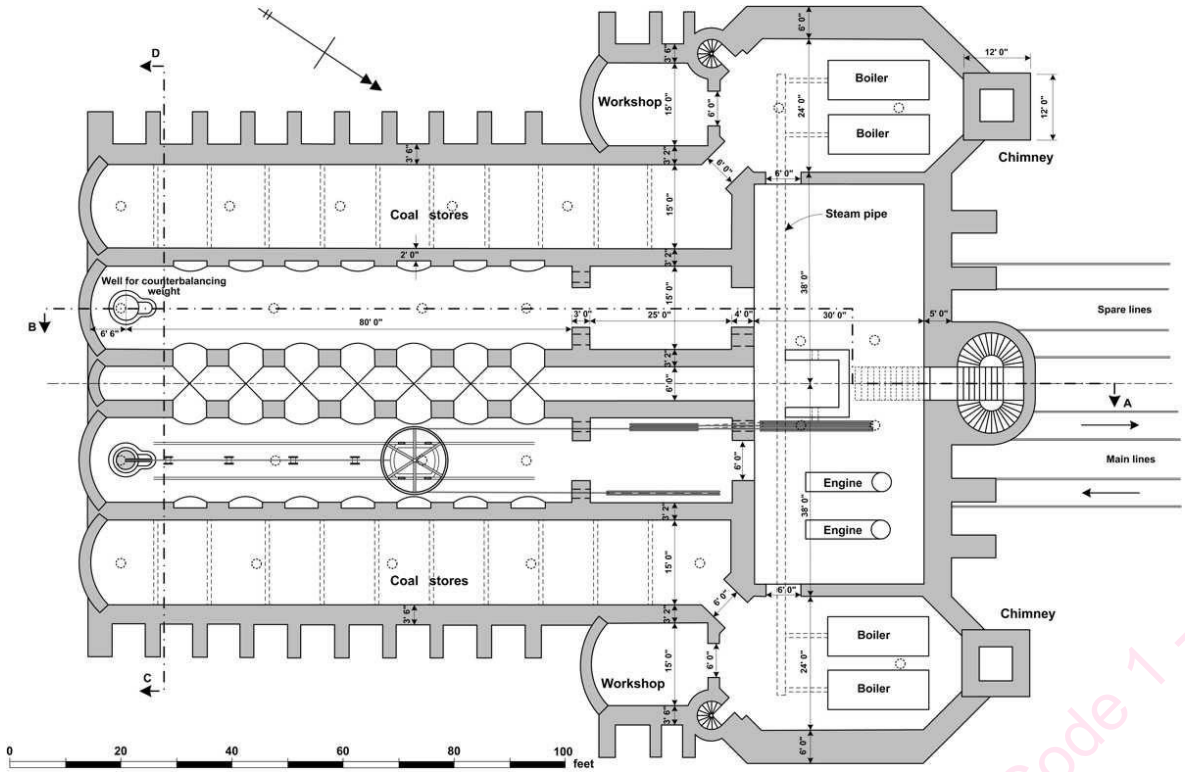


Figure 4 - Plan of stationary engine house (Peter Darley, 2013)

4.3 The Camden Winding Vaults post-construction

4.3.1 The first stage of the line was opened from Euston to Boxmoor on 20th July 1837, however the winding engines were not yet ready, so banking engines assisted trains up the incline.

4.3.2 Coal was shipped into London and transferred via the Regent's Canal to Camden. A buried passage was provided between the nearby Canal and Vaults, crossing the southern end of the coal vaults.

4.3.3 Horses also played a major role in railway operations at Camden, for example in transporting goods. Various sites were developed for stabling, including at Princess Road, and a brick-arched horse tunnel was constructed in the 1850's beneath the railway between the canal bridge and southern wall of the winding vaults.

4.3.4 The Camden rope system operated satisfactorily for a few years, however the advent of longer trains (which needed to be divided to be hauled by the rope), coupled with increased traffic, resulted in a bottleneck. Locomotive haulage with supplementary banking engines, gradually took over and the winding engines fell from use altogether in July 1844. The boilers, engines and drive equipment were removed and auctioned off in 1847. The chimneys were demolished in 1849 and shallow roofs were built over the two boiler enclosures.

Figure 5 – OS Map showing the location of the below ground Camden Winding Vaults. By kind permission of the National Library of Scotland

4.4 Description

4.4.1 The Camden Winding Vault is located directly beneath the West Coast Mainline and is a semi-subterrain structure, partially cut into the ground and partially elevated to form the approach to the Fitzroy Bridge over the canal.

Figure 6 – Aerial View of the site with the location of the Camden Winding Vaults and associated structures

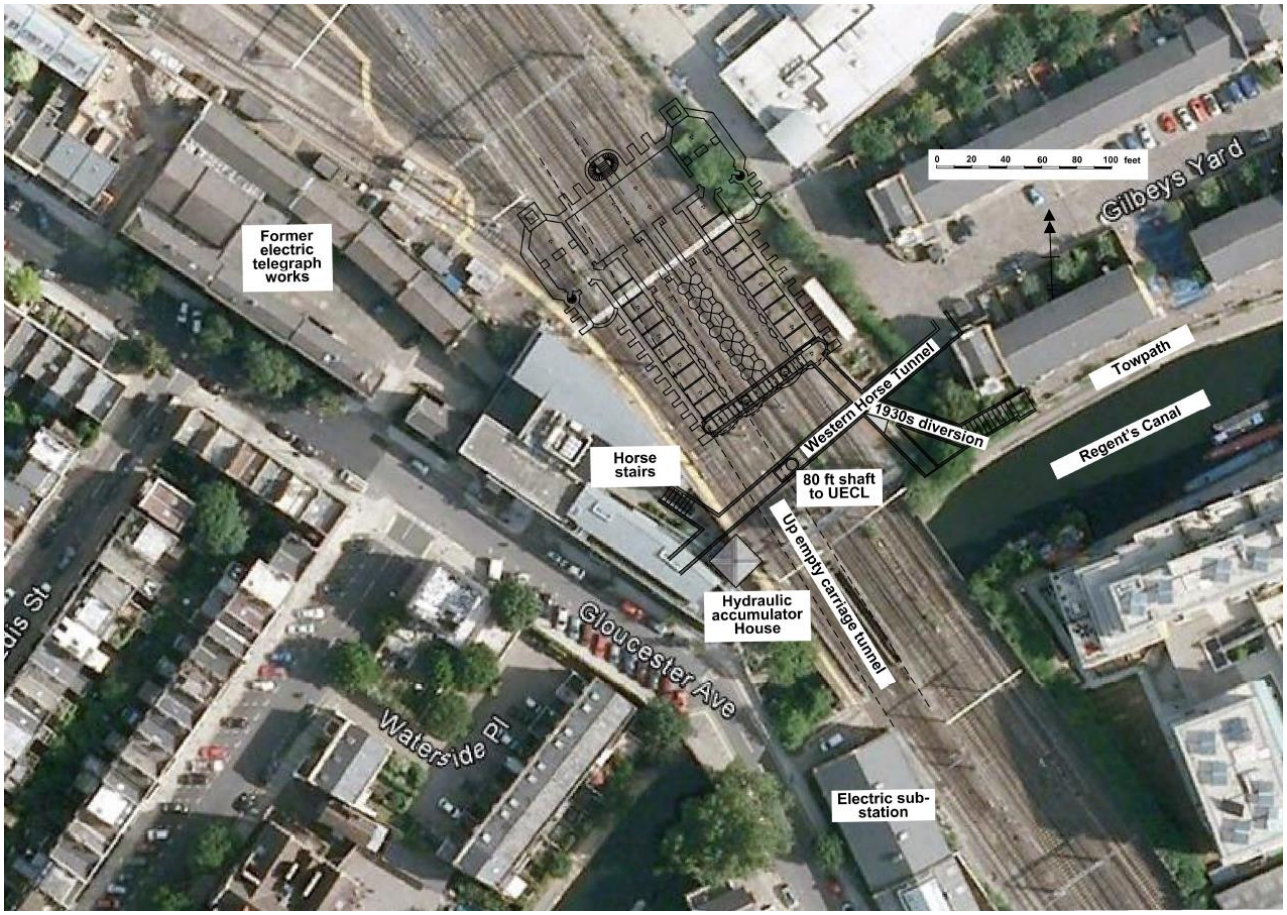


Figure 7 – Aerial View of the site with the location of the Camden Winding Vaults and associated structures

4.4.2 Although the surface chimneys and signal cabin have been demolished, the Vaults survive virtually intact.

4.4.3 This includes the following elements:

- The engine room (21.5 x 8.5m) the arched vault of which spans across the line of the railway. Access to the Vaults from the signal cabin was via a staircase in the northern wall.
- Two flanking boiler rooms (7m x 12.75m), with attached workshops. The boiler rooms contained small spiral staircases and were originally open to the sky, but were vaulted over in the 1850s. The vault of the eastern boiler room has partially collapsed.
- South of the engine room/boiler rooms, five long parallel spaces running parallel to the railway above. These comprise:

- A central groin vaulted corridor (30m x 2m), flanked by and connected by arches to:
- Two tensioning rooms, with semicircular arched vaults (30m x 4.5m). Beyond them:
- Two coal stores, also with semi-circular arched vaults (30m x 4.5m). Approximately 3m above the floor level of each is a series of wrought iron beams which may have allowed coal trucks to be emptied along the full length of the stores.

- At the southern end of the complex is a cross corridor, which contained the counterweight wells.

Figure 8 – The vaults of the coal stores with the wrought-iron beams across the vault

4.4.4 Further to the south and adjacent to the canal, the Vaults link into the Coal Tunnel and the Horse Tunnel. The latter contains a vertical connection to the Up Empty Tunnel below.

4.4.5 The entire structure is built of mass brick masonry. The ceilings are arched or vaulted whilst the floor comprises a series of inverted arches. The walls to the north, east and west were substantially buttressed.

4.4.6 Today, the unused Vaults are subject to regular flooding.

Figure 9 – Flooding in the tunnel-vaulted former tensioning room

4.5 Designations

4.5.1 The Camden Winding Vaults (Camden Incline Winding Engine House) were first listed at Grade II in 1990; but upgraded to Grade II* in 2007 (NHLE No.1342073).

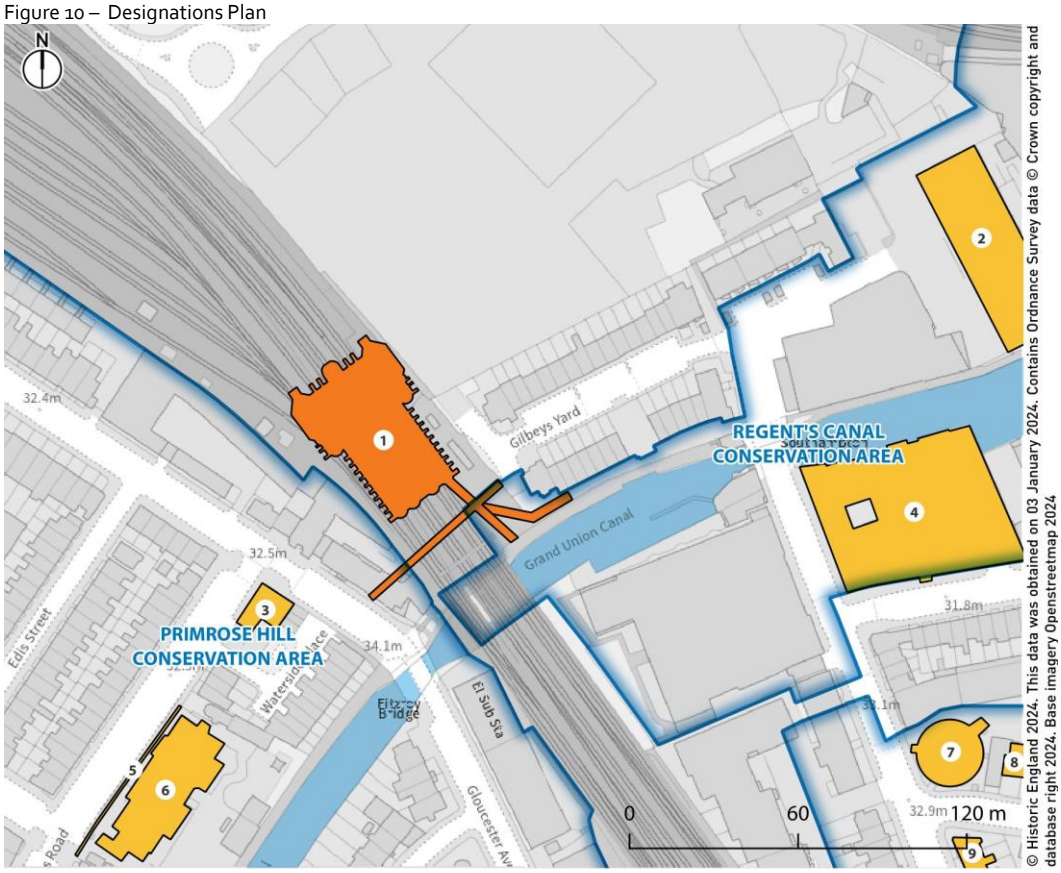
4.5.2 The Vaults are not contained within a Conservation Area, although Primrose Conservation Area lies immediately to the south-east of the site, and the Regents Canal Conservation Area to the south-west.

4.5.3 There are number of Grade II designated properties in the immediate vicinity of the Camden Winding Vaults including: the Piano Factory Building of 1894; Primrose Hill Infant School, a former Board School of 1885; and the former Gilbey House factory, offices and stores (at Nos.24,25 & 26 Oval Road and Nos.38-46 (even) Jamestown Road); all listed at Grade II.

4.5.4 There are also several other listed structures in the area associated with early railway heritage including the Grade II* listed Roundhouse, Primrose Hill Tunnels and Horse Hospital at Stables Yard. Nearby Grade II listed structures include the Engineer Public House, Stanley Sidings, Stables eats of Bonded Warehouse.

4.5.5 A Designation Plan is included below (Fig.9). Although not mentioned in the Camden Winding Vaults listing description, the Horse Tunnels have been included on the plan for clarity.

Figure 10 – Designations Plan



Listed building
Grade II
Grade II*

Conservation areas
Conservation areas

1 CAMDEN INCLINE WINDING ENGINE HOUSE
2 THE INTERCHANGE ON NORTH SIDE OF GRAND UNION CANAL INCLUDING THE HORSE TUNNEL AND STAIRS, VAULTS AND CANAL BASIN
3 THE ENGINEER PUBLIC HOUSE AND ATTACHED WALL
4 24, 26 AND 28, OVAL ROAD (See details for further address information)
5 PLAYGROUND WALLS, RAILINGS AND GATES TO PRIMROSE HILL INFANTS SCHOOL
6 PRIMROSE HILL INFANTS SCHOOL
7 PIANO FACTORY BUILDING
8 36 TO 41, GLOUCESTER CRESCENT
9 2-10, OVAL ROAD AND ATTACHED RAILINGS

4.6 Assessment of significance

Methodology

4.6.1 The *National Planning Policy Framework* (*NPPF*, 2023) places the concept of significance at the heart of the planning process. Annex 2 of the *NPPF* defines Significance (for heritage policy) as: *the value of a heritage asset to this and future generations because of its heritage interest. The interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting.*

Summary Statement

4.6.2 The Camden Winding Vaults possess historic interest as a material record of Britain's early railway history. This is reflected in their listing designation, upgraded to Grade II* in 2010.

4.6.3 The Vaults are of international importance as a rare, and mostly intact surviving engineering feature of the London and Birmingham Railway, the first of all modern main line railways to London (1833-8). As a largely intact structure, the Vaults provide evidence of one of the last uses of rope haulage on a public railway and represent a relatively brief transitional stage in the technological development of railway transportation. Additionally, the winding system is of interest as it was used to solve a topographical and structural need specific to this period of technology and location.

4.6.4 The structure of the Camden Winding Vaults is also of architectural and engineering interest due to the unique design and scale of its semi-underground brick construction. All elements of the overall structure were erected during one phase of construction and possess engineering interest.

4.6.5 The roofing added to the boiler pit enclosures around 1850 is of lesser significance as a later addition. Twentieth-century localised strengthening has altered the Vault's relatively intact appearance but have been necessary for the structure's survival. These structural additions are therefore of neutral significance.

4.6.6 The coal tunnel, which facilitated the supply of coal, transported via the Regents Canal, is of some historical interest for its functional connection to the Winding Vaults. The Horse Tunnels, equally possess historic interest as evidence of the importance of horses to the operation of early railways.

4.6.7 Within their local context, the Vaults also possess group value with nearby and associated London to Birmingham Railway structures. These include the Primrose Hill Tunnels (Eastern portals) and the Roundhouse, Chalk Farm Road which are similarly listed at Grade II*. Since the closure of the winding operations, the relationship between these structures, and indeed the individual elements of the Winding Vaults, have been somewhat diminished. This is also in part due to the considerable changes and development within the immediate setting of these assets.

5 Asset Protection – design rationale for intrusive structural surveys

5.1 Ground Movement and Structural Assessment reports

The locations of the proposed surveys and investigation works (including the intrusive cores) which form part of the Survey Request Form (SURF) were originally defined following the results of the Ground Movement Assessment (GMA) and structural assessment initially carried out by Design House (DH). They based their work on a series of assumptions, such as the extent of potential delamination of the barrel vaults. The investigations scope is to confirm some of the assumptions. Robert Bird Group (RBG) subsequently validated DH's GMA, and refined the GMA to account for the interaction between the ground and the structures, removing some limitations and conservatism associated with the original DH GMA. However this did not remove the need for the investigations to confirm some of the structural parameters and assumptions. The investigations have therefore been specified in the revised SURF which included the surveys described in section 5.2. The locations of the intrusive cores have been informed by the GMAs and mainly focus on the areas predicted to experience the more significant ground movement arising from the HS2 tunnels.

5.2 Description of the surveys

5.2.1 The non-intrusive and intrusive structural survey is needed in order to determine:

- The depth of the brick barrel of the masonry arches
- The extent of delamination in the masonry arches
- Masonry density type and properties
- Mortar composition and properties
- The extent and composition of barrel backfill material

5.2.2 Understanding of these properties will enable confirmation of the building parameters to allow a better informed structural assessment of the potential impacts of tunnelling-related settlement on the Vaults.

5.2.3 The following surveys are proposed:

- Ground penetration radar survey of arch barrels of the main Vaults and the Horse Tunnel
- Horizontal and diagonal cores through the brickwork
- Localised investigation of wrought iron ties

- Hammer tapping inspection of barrel vaults

5.2.4 The selected contractor is to have experience in conducting similar surveys on sensitive listed structures. Details of works related to access, safety and use of powered equipment will be detailed in the sub-contractor

5.3 Survey Methodology

Ground penetration radar

5.3.1 GPR survey will be carried out along the axis of the arch barrel for all vaults, as shown in Figure 10 . Where there is evidence for delamination in other areas, additional GPR survey will be carried out in those locations. In addition, there will be local scanning of the bottom floor vaults in two locations, to be defined once the vaults are cleared from the current water and muck.

5.3.2 The GPR survey is intended to:

- Confirm the thickness of the arch barrel in each vault scanned
- Allow an estimation of the extent of delamination (voids) between the individual arch rings which make up the barrels
- Confirm the depth and extent of backfill material, and identify its likely type
- Confirm the thickness of the bottom vaults
- Confirm the areas to be targeted for the intrusive surveys.

Intrusive surveys: cores

5.3.3 Intrusive surveys, principally in the form of cores, are required to confirm and refine the findings of the GPR survey. Specifically, the cores will:

- Confirm the thickness of the arch barrel, and investigate if there is evidence of delamination between the arch rings
- Confirm the composition of the backfill material and how it is bonded to the arch barrel
- Confirm the depth and extent of backfill material
- Confirm the consistency of the type (including bond type), quality and general condition of brick and mortar throughout the Camden Winding Vaults
- Enable masonry testing of density

- Obtain mortar samples for testing to confirm the composition of the mortar

5.3.4 See Figure 11 for the proposed locations of the cores, which are generally located along the western part of the structure, where predicted settlements are greatest. Their exact location will be defined on the basis of information on areas of potential weakness identified by the GPR survey.

5.3.5 The number and diameter of cores is considered to be the minimum needed to obtain valid results.

5.3.6 Two types of cores will be carried out:

- Horizontal cores through the brick work of the vaults. 8no. of these cores will be 25mm in diameter. 10no. will be 100mm in diameter, which is a reduction from the 36no. previously proposed.
- Diagonal and vertical cores through the brick vaults and the backfill above. 33no. 25mm cores will be drilled, 18no. diagonally and 15no. vertically.
- An allowance has been made for 3no. vertical cores in the bottom floor vaults, if GPR results suggest a need for further investigation.

5.3.7 The 100mm cores will be extracted as cores for physical analysis. The 25mm holes will be examined using a borescope.

5.3.8 All core holes will be backfilled using C20 repair mortar or concrete, with the mix design and method statement to be reviewed by Alan Baxter.

5.3.9 The 25mm cores will be located at surface brick joints to minimise the damage to facing brickwork, and thus visual impact of the holes. To minimise the visual impact of the larger, 100mm cores, the surface brick may be removed to allow the coring. Following backfilling, the surface brick will be refitted using hydraulic lime mortar (NHL2), colour matched to the existing mortar, so there will be no visual impact.

5.3.10 An allowance has also been made to investigate the connection of the wrought iron ties in the coal vaults to the masonry in 8no. locations (see Figure 11). This will only involve (limited) intrusive investigation if there are signs of decay or weakness.

Other non-intrusive surveys

5.3.11 There will be localised hammer tapping inspection of all vaults.

Figure 11- indicative cross sections for the GPR survey indicated by a dashed red line.

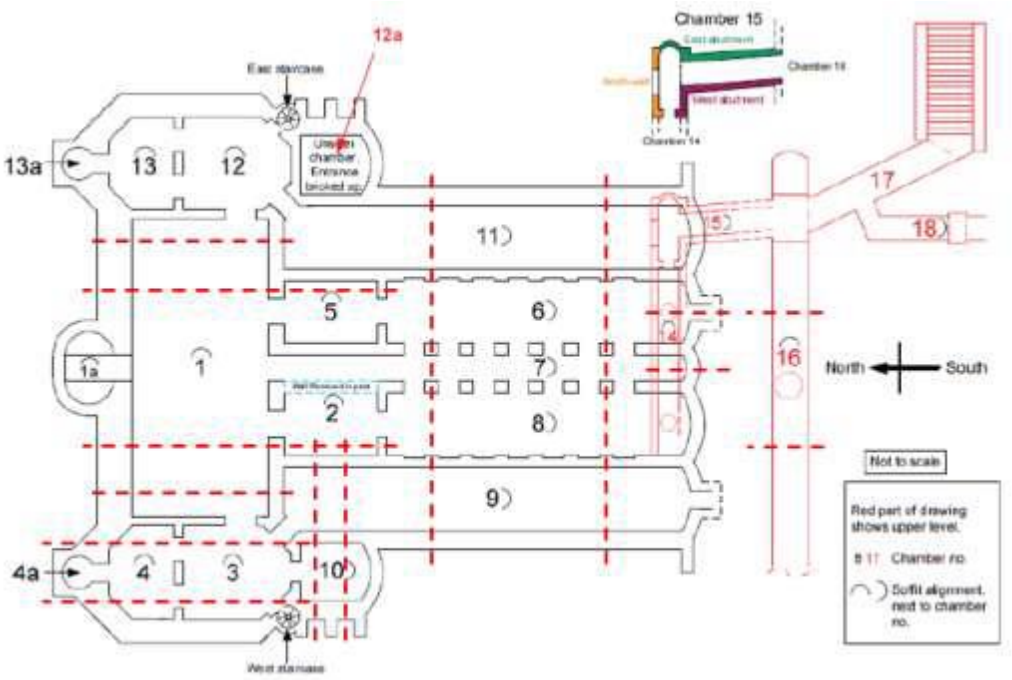
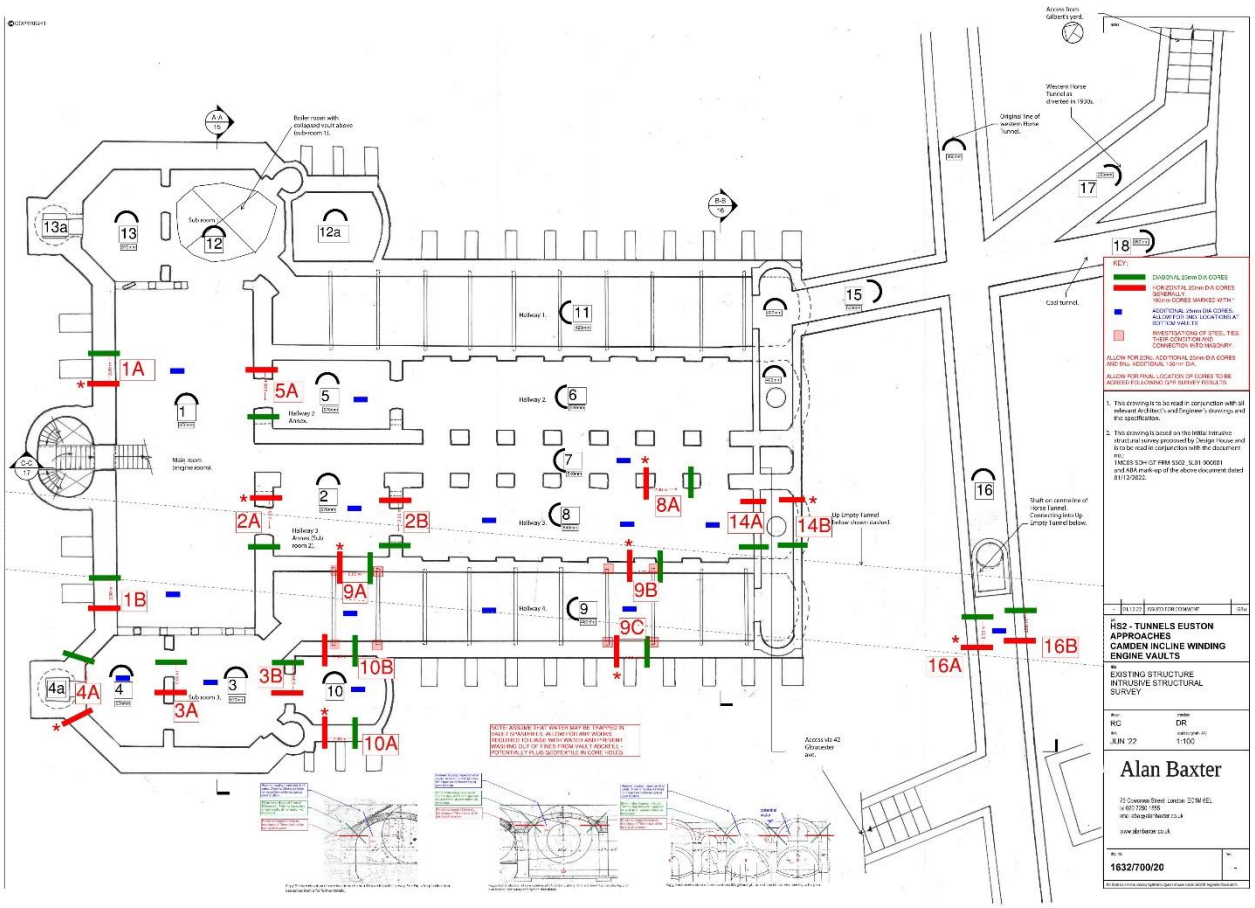


Figure 12 – Proposed locations of intrusive surveys



6 Heritage Impact Assessment

6.1.1 As set out in section 4.8 above, the Camden Winding Vaults are of the highest significance, reflected in their Grade II* listing. This significance, which is architectural and historic, relates to all elements of the original vaults, as well – to a less extent – to the Horse tunnels.

6.1.2 The surveys, both non-intrusive and intrusive, are considered to be necessary to better understand the construction and structural condition of the Winding Vaults, so that there can be a more accurate understanding of how they may react to the settlement which is likely to occur during the tunnel boring process. This in turn will enable the design of an appropriate level of monitoring and mitigation measures to minimise the long-term impact to the significance of the Winding Vaults.

6.1.3 The surveys, particularly the coring, are considered to be the minimum needed to gain the necessary understanding. The number of 100mm cores has been reduced from the 36 initially identified, to 9 in order to further reduce impact to historic fabric.

6.1.4 The process of coring will inevitably lead to some minor loss of historic fabric. However, given the minute scale of these openings, particularly in the context of the total structure, the level of harm is considered to be negligible. In visual terms, any harm from the 25mm cores has been further mitigated by their location, targeting joints which minimise damage to facing bricks. For the 100mm cores, the removal and post-coring replacement of the facing brick will result in no visual harm to the structure.

6.1.5 As all the survey works are internal, there will be to impact to the setting of any adjacent heritage assets.

6.1.6 In summary, the negligible harm of the intrusive surveys to the Grade II* Winding Vaults has been reduced to the absolute minimum necessary to design appropriate monitoring and mitigation measures that will address the potential impacts of tunnelling-related settlement. The proposed works are therefore considered both appropriate and justifiable, given the long-term benefits and structural stability that will be ensured to the listed site.

7 References

Table 2 -

Title	Reference
Camden Winding Vaults: Conservation Management Plan	(Network Rail, 2014)
Francis Whishaw, *The Railways of Great Britain & Ireland*	(David & Charles, 1969 reprint of 2nd edition 1842)
Peter Darley, *Camden Goods Station Though Time*	(Amberley Publishing, 2013)

8 Appendices

8.1 Listing Description

Official list entry

Heritage Category:	**Listed Building**
Grade:	**II***
List Entry Number:	**1342073**
Date first listed:	**18-Jun-1990**
List Entry Name:	**CAMDEN INCLINE WINDING ENGINE HOUSE**
Statutory Address 1:	**CAMDEN INCLINE WINDING ENGINE HOUSE, GLOUCESTER AVENUE**

Location

Statutory Address:	**CAMDEN INCLINE WINDING ENGINE HOUSE, GLOUCESTER AVENUE**

The building or site itself may lie within the boundary of more than one authority.

County:	**Greater London Authority**
District:	**Camden (London Borough)**
Parish:	**Non Civil Parish**
National Grid Reference:	**TQ 28370 84035**

Details

798-1/64/556 GLOUCESTER AVENUE 18-JUN-1990 CAMDEN INCLINE WINDING ENGINE HOUSE

II*

Winding engine house, now railway vaults. 1837. By Robert Stephenson for the London and Birmingham Railway.

DESCRIPTION: The engine house, built of brick to a symmetrical plan, consists of four parallel vaulted underground chambers beneath the railway track, each approximately 35m long by 4.5m wide and 7m

high, with a 2m wide central passage between the two inner vaults with seven arched openings into the main chambers with groined vaulting. At the north-west end the parallel vaults connect two transverse vaults. The larger, approximately 23m long by 9m wide and 5.5m high, housed the twin 60 horse power condensing engines and 20 foot diameter drive wheel. Directly to the south-east, the smaller transverse vault originally housed parts of the winding mechanism consisting of two pulley wheels (of 20 and 12 foot diameter) with the drive rope emerging via the south-east vault and re-entering through the north-east. The engine chamber is flanked by two boiler chambers with workshops attached to the south-east and the bases of the demolished chimneys to the north-west. The boilers appear to have originally been housed in unvaulted pits (contemporary colliery boilers were often housed in the open for greater ventilation), surrounded on the surface by tall walls and either open to the sky or, possibly, with a flat roofed covering. The boiler chamber vaults probably date from the closure of the engine house and the vault to the north-eastern boiler chamber has partially collapsed.

The two central parallel vaults housed the rope tightening mechanism; they have wells at the south-east end for the counterweights which kept the ropes taught (now filled with debris) and a line of four circular openings in the crown of each vault, possibly to provide ventilation when the vaults were sealed in 1849. The outer vaults contained chambered coal stores. These have ten cast-iron beams across the vault, approximately 3m above floor level, and cast-iron brackets of unknown purpose fixed along the walls. All machinery has been removed.

The vaults were reached from track level by spiral stone stairs to the engine room, which have been damaged and infilled with rubble. These originally emerged in a small hut used by the operator who signalled for the engines to start on receipt of a pneumatic signal from Euston. There are also smaller extant spiral stairs to each boiler room. Coal was taken from the canal through a tunnel to the engine room (which was subsequently blocked off).

HISTORY: The London and Birmingham Railway (L&BR) was the first truly long distance passenger railway in the world, following the successful experiment of the shorter Liverpool and Manchester Railway in 1830, on which locomotive traction for passenger and goods traffic was demonstrated to be feasible. Engineered by Robert Stevenson (1803-1859), the L&BR received its first Act in 1833 with a terminus at Camden station. Subsequently, a site became available in Euston Square, and the company obtained an additional Act in July 1835 to extend the railway to the New Road, with Camden Depot subsequently used for goods traffic, including livestock. The first section of railway was opened from Euston to Boxmoor, near Hemel Hempstead, on 20 July 1837 and in October that year it was operational as far as Tring. The whole line from London to Birmingham was opened on 17th September 1838, becoming the first main line trunk railway with a London terminus.

Hilly terrain to the north of London posed an obstacle, and major excavations were required to bring the line through it, especially Primrose Hill tunnel and Primrose Hill cutting. Despite these works, the last mile of the line had to descend to Euston on an average gradient of 1 in 85. There is debate about the reason for the construction of the steam-powered winding engine to haul trains up the incline. It was either thought necessary over fears that it was too severe a gradient for railway's early locomotives to tackle, although they were used on similar gradients on the earlier Bolton and Leigh and Warrington and Newton railways, or alternatively it was due to opposition to locomotives from local interests.

Cable haulage using fixed engines had been used as early as 1803 on the otherwise horse-drawn Preston

and Walton Tramway, prior to the invention of the locomotive. Subsequently, the majority of early steam railways used fixed-engine cable haulage for steep gradients including the Stockton and Darlington (1825); Springwell Colliery Railway (Bowes Railway - 1825); Canterbury to Whitstable (1830); at Edge Hill on the Liverpool and Manchester; and the Cromford and High Peak (1831). The alternative reason for the use of rope haulage at Camden was given by Peter Lecount, an assistant L&BR engineer, in his 'History of the Railway connecting London and Birmingham' (1839) - "It is not because locomotives cannot draw a train of carriages up this incline that a fixed engine and endless rope are used, for they can and have done so, but because the Company are restricted, by their Act of Parliament, from running locomotive engines nearer London than Camden Town". The clause in the Act is thought to have been introduced by Lord Southampton, an important local landowner, who feared that smoke-belching locomotives would reduce property values. However, an accommodation was clearly soon reached as locomotives were in use on the incline from its opening in July 1837 until the winding engine came into operation in October of that year, and thereafter when the winding engine was out of action.

The steam-powered winding engine apparatus, hauling an endless rope to draw trains out of Euston, was established at the top of the incline, at Camden station, close to the Regents Canal. The engines were placed underground in a barrel-vaulted chamber. These consisted of two 60hp engines and associated boilers and winding machinery, supplied by the firm of Maudsley's of Westminster Bridge Road. Two chimneys, over 132ft (40m) tall, stood adjacent to the engine chambers, flanking the railway on either side. The rope was 3744 yards (3423.5m) long (claimed to be the longest unspliced rope on record), of 7 inches in circumference and weighed 11.5 tons; to keep it taught it was passed round a pulley on a moveable counterweighted carriage before emerging on the surface between the rails. The engines were supplied with coal via a tunnel which ran from the vaults to a dock on the Regent's Canal. Trains of up to 12 carriages were hauled up from Euston to Camden station (at a speed of between 15 and 20 miles per hour), where locomotives waited to take the trains onwards.

The construction of the London and Birmingham Railway was depicted by the artist John Cooke Bourne and published as lithographs in 1839. They include a view of the construction of the stationary engine house as it appeared in April 1837, with the walls partially completed and centering being erected for the vaults. This print has often been referred to as illustrative of the energy and large-scale enterprise of the early railway age.

The winding engine operation ceased in July 1844, after a debate in 1843 between the Company and Robert Stephenson as to their continuing viability. The Company decided that savings in time and money could be made by using larger locomotives on the incline, albeit with two locomotives usually required. Stephenson argued that the savings were minimal but he lost the argument and in 1847 the winding engines were sold and removed with the chimneys being demolished in 1849. The vaulted chambers survive underneath the modern electrified railway trackbed, and were listed at Grade II in 1990.

SOURCES Camden Railway Heritage Trust, Camden Railway Heritage Trail - Primrose Hill to Camden Lock and Chalk Farm (2009) Morriss, R, The Archaeology of Railways, Tempus (2003) Simmons, J and Biddle, G, The Oxford Companion to British Railway History (2003) Smith, D, Civil Engineering Heritage: London and the Thames Valley, London (2001) Royal Commission on the Historical Monuments of England - Historic Building Report on the Camden Incline Winding Engine House (1995)

REASONS FOR DESIGNATION: The Camden Incline Winding Engine House is designated at Grade II* for

the following principal reasons: * Historical and technological Interest: as a remarkable survival of international importance, of a notable engineering feature of the London and Birmingham Railway, the first of all modern main line railways to London (1833-8). The winding engine vaults represent, as one of the very last uses of rope haulage on a public railway, a relatively brief transitional stage in the technological development of railway transportation; * Architectural interest: for the grand scale and unique design of their underground brick construction; * Group value: with the nearby and associated London to Birmingham Railway structures of Primrose Hill tunnel and the Roundhouse, both listed at high grades.

Legacy

The contents of this record have been generated from a legacy data system.

Legacy System number: **477225**

Legacy System: **LBS**

Sources

Books and journals

Simmons, , Biddle, , The Oxford Companion to British Railway History, (1997)

Legal

This building is listed under the Planning (Listed Buildings and Conservation Areas) Act 1990 as amended for its special architectural or historic interest.