Historic England

EARLY RAILWAYS IN ENGLAND:
Review and summary of recent research

David Gwyn and Neil Cossons

Discovery, Innovation and Science in the Historic Environment

Research Report Series no. 25-2017

EARLY RAILWAYS IN ENGLAND

Review and summary of recent research

A study for Historic England

by

David Gwyn and Neil Cossons

February 2017

EARLY RAILWAYS: Review and Summary of Recent Research

Report by Dr David Gwyn (Govannon consultancy) and Sir Neil Cossons for Historic England

CONTENTS

Executive summary	ii
1 Terminology	1-2
2 Context	3-19
2.1 Introduction	
2.1 Background	
2.3 Stakeholders and consultees	
2.4 Literature review	
2.5 Conclusions	
3 Historical development	20-37
3.1 The early mine railway – 1553 to 1603-4	
3.2 The wooden waggonway – 1603-4 to 1770	
3.3 The early iron railway – 1770 to 1830	
3.4 The early railway's contribution to the Stephenson era – 1830 to 1840	
3.5 Conclusions	
4 Key features for assessment and potential designation	38-45
4.1 Policy and assumptions	
4.2 Attributes	
5 Discussion	46
6 Conclusions	47
7 World Heritage considerations	48-49
8 Recommendations	50
9 Consultation	51
10 Bibliography	52-58
Illustrations	59-62
Appendix 1: Currently designated sites	63-80
Appendix 2: Summary list of significant early railways	81-86
Appendix 3: Archaeological studies of early railways	87-90
Appendix 4: Artistic depictions of early railways	86-107

Front cover illustration: early 19th century water colour showing the Surrey Iron Railway crossing Chipstead Road. Source: Wikimedia commons

EXECUTIVE SUMMARY

Early railways in England – broadly, those of the pre-locomotive period – were numerous, geographically widespread and well developed. They made a significant contribution to the rise of the new industrial economy between 1700 and 1830. They were important in their own right and as precursors to the railway revolution of the second half of the 19th century.

Since 2000, early railways have benefitted from focussed research and debate through a series of international conferences – six in all – and the publication of the papers that have emanated from them.

The material evidence of early railways is more extensive and more significant than previously thought. Important elements of this evidence are held in museum collections.

This study, commissioned by Historic England, reviews the current literature and summarise the wider state of understanding of early railways with a view to recommending future research and publication and to offer guidance on potential designation. It is not intended to be exhaustive nor unduly prescriptive, more to offer a way forward that is practical and achievable.

The most important conclusion is that a wide-ranging survey of early railway heritage assets should be undertaken. This should embrace field evidence, documentary sources and collections held in museums. It could build on the existing corpus of knowledge and the expertise of those people already committed to the study of the history and archaeology of early railways.

The objectives has been to define and further refine our current understanding of early railways, identify the most significant material evidence and – in particular – those elements at risk; to offer guidance and set out priorities for future designation assessment; and to propose methodologies for achievement of these aims.

Our view is that the history and archaeology of early railways deserve more serious consideration than has hitherto been the case and we put forward practical proposals on how this can be achieved with the extensive involvement of volunteers under clear and co-ordinated management.

1 TERMINOLOGY

Counter-balance: a means of operating an *inclined plane* whereby the load travels downhill and descending vehicles are thereby enabled to haul empty vehicles uphill by means of a rope or chain passed around a wheel or drum at the summit, often in a *winding-house*

Edge railway: a form of *railway* where the support is provided by the rails and guidance by flanges on the wheels; these are most commonly located on the inside faces of the wheels but may be on the outside face or on both faces

Fixed engine or winding engine: a mechanical prime-mover, generally steam, which might turn machinery or provide traction *eg* by winding on an *inclined plane* (often situated in a *winding house*)

Flange: a raised rim on a vehicle wheel providing guidance for the vehicle on an *edge railway* track, the vertical part of a plate providing guidance on a *plateway*

Gauge: the distance between the rails; conventionally measured from the inside face of the rails on an *edge railway*, between the outsides of the flanges on a *plateway*

Inclined plane: a length of *railway* on a gradient too steep to be worked by *locomotive* or by animal traction, in which vehicles are moved by rope or chain, either on a *counter-balance* system or by a *fixed winding engine*

Locomotive: a self-propelling prime mover; on a *railway*, it provides traction to a *train*

Plateway: a form of *railway* in which both support and guidance are provided by the rails, generally flanged (L-section) cast-iron plates, though wrought-iron and steel plateways are known

Portage railway: a *railway* bypassing an un-navigable section of waterway or connecting two waterways.

Public railway: a *railway* built under a measure of public control such as an Act of Parliament, whether specifically authorising a railway or the construction of a tributary railway to a canal

Railway: a prepared track supporting a wheeled vehicle and where guidance is supplied by the interface between the track and the wheel

Rutway: a form of *railway* in which channels are cut in naturally-occurring bedrock to support and guide wheeled vehicles

Stoneway: a form of *railway* using prepared stone blocks, to support and guide wheeled vehicles

Strap-rails: a running surface of cast- or wrought-iron on wooden or stone rails

Technological diffusion: here used in the sense of the process by which innovations (new products, new processes or new management methods) spread within and across economies and jurisdictions

Train: two or more vehicles coupled together

Tram: here used for any vehicle running on a *plateway*

Vehicle: a word used here as a catch-all for any sort of wheeled item running on a *railway*

Waggonway (sometimes wagonway): an *early railway* making use of wooden rails

Winding house: a structure erected at the summit of an *inclined plane* to house a wheel or drum for rope-haulage and also for the *fixed engine* where this is used to provide traction.

Not used

Tramway: a loose term for various types of industrial and mineral *railways* as well as for early railways generally and for intra-urban passenger systems; only used in the present document in the case of *public railways* where it formed part of the official title.

Geographical Regions

The following are Historic England's definitions:

North-east of England:

● County Durham ● Northumberland ● Tees Valley ● Tyne and Wear ● Yorkshire

North-west of England:

● Cheshire ● Cumbria ● Greater Manchester ● Lancashire ● Merseyside

South-east of England:

● Berkshire ● Buckinghamshire ● East Sussex ● Hampshire ● Isle of Wight ● Kent ● Oxfordshire ● Surrey ● West Sussex

East of England:

● Bedfordshire ● Cambridgeshire ● Essex ● Hertfordshire ● Norfolk ● Suffolk

East Midlands

● Derbyshire ● Leicestershire ● Lincolnshire ● Northamptonshire ● Nottinghamshire ● Rutland

West Midlands:

● Herefordshire ● Shropshire ● Staffordshire ● Warwickshire ● Worcestershire ● conurbation from Coventry to Wolverhampton

South West:

● Bristol ● Cornwall ● Devon ● Dorset ● Gloucestershire ● Isles of Scilly ● Somerset ● Wiltshire

London

● the local authorities within Greater London

2 CONTEXT

2.1 Introduction

This document has been commissioned by Historic England in response to a perceived need to understand the nature and extent of features, structures and buildings associated with early railways in England.

It has been written, in the main as a desk exercise, by Dr David Gwyn MCIfA FSA and Sir Neil Cossons OBE FSA after extensive consultation with individuals and organisations relevant in the field. This study is based on their knowledge, understanding and opinions and should not be taken as reflecting the views or policies of the commissioning agency.

2.2 Background

In the broadest sense railways can be defined as prepared tracks that support a wheeled vehicle and where guidance is supplied by the interface between the track and the wheel. In this generic form they have a long pedigree, with their origins in classical antiquity.

The prepared track may be made of stone, wood, cast-iron, wrought-iron or steel. The guidance can be applied by the track itself – channels or flanges – or by the vehicles, in the form of wheel-flanges or guide-pins or rollers. In the modern railway the vehicle generally has flanged wheels which run on the upper edge of steel rails.

Categorising railways for the purposes of a document such as this is not easy, since issues arise from the retrospective assigning of titles to *types* of railways in ways which imply exclusivity and linear evolution instead of overlap and diversity – a railway can be 'early' in concept if not in time. With these reservations in mind, the following may be useful:

Early railways

The seminal change that led to the railway revolution of the 19th century was the application to pre-existing railways of the *steam locomotive engine* – *ie* a steam engine moving with the load or *train*. The locomotive engine developed rapidly from the early 1800s, achieving by the 1840s a general morphology that lasted until its extinction in the 1960s (Duffy 1982-1983; Bailey 2014). Its development was made possible by the maturing of the track into its essentially modern form by the 1840s, in order to enable trains to travel at greater speeds and with heavier loads.

In the most general sense the term *early railway* is used to define those railways that predate, in concept if not necessarily in time, the Stephenson-era locomotive-worked railways established in the 1830s. Defining a monument-type against something that it is not has its pitfalls, but *early railway* has proved a useful and generally understood means of analysing the railed systems that prevailed from Prehistory to 1830, both in England and elsewhere in the world. It is preferable to *pre-locomotive railway* because many railways built before 1830 did in fact use locomotives, often in conjunction with other forms of mechanical traction or with horses.

It is often assumed that early railways only served to connect extractive industries to navigable water. It is clear that long before 1830 many railways were carrying out different functions, for instance as portage railways, or connecting market towns, or as internal systems in manufactories, farms, mines and quarries, on military sites and on construction projects. In this sense, it was the benefits accruing from the reduced rolling resistance of a railed way that enabled these early railways to achieve success at a time when road travel, especially for heavy loads, was laborious and

subject to the effects of weather. Many hundreds of miles of railways were in use in England before the advent of the steam locomotive engine. The principles of some form of government control or sanction and of the carriage of fare-paying passengers on railways were also well established before 1830.

Main line railways

The railways that were built world-wide in emulation of the Liverpool & Manchester Railway from 1830 onwards have come to be known as *main line railways*, in that they increasingly came to connect cities, regions and jurisdictions. They typically used the steam locomotive engine as their prime mover for many years. Calling them *main line railways* does not obscure the fact that they also included secondary routes and branch lines. They are characterised by mechanical traction, the carriage of both goods and passengers, and some state regulation. In Britain and elsewhere private ownership prevailed though some form of state regulation is evident from early on and gradually increased. With notable exceptions, they soon adopted broadly compatible technologies over wide areas, offering inter-operability. For this a common track gauge was essential, 4' 8½" being a standard recognised in the 1840s and near-universal throughout England from 1892. In this sense railways developed into effective transport networks in the 19th century as had the inland waterways in England at the end of the 18th. However, the gauge is not relevant to this definition, since these systems have operated on gauges of between 7' 0¼" and 2'; nor is motive power, which may be steam, atmospheric, internal combustion or electric.

Industrial railways

Main line railways can be distinguished from another lineal descendant of early railways, namely *industrial railways* owned by, or exclusively serving, an industrial undertaking or undertakings, either as internal systems or to provide a link with another transport system. Many early railway practices survived on such systems, such as the use of rope haulage, but they were commonly also influenced by evolving main line practice. They sometimes used redundant main-line equipment, but were, and are otherwise distinctive in terms of their engineering and archaeology. It has been suggested that their total UK extent might have been hardly less than the track-miles of public railways by the beginning of the 20th century (Lewis 1999, 114).

This category might be distinguished from *contractors' railways* or *constructional railways* which were essentially temporary and used as needed to build, and sometimes then to maintain, sites such as canals, main-line railways, water-works or housing estates. It was the temporary nature of these railways used in railway construction that gave rise to the term *permanent way* meaning the standardised track of the established main line railway. Little evidence usually survives of these temporary contractors' railways although archaeology has revealed remains of the short-lived navvy settlements that frequently accompanied them.

Intra-urban tramways/street railways

These are systems designed to move people and occasionally goods along public roads within towns, typically worked by horse, steam or electricity. These occasionally extend out of towns along rural roads, but are largely outside the scope of this study.

Mention should also be made of:

Sub-surface urban railways

These are intra-urban railways deliberately built underground.

Military railways

These are railways built by the armed forces either to provide training facilities for soldiers, or to serve military, naval or air-force establishments, or as temporary systems in war-zones to supply arms and ammunition to the front line and to move personnel.

Estate, farm and institutional railways

Railways have been used to serve estates, farms and institutions such as hospitals. Some large houses used short railway systems to move coal or laundry.

Miniature railways

Miniature railways are built to resemble full-size systems in miniature to provide entertainment and enjoyment, generally within the context of the leisure industry, though there are also examples where the main purpose was to acculturate children to the idea of working on railways. There is some cross-over with the narrowest gauge industrial railways and main line railways.

Toy and model railways, locomotives and rolling stock

Though these might count as 'portable antiquities' rather than as monument types, they are relevant to the railway narrative as evidence of collective identification with this form of transport, and are particularly relevant to early railways, as early model locomotives are an important source of evidence for design evolution. A model built as a demonstration prototype for scientific assessment might also eventually become a child's plaything and then, when its significance is recognised, a museum item.

2.3 Stakeholders and consultees

Interest groups and interested individuals

Serious study of early railways in England has been driven mainly by individuals who have developed a personal expertise in the subject. This was true from the 1930s to the 1980s, when the leading figures were Loughnan Pendred (1870-1953), C.F. Dendy Marshall (1873-1945), Charles E. Lee (1901-1983) and Charles Ralph Clinker (1906-1983). It remains true today. Bennett, Clavering and Rounding speak for many who interest themselves in early railways when they say in the context of the Tyneside waggonway ' ... we do not look on the amateur local historian as representing a service industry for the benefit of the professional, straightening the beds before he does his rounds. Our long tradition has other virtues than a knowledge of local quirks and a heart in the right place' (Bennett, Clavering and Rounding 1990, 4-5).

Some interest-groups are not necessarily focused on railways at all. An example is the group of mine-explorers who have been studying the Elizabethan copper-mines in the Lake District with the active co-operation of site-owners and the National Park, whose activities led to the identification of the remains of the earliest known railway in England. Another is the Stover Canal Society, under whose auspices part of the Haytor granite railway has recently been excavated.

Social media

Several relevant groups have been established on social media. These include facebook's 'Haymotor Tramways, Plateways and Railways' (105 members at 5 February 2016), 'Industrial Railway &

Locomotive Appreciation Society' (1,600 members), 'Industrial Locomotive Enthusiasts' (1,818 members) (https://www.facebook.com, accessed 5 February 2016).

These suggest an active enthusiast interest and following that has not yet necessarily engaged with academic scholarship on the subject or with the series of Early Railways conferences (see below).

Learned societies

Newcomen Society

The Newcomen Society, founded in 1920, is the oldest society in the world specialising in the history of engineering and technology. It has included a number of papers on early railways in England and elsewhere in its *Transactions*, now *The International Journal for the History of Engineering and Technology*. Pendred, Dendy Marshall and Lee (see above) were all members.

Association for Industrial Archaeology

The Association for Industrial Archaeology, established in 1973, publishes *Industrial Archaeology Review*, a bi-annual peer-reviewed journal; this has provided an outlet particularly for developer-funded assessments where early railway remains have been discovered. A quarterly newsletter, *Industrial Archaeology News*, contains shorter articles, reviews and a calendar of events.

The Railway & Canal Historical Society

The Railway & Canal Historical Society was founded in 1954 to bring together those interested in the history of transport, with particular reference to British railways and waterways, and to promote historical research and raise the standard of published history. The *Journal of the Railway and Canal Historical Society* has been published since 1955. The Society also has a book-publishing programme, and supports an Early Railways Group which shares occasional papers among its members.

University-led research

Railway history has been taken less seriously as an academic study in England than in the United States where the dramatic role of the railroad in building and unifying the nation has long been recognised. Professor Jack Simmons (1915–2000) of the University of Leicester launched *The Journal of Transport History* in 1953 with Michael Robbins (1915-2002), a friend from school-days at Westminster who shared his life-long interest in railways. Both made a distinguished contribution to railway history and the wider impact of the railway on society, the economy and the landscape. Simmons published extensively on railway history, and spent much of his academic career demonstrating how railway technology interacts with national and local social and economic factors. He argued that the railway has been 'too much treated on its own, as a piece of mechanism, a device... No one has assigned (railways) their place in the general life of the age' (Simmons 1991, 11). Robbins delivered a lecture on similar lines to the Railway & Canal Historical Society entitled 'What kind of railway history do we want?' (Riden 2016). Railway geographers (eg Professor James Henry [Jay] Appleton [1919-2015]) and Professor John Allan Patmore [b 1931]) have noted the impact of railways on the landscape and their influence on the development of railway towns and seaside resorts as well as their profound effects in shaping urban morphology. However, the insights of these and other scholars have barely been applied to pre-1830s railways, other than Palmer and Neaverson 2002.

The first academic to take a serious interest in early railways was Dr Richard Smith (1914-?) of Nottingham University, who published an important study of the very first overland waggonways in England (Smith 1960).

However the academic torchbearer has undoubtedly been Dr Michael Lewis (b. 1938), a classically-trained archaeologist. Dr Lewis was elected to a Fellowship at Corpus Christi College, Cambridge on the basis of his work on Romano-British archaeology but devoted his time to writing *Early Wooden Railways* (published in 1970) before moving on to the University of Hull's Department of Adult Education. *Early Wooden Railways* has set an academic benchmark ever since. Dr Lewis has now retired but continues to publish on early railways.

The Institute of Railway Studies (IRS) at the University of York currently offers a two-year, part-time postgraduate diploma in Railway Studies though its Centre for Lifelong Learning; this is taught online via distance learning, with an optional residential weekend each year. In addition, students may enrol for research degrees (full-time and part-time) at Masters and Doctoral level. Its website (https://www.york.ac.uk/railway-studies/) explains that it is anxious to recruit students with interests in railway-related study of heritage, history (including business history and cultural history), material culture and memory. Professor Colin Divall, who was then associated with it, noted that the first International Early Railway Conference was part of a trend amongst railway historians whereby distinctions between academics, lay historians and enthusiasts were diminished, to the great advantage of all, but pointed out the pitfalls of a Whig view of technical history which stresses the 'one true path' of mechanical development, and to the danger of failing to engage historians in other disciplines, as well as public, non-specialist audiences (Divall 2003).

The archaeological community

The archaeological community includes academic archaeologists, local government employees, and self-taught archaeologists. Dr Michael Lewis' careful blend of material and documentary evidence in *Early Wooden Railways* has informed the work of archaeologists carrying out excavation and survey of identified early railway formations.

A landscape archaeological approach is explored in Alfrey and Clark's study of the Ironbridge Gorge (Alfrey and Clark 1993), which makes several important points – that the surviving evidence for early railways is unlike the archaeology of post-1830 railways, and that some were so ephemeral that they leave no archaeological trace, They also identify the importance of place-name elements such as 'Wynd' in locating early railways.

There is still little archaeological evidence for the period from the mid-16th century to the mid-18th century. The gaps in the documentary record and the paucity of archaeological evidence for the very earliest period of railway building and operation in England were reviewed in Lewis 2006 but the possibilities that a focused archaeological examination could offer were demonstrated by the discovery of fragments of a *hund*-way from the 1560s in a mine in the Lake District. These were located by an amateur group working closely with the National Park. Hitherto, the majority of archaeological excavations have been of sites from the late 18th or early 19th centuries. Grenter's excavation at Bersham, although it took place in Wales, is mentioned here because it identifies a waggonway which follows north-east of England practice and which can be dated with some confidence to 1758-1763 (Grenter 1993). Other archaeological investigations of waggonways such as the Lambton D pit heapstead (Ayres, Nolan and Durkin 1996) and the Newbottle waggonway have all been on later sites still. The wooden rails in Ironbridge excavated in the 1980s are undated but unlikely to predate the mid-18th century Bedlam furnace (Jones 1987).

There has also been surprisingly little excavation or detailed recording in England for the period 1810-1840. Michael Lewis's collection of iron track components is curated at Ironbridge, and local historians have uncovered lengths of stone sleeper blocks, or located and recorded pieces of cast-iron rail as part of their research on a particular railway or industry. One significant project is an archaeological desk-based assessment and measured landscape survey completed in 2012 on the Silkstone plateway in South Yorkshire, commissioned by East Peak Innovation Partnership on behalf of the Roggins Local History Group, with archaeological expertise contributed by ArcHeritage of York. It formed part of the East Peak Industrial Heritage Support Programme, a partnership project co-funded by Leader and English Heritage (with funding from English Heritage, the Department of Environment, Food and Rural Affairs and the European Union). This led to identification of 951 features along this 2½-mile long canal feeder, to the making of management recommendations, and to interpretation of the route (ArcHeritage 2012).

We note also that Dr Michael Bailey and Dr John Glithero have convincingly demonstrated how effectively archaeological investigation can be carried out on machines. Their several locomotive studies have shown how, by considering them as cultural artefacts, our understanding of their design and adaptation is greatly enhanced (Bailey and Glithero 2000, 2001, 2010).

The planning context

The introduction of *Planning Policy Guidance 16: Archaeology and Planning* (*PPG 16*) in November 1990 led to an expansion of archaeological fieldwork and to the identification, and in some cases the informed excavation, of early railway sites – see Appendix 3.

PPG16 was superseded by *Planning Policy Statement 5*: *Planning for the Historic Environment* in 2010, and was itself superseded by the *National Planning Policy Framework* in 2012, of which section 12 'Conserving and enhancing the historic environment' states:

> Local planning authorities should set out in their Local Plan a positive strategy for the conservation and enjoyment of the historic environment including heritage assets most at risk through neglect, decay or other threats. In doing so, they should recognise that heritage assets are an irreplaceable resource and conserve them in a manner appropriate to their significance. In developing this strategy, local planning authorities should take into account:
>
> - the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation;
> - the wider social, cultural, economic and environmental benefits that conservation of the historic environment can bring;
> - the desirability of new development making a positive contribution to local character and distinctiveness; and
> - opportunities to draw on the contribution made by the historic environment to the character of a place.

Museums

Early railways are represented in the collections of several museums in England, though there is no museum with a specific remit for them. Some of these collections are displayed, as are working replicas; some are stored but are usually available for study.

Beamish, the North of England Open Air Museum

Beamish, near the town of Stanley, County Durham, interprets the story of the north-east of England and of the Great Northern coalfield, and operates a short length of track with replica locomotives and rolling stock reflecting practice of the period 1812 to 1825. Nearby is a non-operational replica length of wooden waggonway associated with a horse-gin for colliery shaft-winding. Visitors to Beamish are able to compare these two systems, as well as with a late Victorian steam railway and a 20th century intra-urban electric tramway.

Beamish's approach is imaginative and engaging. A particular attribute is the creation of period-specific landscapes; the two early railway recreations run through the 'Pockerley landscape', an evocation of regional building styles and agricultural practices of the late Hanoverian period, complete with a gibbet. When a wooden stage-coach in the Beamish collection was damaged by fire, the remains were placed in the Pockerley duck-pond as both the most effective means of conservation and also in order to recreate the Leighton brothers' famous engraving 'Changing times', where a stage-coach has become a hen-house whilst a train passes in the background (see Appendix 4)

Stephenson Railway Museum, North Shields

This Museum's collection includes the Stephenson locomotive *Billy*, built by the Killingworth colliery workshops for the Killingworth waggonway *c.* 1815-1820.

Head of Steam Museum, Darlington

Darlington's Head of Steam Museum also illustrates the development and operation of railways in the north-east of England; its collections include Stockton & Darlington Railway material as well as its successor railways. Exhibits include two early locomotives, Stephenson's *Locomotion No 1* built for the opening of the Stockton & Darlington Railway in 1825, and *Derwent*, built in 1845 to a design that has its origins in the 1820s.

Science Museum Group

The Science Museum Group comprises three museums relevant to early railways. These are:

Manchester Museum of Science and Industry (MOSI), located in the former Liverpool Road station of the Liverpool & Manchester Railway, where the focus is on the regional story, and on the L&M's role in its development. A replica 'Planet' locomotive is housed here.

The National Railway Museum (NRM)'s main site at York; this curates the iron components of the Gaunless bridge of 1823 from the Stockton & Darlington, as well as several items of early track and rolling stock, including a Stratford & Moreton Railway wagon, the Foster, Rastrick and Co locomotive *Agenoria* (1828-1829), and the steam winding engine from the Swannington incline of the Leicester & Swannington Railway in Leicestershire (1832). The NRM is directly involved in research into early railways, and its strategic master-plan for the next ten years telling a more coherent early railways story. NRM senior staff indicate their commitment to progress understanding of England's early railways.

The NRM's site at Shildon; this is located in a complex that includes Timothy Hackworth's railway workshops of the 1830s, and offers a 'Cradle of the Railways' tour around these historic buildings including the coal drops and the Stockton & Darlington Railway's stables, which also includes the *Sans Pareil* locomotive, built by Timothy Hackworth in 1829 to compete in the Rainhill Trials on the Liverpool & Manchester.

The London Science Museum includes an early Trevithick engine which possibly contains parts from the London demonstration locomotive *Catch Me Who Can* of 1808, the 1814 *Puffing Billy*, the 1829 *Rocket* and the Grand Junction Railway's 1845 *Columbine*, as well as several early locomotive models. The Museum illustrates the development of locomotive technology in the context of power-generation.

Ironbridge Gorge Museums

The Ironbridge Gorge Museums curate several sites with early railway material, including a plateway at Blists Hill, and the Hay incline. Dr Michael Lewis's collection of early railway track items is also preserved here, for which a basic catalogue is available.

Local museums

Local museums contain individual items, for instance of rolling stock, such as the Royal Cornwall Museum; early track items are preserved in the Stretton Collection held by Leicester City Museum and at Ironbridge.

It is at Beamish that early railway can be best appreciated, in a landscape context that brings the re-created technology to life and in a way whereby the comparison can be made between the various stages of railway technology, from horse-haulage on a wooden waggonway through the early stages of steam locomotion in the early iron railway period, to its late Victorian flowering and to the development of 20th century intra-urban systems.

Other museums play to their strengths, telling the story of a region, or of an area or a particular railway, but informal discussion with museum professionals leads us to suggest that even at the NRM the early railway narrative does not emerge, nor does research on early railways figure in its programmes.

International Early Railways Conferences

An important development in 1996 was the establishment of what has since become a series of quadrennial international conferences on 'railways which were pre-main line in concept if not necessarily in date', held at different locations in the United Kingdom. These were held under the auspices of an informal association, the Early Railways Committee; this has now thrown in its lot with a similar group dedicated to the early main line period, and no longer exists as such. Published proceedings (Guy A and Rees J [eds] *Early Railways 1* [2000], Lewis MJT [ed] *Early Railways 2* [2003], Bailey MR [ed] *Early Railways 3* [2006], Boyes G [ed] *Early Railways 4* [2010], Gwyn D [ed] *Early Railways 5* [2014], here abbreviated to *ER1-ER5*) represent the most significant and outstanding corpus of published research on early railways. They include papers on railways in France, Prussia, Italy, the USA, Canada, Africa, Australia and New Zealand as well as on English, Welsh, Scottish and Irish topics.

Together with the occasional papers produced by the Early Railways Group of the Railway & Canal Historical Society, these conferences have provided a forum for exchanging information, research techniques and source-material. Contributions to the conferences have come from individuals with a range of backgrounds, many from museums, but mostly from interested amateurs, with a number of professional archaeologists. A few have been academics in the fields of engineering, history and history-archaeology. The success of the first gathering, at Durham, was most gratifying to its organisers, and subsequent conferences confirmed that there is a considerable appetite amongst persons with an interest in railway history for studies of this early period.

This corpus of published work emanating from these conferences has in part stimulated Historic England to commission the present study. The priority for further study was noted by Cossons (2001) in the keynote address for the first conference, and also in Burman and Stratton (1997, 3-17).

Historic England

The Historic Buildings and Monuments Commission for England (HBMC) was established under the National Heritage Act 1983 to take on the work and responsibilities of the former Department of Ancient Monuments and Historic Buildings of the Department of the Environment. The HBMC adopted the trading name English Heritage (EH) which it retained until April 2015 when the 400+ properties in its care were transferred to a new Trust which continued to use the name and brand English Heritage.

The statutory, advisory, research and archive responsibilities were retained by the HBMC which has adopted the name Historic England (HE). Historic England is the principal adviser to the United Kingdom Government on the historic environment of England. It is responsible for designation (principally Listing and Scheduling), commissioning research and excavation, publishing, and maintaining the National Monuments Record. As part of its programmes of designation HE commissions thematic surveys in order to enhance its database and inform Listing and Scheduling.

Such sites and structures that reflect the history and archaeology of early railways and are currently Listed and/or Scheduled are set out in Appendix 1

2.4 Literature review

Context

Published literature on early railways in England is extensive and takes many forms. Some publications offer UK-wide (or international) overviews which are now out of date, though pioneering in their time. Other wide-ranging studies have more than stood the test of time, most notably Lewis (1970). Some important regional studies have been published, such as Bennett, Clavering and Rounding (1990). Others are histories of individual systems, which vary from comprehensive and well-researched book-length studies to brief notices in county archaeological or antiquarian journals. A few thematic technological studies have been undertaken on, for instance, locomotives or inclined planes. Overall, it is fair to say that the great majority of research and publication has been undertaken by individuals whose interest is in technology, rather than social or economic history. There is also a notable absence of broader synthetic studies placing early railways in wider social or economic context. Crucially, there is no equivalent general text based on sound and comprehensive scholarship that takes up the threads of Michael Lewis's *Early Wooden Railways*.

Methodology and approaches

Though studies of early railways have multiplied in recent years, little has been written about what constitutes an 'early' railway, and the organisers of the International Early Railway Conferences have been intentionally (and wisely) vague about definitions. Carter and Carter 2014 have suggested the entire New Zealand railway system as a late 'early railway'. Gwyn 2010 argues that present-day railway technology is still in essence Hanoverian. Hughes 1990 discusses categorisation, suggesting that early railways be considered under two distinct headings, 'simple railways' and 'hybrid (experimental) railways', and ascribes specific characteristics to each. The terminology adopted by Hughes is suggestive, though it may be noted that 'hybrid' implies derivation from two existing parents, and that industrialists and landowners were unlikely to invest in technologies that were purely at the experimental stage.

Bennett, Clavering and Rounding by contrast advocate a chronology for Tyneside coal-carrying railways which cuts across distinction between 'early railways' and their successors, involving a 'classical wooden way' period of 1600 to 1775, an age of 'invention and transmission' from 1775 to 1825, and an 'era of rope and steam' which lasts until 1950 (Bennett, Clavering and Rounding 1990, 12).

The stated purpose of a challenging paper by Michael Duffy in the *Transactions of the Newcomen Society* (Duffy 1982-1983) is to 'define a set of concepts useful for analysing technological change and to employ them in the evolution of the Stephenson Railway Traction system'; the author is highly critical of 'supposedly serious railway studies' which, while apparently scholarly, lack any theoretical underpinning, but more significantly for present purposes identifies George Stephenson's contribution as that of a philosopher-technologist who, throughout a period of 'fruitful inception' from 1821 to 1837, identified and combined the elements which made up a traction system which then endured for 120 years.

Gomersall and Guy 2010 sets out the research agenda for early railways.

Biographies

The Victorian and Smilesian fascination with the heroic individual underlies some of the first writings on early railways in England – which, significantly, date from the same period as the first attempts to preserve early railway artefacts and to replicate early railway technology (Bailey 2014). Smiles 1857 provoked a controversy over the origin of the locomotive blast-pipe which still after 160 years has not entirely gone away. Young 1923 is valuable on detail and on the social milieu of the Hackworths but does not shy away from the fight over the matter of the blast-pipe.

LTC Rolt's biography of George and Robert Stephenson first appeared in 1961. It was reprinted in 1962, 1978 and 2009 and has been reprinted again in 2016. It is ultimately in the Smiles mould, but is a compelling book which makes clear what at an extraordinary nursery of engineering and wider talent the early railway culture of the great north of England coal-field actually was.

Other notable biographies are Skempton and Hadfield 1979 on William Jessop, Schofield 2000 on Benjamin Outram, and Burton 2002 on Richard Trevithick.

Skempton 2002 is a particularly important source as it provides a fully referenced baseline account of the major engineers of the early railway period with a list of their main achievements, and sets out their involvement not only with early railways but also with other transport and infrastructure projects, thereby providing an overall technical context.

Bailey 2003 devotes only one chapter to Robert Stephenson's early years but provides a clear exposition of his training, circumstances and first steps in railway engineering. Macnair 2007 is a detailed biography of William James, 'The man who Discovered George Stephenson', and makes thorough use of primary sources to provide a balanced judgement on a complex but clearly influential man. Since few of James' schemes came to direct fruition, it provides little information about surviving features but illustrates the way in which the railway's potential as a traction system came to be recognised in the first three decades of the 19th century.

One biographical study which merits mention here – though it is a lot more besides – is Gamst 1997, which describes the careers of Franz Joseph von Gerstner, and, more particularly his son, Franz Anton, builder of the first major European system, from Linz on the Danube to Budweis on the Vltava (Moldau), after making the first of four visits to England to study railway engineering in 1822.

Gamst's main focus is the report on American railroads which the younger von Gerstner carried out in 1842-1843, but the value of the study lies in the way in which it sets out the context for international technology transfer and technical diffusion in individual experience and ambition.

Overviews

Dendy Marshall 1938 and 1953 were both pioneering studies in their time, the one a history of British railways to 1830, the other a history of locomotives in the UK, France, Prussia, Wallonia and the USA to 1831, but there is little in either publication that has not now been superseded. The same is true of Lee 1943. Baxter 1966 is an attempt at an overview of early railways in England, Wales and Scotland, but is confused and inexact. Guy and Rees 2011 is an excellent introduction to the subject.

In 1970 Dr Michael Lewis published his pioneering *Early Wooden Railways*, which not only offered a magisterial overview of their development from the Medieval period to the early 19th, and from Tyrone to Kazakhstan, but also established a typology of early railway development which has needed no significant revision since. Skilfully blending material and documentary sources, this publication has set the benchmark for early railway studies ever since.

Towards the end of 19th century, the popularising historian Clement E. Stretton began publishing copiously on early railways but has been criticised for inaccuracies and fabrications ever since (*eg* Stretton 1905).

Guy 2014 discusses the variety of types and function of early railways, emphasising their extent and ubiquity, and the way in which they sprang up within the environments of towns and peri-urban industrial zones. He quotes a comical volume of 1807, *More Miseries*, which includes among everyday annoyances, 'crossing an iron railway'.

Regional studies

Bennett, Clavering and Rounding 1990 emphasise how the Newcastle waggonway systems formed part of a complex world of regional rivalries, but it remains a rarity in early railway studies as a detailed examination of a particular region and how it invested in such a transport system. As Lewis 1996 points out, it also illustrates the importance of detailed local knowledge. Books in the David & Charles *Regional Railways* series tend to be cursory in their treatment of pre-1830s railways.

The establishment of the Ironbridge Gorge Museum Trust in 1968 and the inscription of Ironbridge Gorge as a World Heritage site in 1986 encouraged analysis of the role of early railways within this broader industrial landscape in ways that might be regarded as regional studies (Trinder 1981; Alfrey and Clark 1993, 70-74; Trinder 2005). Stokes 2001 goes further, and analyses the role of the north-east of England's railways in the formation of regional identity, and in the context of politics, parliamentary representation, banking systems, etc.

Local studies and single-system histories

Books and articles on individual lines are too numerous to cite in full (but see **10 Bibliography** below). They vary in scope, ambition and quality, from short notices to (for instance) Boyes and Lamb 2012, which considers the Peak Forest canal and railway together, as a business and as engineering achievement, from the 18th century to the early 20th. Other monographs of note are Ewans 1977 on the Haytor granite railway and the Stover canal, Cook and Clinker 1984 on the railway systems that extended from Hereford into Wales, Rimmer 1985 on the Cromford & High Peak, Norris 1987 on the Stratford and Moreton, Bick 1987 on the Gloucester & Cheltenham, Kirby 1993 on the Stockton & Darlington, Rattenbury and Cook 1996 on the Hay and the Kington, and

Barritt 2000 on the Preston tramroad. Even so, it is remarkable what has not been written; there is for example no up-to-date book-length account of the Hetton.

Research on early railways in Scotland and Wales

The 'overview' studies, in particular Baxter 1966 and Lewis 1970, consider early railways in Scotland, whilst Brotchie and Jack 2007 chronicle the early railways of the West Fife region in some detail. Robertson 1983 is unusual in that it concentrates on economic rather than engineering considerations. Ferguson 2006 considers transfer of technology within the UK, arguing that the process was not entirely from England to Scotland. Though Scotland did not have many railways until the end of the 'early' period, Scottish engineers and entrepreneurs were careful to evaluate English technology and were making considered choices about gauges and locomotive design.

Gwyn 2004 argues that early railway technology transfer should be seen as a diffuse process in which the technical cultures of individual regions within national communities are important, citing the links between the north-east of England, the state of Maryland, and south-east Wales. He argues here that the bogie vehicle was devised in Wales in 1821 and that the idea was passed on to the Liverpool & Manchester and to the Baltimore & Ohio by personal contact.

Hughes 1990 is a study of a rural railway in upland Wales dating from the 1820s which locates it firmly within the context of its landscape, and of the social, economic and cultural networks that brought it into being, an analysis that is to a great extent missing from studies of railways generally. The same author's *Copperopolis* (Hughes 2000) examines the industrial archaeology of Swansea in a way which identifies the significance of early railways in mining and as feeders to the canal; Hughes is now working on a detailed archaeological study of the canal and its railways under the sponsorship of the Canal and River Trust. Van Laun 2001b is a detailed analysis of the evidence for the early railways which supplied South Wales' ironworks with limestone, based on his University of Hull PhD thesis supervised by Dr Michael Lewis, and reflecting Lewis's blend of documentary sources with material evidence. Van Laun's study performs an important service in illustrating and unravelling the extraordinary complexity of even apparently simple industrial systems.

Research currently in hand suggests that although Wales had very few railways until the 1790s, by 1830 it probably had more railway mileage than England. Although English capital and English expertise were central to their development, research indicates that Wales was also the locus of a significant number of technical 'firsts', including rails made entirely of iron (in 1787 – as distinct from the iron strips laid on wooden rails as in Coalbrookdale twenty years earlier), attested steam locomotive traction (1804), passenger services and railway travel as a leisure activity (by 1807), articulated rolling stock (by 1821), rack and adhesion working (1832), bogie locomotives (1838) and fixed-frame multi-axle locomotives (1848). Caernarfon, Swansea, Abergavenny, Brecon and Newport had public railways before Liverpool, Manchester, New York, Paris or St Petersburg. Wrought-iron rails were as likely to be rolled in Wales as in England (Dendy Marshall 1938; Lewis 2014; Gwyn 2004; Lewis and Rattenbury 2004; Gwyn in progress). Whilst early railways in Wales made extensive use of technologies imported from England (and some early railways operated across the border), it would not be true to describe it as purely a 'recipient' or 'non-initiating' culture.

The relationship between the two countries in terms of railway development was to an extent symbiotic and as such merits closer study. Wales offers a challenging contrast to the study of early railways in England, both in terms of the scope and methodology of the work that has been undertaken and also in terms of understanding of how the country adopted this particular form of transport technology.

Technology transfer/technical diffusion

It is broadly true to say that the railway arrives in England from the German-speaking mining lands in the 16th century but that by the 18th century England had become an 'initiating culture' in terms of this technology. Even before the turmoils of the revolutionary and Napoleonic periods, the *voie anglaise* and the *englischer kohlenweg* were being adopted in continental Europe, inspired by published accounts of travellers from Sweden, France and Prussia. Most of these deal generally with industrial development, such as Angerstein in 1753-1755, published in English translation (Berg 2001) and Jars 1774-1781, which is available online, rather than specifically with railways.

Others *savants* came after Waterloo. The French political economist Joseph-Michael Dutens was drawn to England in order to understand the canal system and what he termed the *esprit des lois* in the wake of his country's military defeat, but his *Mémoires sur les travaux publics de l'Angleterre* includes a valuable description and plans of the Coalport inclined plane (Dutens 1819, 38-48, available online). Around this time, visitors begin specifically to inspect railways, such as de Gallois 1818 (available online), von Oeyenhausen and von Dechen 1826-1827 (available in English translation – Lee and Gilbert 1971), and Coste and Perdonnet 1830 (available online). These are important and illuminating sources for many reasons – observations about the standard of construction or efficacy of particular railways are offered by individuals with no axe to grind, and represent an 'on the spot' assessment of technology, free from the historian's obligation to offer retrospective judgement. They do however tend to focus on the systems that in one way or another were innovative, rather than those that were workaday but effective.

Visitors from the USA begin arriving in 1825. They were less apt than Europeans to commit their thoughts to paper but the journeys they made were clearly influential on emerging American railroad practice. These contemporary accounts of English railways are not only informative but form part of a narrative of transfer and diffusion that is central to understanding the evolution of a global technology in which England played so central a part. They have also been studied in some depth (Stapleton 1978).

The early stages of this process are traced, and its significance discussed, in Lewis 1970. Cowburn 2001 demonstrates how France's loss of the Ruhr and of the Liège coalfields after 1815 compelled the opening up of the St-Étienne mineral basin, where the Stephenson approach is adopted, albeit modified, to move coal to the Rhône and the Loire. Achard and Seguin 1926-1927 and Forward 1943-1944 discuss the use of both Stephenson and French-built locomotives on this system. Clarke 2001 discusses the building of Blenkinsop-designed steam locomotives in Prussia in 1816 and 1818. Another was put to work at Horloz colliery in Wallonia (part of France and later of the Netherlands and Belgium), possibly as early as 1814 (de Bruyn, n.d.).

Gamst 1997 discusses Franz Anton von Gerstner's visits to England as part of the design process for the Budweis to Linz railway. This particular system, which connected the Vltava with the Danube, and hence northern Europe with *mittel Europa* and the Balkans, nevertheless represents the only significant departure from the English pattern in this period, with its wooden strap rails and narrow gauge. The same author returns to the theme of technology transfer in Gamst 2001, which traces British influence on USA railway development from the first system in 1795. From Gamst's account, it appears likely that the first railways in the USA were short artisan-built systems, but that once longer and more ambitious systems were in prospect from about 1825, it became necessary to see what the engineering options were and what would best serve the needs of the new republic. Stapleton 1978 had previously discussed the role of visitors from the USA to Britain on the development of USA railroad technology. Dilts 1997 traces this process in the building of the Baltimore & Ohio, 'the Railroad University of the United States' (Dilts 1997, 2). MacDonald 2001 analyses the 'British roots of Canada's first industrial railway' of 1839-1840 and MacDonald 2003 examines the Champlain & St Lawrence.

Caldwell, Campbell and Brougham 2014 is a detailed account of how a fortuitous archaeological discovery in a coal-rich area of New South Wales confirms technology transfer from the north-east of England, whereas Longworth and Rickard 2015, though no more than a list of the very earliest Australian railways, illustrates how local adaptation to circumstances was also important.

The outstanding exemplar – unequalled anywhere – of a detailed historical and archaeological regional study of railways, their history, formations, engineering, structures, buildings and equipment, is Rödel (ed) 2005, a comprehensive three-volume survey of the railways of the state of Hesse. Published by Kulturdenkmaler in Hessen under the auspices of Denkmaltopographie Bundesrepublic Deutschland, it offers a format and a model that deserves serious consideration as a means of documenting the archaeology of the British railway system.

Traffic

The very earliest railways began as purely private unidirectional mineral handling systems, and it is only gradually that any of them developed back-carriage. It also clear that the railways built from the late 18th century to connect with canals and built under canal acts of parliament might carry a variety of goods, and that there might be movement from the canal to a point-of-sale elsewhere on the railway. Cook and Clinker 1984 indicate the two-way nature of traffic on the systems connecting Abergavenny with Hereford but note that the Hereford terminus, which might have provided archaeological evidence, was largely obliterated by the new Wye bridge. Rimmer 1985 draws attention to the bi-directional nature of traffic on the Cromford & High Peak, a point developed by Hodgkins 2003, and describes the wharfage and warehousing at each end. Barritt 2000 illustrates proposed and actual canal interchanges at both termini on the Preston to Walton Summit plateway.

It is also understood that on many of the railways built from the late 18th century, services and motive power were by no means necessarily provided by the railway itself. Persons and organisations using the railway more often provided their own vehicles and motive power. In some cases, specific services were contracted out by the railway, such as passenger carriage.

Thematic studies

A consequence of recent research is that there is now less emphasis on potentially misleading claims about technical 'firsts' (at least among the informed), less 'techno-Whiggery' (to use the Early Railways Committee's apt phrase), a more realistic understanding of the relative importance of locomotives and other forms of mechanical power, and more emphasis on the dissemination of knowledge that underpinned the development of railway systems.

Formation

After Lewis 1970, civil engineering, formation and buildings have had scant attention – in part a reflection of Lewis' comprehensive coverage. Trinder 1981 considers railway formations in the Ironbridge Gorge and there is some discussion in Ashforth 2014 in the context of the Harrington waggonway in the Cumberland coalfield. Bennett, Clavering and Rounding 1990 make it clear that Tyne waggonways required ever-more ambitious earthworks to minimise 'pulls' and 'runs', culminating in the 100' high embankment by which the Tanfield waggonway crossed Causey Burn.

Track

Track is considered in Lewis 1970, Jones 1987, Grenter 1993, Boyes 2001, Van Laun 2001, Van Laun 2003, Lewis 2003, Smith-Grogan 2010, Allison, Murphy and Smith 2010, King 2014, Northover 2014,

Hartley 2014, Smith 2014 and Waterhouse 2014. Iron and wooden track can survive well archaeologically. Because iron edge rails and plates represented a major capital investment, documentation is often detailed. Northover 2014 chronicles the decision-making process by which the Plymouth & Dartmoor bought rails and the tendering process involved.

Vehicles

Vehicles have been less comprehensively studied than locomotives in terms of railway studies. Darsley 2004 considers the remarkably long history of the chaldron wagon, developed in the north-east of England. Lewis 1970 and Van Laun 2001b discuss the 'Shropshire wagon' as it was used in both Wales and England. Lewis 2014 touches on passenger vehicles and describes the Portreath carriage preserved in the Royal Cornwall Museum. There is no equivalent study to John White's books on goods and passenger vehicles in the USA (White 1978; White 1995).

Motive power

Locomotive power has been thoroughly considered. Guy 2001, Rees 2001, Bye 2003, Crompton 2003, Rees 2003, Rees and Guy 2006, Bye 2010, Bye 2014, Winstanley 2014 and Hopkin 2014 represent significant contributions to the development of locomotive technology in England. Bailey 2014 is an informed overview of the locomotive from 1803 to 1852 based on the surviving examples and replicas.

Fixed engines and inclined planes are considered in Tew 1943-1945, Mountford 2001, 2003, 2010 and 2013, Bodman 2012, Boyes 2014 and in Waterhouse 2014. This last source is particularly interesting as it describes an archaeological examination of an inclined plane operated by a water-wheel. Nevertheless, a typology has not been established and the relationship between canal locks, canal inclines, rail inclines, and other systems for raising and lowering goods and materials is not fully understood.

Even less attention has been paid to animal traction on early railways, a particularly surprising omission given its importance.

Interchange

Most early railways carried minerals to navigable water for onward transport. Few connected with roads or with other railways, though some systems installed sidings to later railways once the national systems began to grow in the mid-19th century.

The type and nature of inter-modal facilities varied considerably according to the goods carried. Lewis 1970 and Bennett, Clavering and Rounding 1990 have much to say on the subject of the staithes from which coal was transferred from waggonways to vessels. Van Laun 2006 discusses the waggonways which served Whitehaven. Hair and Ross 1844/1987 illustrate the 'drops' at Wallsend, Sunderland, Middlesbrough and those belonging to the Clarence Railway, and the Benwell colliery staith. Powell 2000 offers a detailed typology of coal-shipping machinery from the pre-waggonway period through to modern times. Redvers-Higgins, Willies and Wain 2011 set out the way in which Ralph Allen's stone-carrying railway was integrated with the use of cranes and river vessels in the mid-18th century. Alfrey and Clark discuss the archaeology of rail-served wharves on the Severn (Alfrey and Clark 1993). These last three publications underline the fact that fully to understand early railway technology means consulting sources that do not necessarily come under the heading of 'railways'.

Many of the local studies and single-line histories devote some space to interchange sites – Bick 1987 for instance to the arrangements at Gloucester docks, whilst Boyes and Lamb 2012 provide a context to the junction between the Peak Forest canal and the railway. The archaeology of the Morwelham quay in West Devon, which shipped tin, arsenic, copper, lead and manganese transported by the Tavistock canal then fed downhill by a connecting incline, is discussed in detail by Waterhouse 2014.

Very little has been written on interchange between road and rail on early railways. The Wollaton waggonway connected with a road system, as did some of the later Coalbrookdale systems – lines ran downhill from the ironworks to wharves on the Severn but also against the grade to a yard on Watling Street (Trinder 2005, 37-40)

Infrastructure

Little attention has been paid to infrastructure. The very earliest railways presumably had little need of ancillary buildings, but by the late 18th century at least, it is hard to imagine that many of them did not require weigh-bridge houses, offices and stables; by the 1820s, passenger stations and repair facilities would have been needed. The single-line studies and archaeological investigations have had most to say on infrastructure but there is clearly much more that could be added. Guy 2010 discusses the use of lineside kettles for locomotives, and Hartley 2010 the structures associated with the Coleorton Railway.

2.5 Context - conclusions

- Early railways in England have attracted a considerable degree of interest from a wide variety of individuals, institutions and associations

- A significant amount of research has been undertaken and published on early railways in England

- Research has identified gaps in knowledge as well as areas where information is readily available

- Gaps in knowledge include:

  - technical development from the mid 16th century to the mid-18th century
  - the use of animal traction
  - the mechanical engineering of rope haulage
  - the civil engineering of formations
  - the form and organisation of inter-modal facilities
  - regional typologies
  - landscape context

- Research has identified the British and global context for the evolution of early railways in England and confirmed that such railways were being adopted world-wide pre-1830

- Archival and bibliographic coverage of early railways in England is extensive but not comprehensive, and is very strongly weighted to the period from the mid-18th century to 1830

- Archaeological site-investigations have not been undertaken on sites dating from the late 16th century to the mid-18th century.

- Archaeological examination of machinery has established the potential for this type of investigation to inform understanding of early railways in England

- Archaeological evidence includes railways laid underground in mines

As Michael Lewis pointed out twenty years ago, ‘Daunting though the task would be, the field is still wide open for an authoritative study of the crucial thirty or forty years which led up to the Railway Age and made it possible’ (Lewis 1996, 81).

3 HISTORICAL DEVELOPMENT

3.1 The early mine railway – 1553 to 1603-1604

Context

The earliest railways of which we have any detailed knowledge were found in the German-speaking mining areas of central Europe. These were short systems, running from the working area of the mine along a level tunnel, only emerging to daylight near the entrance, where ore was processed. Exceptionally there might be a short overland system connecting other departments of the mine (Flach 1974 [1661]). Their arrival in England reflects government sponsorship of copper mining.

Precursors

There is evidence for the use of railways in this context in the Roman empire – an adit at the Três Minas gold mine in Portugal preserves V-section channels cut into the rock at a gauge of about 1.2 metres. This is the only Roman mine railway so far identified, but it is unlikely to be the only one ever built, and it has been suggested that this technology lingered on in Byzantine territories, to re-emerge in the late Medieval period in mines in the eastern Alps or the Tirol. A Roman mine railway in England is a remote possibility; Lewis suggests that if anywhere in the UK had such a system, it might have been Dolaucothi gold mine in south-west Wales (Lewis 2001). Smith-Grogan 2010 refers to a possible Roman quarry rutway of 300 CE at Blunsdon in Wiltshire.

The first mine railways in England

The first railways in England probably date, at earliest, from the second half of the 16th century and were associated with mines where German-speaking miners were employed. Smith-Grogan 2010 suggests that several Cornish rutways might date back to the 1550s and be associated with Burchard Cranich and Ulrich Frosse. The West-Country mining engineer Sir Bevis Bulmer (1536-1615) was familiar with Agricola's *De Re Metallica* (Skempton 2002), and another possible literary conduit is Sebastian Munster's *Cosmographia Universalis*, published in German in 1544 and in Latin in 1550. This includes a woodcut of a *hund* on flanged wooden rails in a mine at Ste Marie/Markirch in Alsace (Lewis 1970, 51). The part of the Latin edition which deals with the New World was translated into English by Richard Eden in 1553; whether or not he was familiar with the other parts of the text is unclear but Eden claimed to be an expert in the transmutation of metals and to have visited 'the deep mines' (Kitching 1971, Gwyn 1984).

No railway systems were identified in the excavated portions of the technically-advanced Coleorton deep collieries in Leicestershire, active 1460-1600, the only ones from this period to have had the benefit of detailed archaeological study (Hartley 1994). The first rail system in England for which both documentation and material evidence survives is the *hund* guide-pin system described in *ER4* (Allison, Murphy and Smith 2010) in one of the Caldbeck mines exploited by the Company of Mines Royal financed from Augsburg, which was introduced by Daniel Höchstetter in the 1560s.

Attributes

Formation

The only known railway from this period was laid on the floor of a mine level. Whilst it is by no means impossible that there were short overland railways in this period, perhaps in the Severn Gorge, they are unconfirmed.

Track

Smith-Grogan 2010 identifies shallow stone rutways in Cornwall which are mostly of 4' 4" gauge. The rails identified in the Calbeck mine are wooden *gestange* for a *hund* system whereby a vehicle was propelled along rails, guided by a vertical guide-pin.

Though Peter King has argued cogently for the use of edge railways and of inclined planes in the Severn Gorge in the reign of Elizabeth I (King 2010), there is as yet no evidence for such things, either documentary or archaeological, nor is it evident when or where edge railways were first devised. Michael Lewis argued in *Early Wooden Railways* that the edge rail was in all probability an English invention, despite the claims made for the mining industry of Transylvania:

> Did this happen in the vigorous and expanding England of the first Elizabeth or in a primitive corner of eastern Europe then subservient to the yoke of Turkey? We cannot be categorical, but the evidence is enough to suggest that the honour belongs to England.
>
> The faint possibility still remains that the flanged wheel could have been invented here before the Turkish period, or during its earliest years, to lie dormant until resuscitated two centuries later (Lewis 1970, 77, 85).

Michael Lewis has since reconsidered this view, suggesting that knowledge of the horse-drawn wagons known as *riesen* in Lower Hungary which ran on elongated rollers, and which were kept on the track by guide-wheels on vertical spindles, might have been passed to England by Höchstetter along with the *hund* system, and that English and European examples may have gone through a similar evolutionary process whereby the rails wore the rollers down into double-flanged wheels and the guides became redundant (Lewis 2006). However, as Lewis points out, 'Even if the English waggonway did borrow something from European practice, the fact remains that its subsequent development was wholly British.'

Vehicles

The Caldbeck mine used a *hund*, a small carriage for carrying minerals such as had been developed in continental Europe. A replica is on display at the NRM (1995 7726). Any edge railways from this period might have used *riesen*.

Motive power

Propulsion underground would have been human. Any inclined planes down the slopes of the Severn Gorge might have been counter-balanced.

Interchange

Some of the Cornish rutways seem to have connected mine headings with nearby beach ramps. Any overland railway connecting with navigable water implies at least a jetty or a loading point. It is likely that the Caldbeck railway simply terminated at the tunnel mouth and that ore was tipped out here for crushing.

Infrastructure

A copper mine or (less probably) a colliery might have had some ancillary buildings but it is unlikely that any railway from this period would have required any service structures.

3.2 The wooden waggonway – 1603-1604 to 1770

Context

Wooden waggonways developed in the context of the English coal-trade, above all in the great north-east of England coalfield, the most productive in Europe, where they gradually supplanted wain-ways.

The earliest known waggonways

Documentation dating from the opening years of the 17th century indicates that wooden railways, 'waggonways', were being laid as overland systems, connecting a drift or a shaft-head with navigable water, or occasionally with an interchange yard on a road system. Most of what we know of them comes from legal disputes, and for this reason it is quite possible that there were other systems of which historians are unaware because they prompted no quarrels.

One of these was at a colliery at Broseley near the Severn Gorge in Shropshire, on the south side of the river, to a wharf at the Calcutts, slightly downstream of the later Iron Bridge; it was laid in October 1605, was a mile or so long and included 'tilting rails', which have been interpreted as an inclined plane (Smith 1960; King 2010). As indicated above, it is quite possible that this was not the first railway in the Gorge.

A year or two before, a railway had been laid from Strelley pits to a yard at Wollaton in the Nottinghamshire coalfield which was later described as one of the 'new and extraordinary invencions and practises for the spedy and easy conveyance of the said coals, and especially by breaking the soyle for laying of rayles to carry the same upon with great ease and expedicion ... and by drawing of certen carryiages laden with coals uppon the same rayles.' This suggests that railways were new to this region but Huntingdon Beaumont (*c.* 1560-1624), who leased the Strelley pits, had contacts from whom he could have learnt of their existence elsewhere (New 2014). He was a younger son of the lord of the manor of Coleorton in Leicestershire, where coal was being mined on an extensive scale (Hartley 1994). A further reference, however, in a letter dated 1 May 1610 from Robert Fosbrooke to Sir Percival Willoughby, states '… I beseeche you to take order with Sir Thomas that we maie have liberty to bring coales down the railes by wagon, for our cariadges only, and we will bring them down the railes ourselves, for Strelley cartway is so fowle as few cariadges can pass …' perhaps suggests that the railway was by then a familiar feature (Smith 1960, 123)

Beaumont introduced the waggonway to the north-east. According to the Newcastle historian William Gray, 'Master *Beaumont* a Gentleman of great ingenuity ... brought with him many rare Engines, not then known in these parts, as ... Waggons with one Horse to carry down Coales from the Pitts, to the Staithes, to the River, &c.' Beaumont's three railways were on the north-east coast, at Bedlington, laid around 1608, and at Cowpen and Bebside, undated but probably much the same time (Smith 1960, Lewis 1970). Railways in the north-east developed into systems of extraordinary density with a complex history, reflecting intense regional rivalries and the profits that could be made from supplying London with coal. Even so, it was not until 1621 that the first recorded waggonway was built to the Tyne and it was not until the Restoration of 1660 that they became common. In the meantime, wain-roads remained a more cost-effective solution for most coal-owners (Bennett, Clavering and Rounding 1990, 35-56).

Typology

Lewis 1970 first set out the basic typology for the waggonway which has been accepted ever since. He identifies two schools of construction, one deriving from the north-east, the other from the

Midlands, in particular Severn-side. The way they differ in their technology is still apparent in railway engineering to this day.

The collieries of the north-east of England developed broader gauge and larger capacity waggonways which ran from shaft-heads to staithes on the River Tyne. It is quite possible, though unconfirmed, that in this respect they followed Wollaton practice, but there is little firm evidence for the form they took before the middle of the 18th century. By this time a regional consensus had emerged that the economic limit of length of a waggonway (across a type of terrain which was entirely unsuited to the building of canals) was 10 miles (Lewis 1970; Bennett, Clavering and Rounding 1990, 132).

Similar systems came to be found in English coalfields technically influenced by Tyneside, namely Cumberland and Yorkshire, as well as in north-east Wales and parts of lowland Scotland and Northern Ireland.

The Shropshire coalfield developed smaller capacity systems running on narrower gauges. Here, mines were mainly levels, rather than deep mines such as prevailed in the north-east, and so a compact waggonway could run from the coalface to daylight and then down to navigable water. The Severn Ironbridge Gorge and its immediate environs were home to many such railways. From the mid-18th century, similar waggonways also ran direct from ironstone mines to Bedlam furnaces downstream of the later Iron Bridge.

Some of these nevertheless had very short lives. Alfrey and Clark 1993 quote a document of 1755 to the effect that they were 'of the mushroom breed, only the produce of one night' (Alfrey and Clark 1993, 71). Others fared far longer, though doubtless they went through changes in use and form. The establishment of new coke-fired furnaces in the 1750s and the expansion of mining led to the provision of further railways, the longest running from Ketley (near Watling Street) to Coalbrookdale Wharf on the Severn, so that by about 1775, Abiah Darby (the widow of Abraham II) stated that the Company had 20 miles of railways. Other railways ran to land-sale wharfs on Watling Street (Trinder 1981, 71-74).

Railways deriving from Shropshire practice were to be found in coalfields which were adjacent and technically influenced by it – Staffordshire and Warwickshire, as well as parts of Wales and of Scotland.

The Tyneside system is the design-ancestor of the median-gauge railways of the present day, and in particular of the UK, continental European and USA gauge of 4' 8½". Narrow-gauge railways derive ultimately from the Shropshire system, as the inspiration for the railways built in the heads of the South Wales valleys in the 1790s, subsequently adopted and developed in the Gwynedd slate industry. This was then offered as a cut-price system suitable for the developing world by the Festiniog Railway's engineer in 1870, when the great and the good were invited to see it in operation (Gwyn 2010, 138).

Traffic

Although north-east of England waggonways came into being to serve the coal industry, by the late 17th century some were carrying other goods as well. The Chopwell Way and the Tanfield Way carried lead from the north Pennines, the East Winlaton way and its successor the Western way carried billets of Swedish steel to Cowley ironworks (Bennett, Clavering and Rounding 1990, 58, 61-62. At Coalbrookdale, railways were being used to move iron from 1747 (Trinder 1981, 72; Alfrey and Clark 1993, 70)

The first significant system in England which was purpose-built to serve an extractive industry other than coal was Ralph Allen's wooden railway of 1731 near Bath, connecting his Combe Down stone quarries to the river Avon, which was integrated from the start with the use of river-boats and cranes to form a complete industrial handling system (Redvers-Higgins, Willies and Wain 2011; Lewis 1970). However, it is only with the coming of the iron railway (see below) that railways are commonly used in quarrying.

Demise of the waggonway

Although the technology of the railway was changing by the late 1760s and early 1770s, with the introduction of iron components, some wooden waggonways continued to function until the early 19th century, and other forms of wooden railway lasted far longer still.

Attributes

Formation

The scale of the railway formations built in this period varies enormously. Waggonways in the north-east were heavily capitalised, high-capacity operations engaged in a very competitive trade. Not surprisingly, the embankments ('batteries', also known as 'mounts' and 'bulwarks') associated with them can be very large indeed, in order to minimise gradients – which could nevertheless be ferocious (Lewis 1970).

A single horse could however haul an empty chaldron on a gradient of 1 in 10, and keep it in check on the down journey, which gave the waggonway-wright some flexibility over the choice of route and placed the coal-owner at an advantage over the wayleave owner (Bennett, Clavering and Rounding 1990, 179).

Shropshire railways by contrast could be laid with minimal earthworks (Alfrey and Clark 1993, 70-71).

Track

Tyneside systems ran on gauges of between 3' 10" and 5', Shropshire systems of between 2' and 3' 9" (Lewis 1970, 181, 267). These waggonways used wooden rails, fixed to wooden sleepers with wooden pins. The space between and around was filled with stone ballast. Outside the rails, ballast was laid nearly to the top of the rail to form a path for the waggon-men to follow. The sleepers were 4" to 8" square and longer than the gauge of the way. The rails were 4" to 5" wide and high, perhaps with the width usually slightly exceeding the height. The rails might be 6' long, pegged to the sleepers every 18" with treenails of young oak 6" to 7" long. The joints were above a sleeper, with adjoining rails merely butting up to each other. If a rail became damaged it could be turned over. At Newcastle, the practice evolved from the mid-18th century of laying a 'double way', whereby a second rail was fixed to the top of the first. This allowed more ballast to be laid above the sleepers, thereby protecting them from the horses' hoofs. This had the advantage that the joins between the rails did not have to be above a sleeper, and made for a more durable system

Vehicles

It is worth stressing that until the second half of the 18th century not only the rails but practically all the components of a railway were of wood. It is only in 1729 that we first learn of iron wheels, at Coalbrookdale; their use soon spread (Lewis 1970, 107, 195-198).

Shropshire-type wagons were generally small in capacity, between 14 cwt and 60 cwt, and Tyneside-type between 37 cwt and 50 cwt (Lewis 1970, 184-190, 268).

Motive power

Propulsion of vehicles was carried out by animal power, by gravity and by counterbalance inclined plane. Angerstein in 1753-1755 provides the first known illustration of an inclined plane in England, at Coalbrookdale, single track with a passing loop to the banks of the Severn (Angerstein 2001, 338).

Interchange

Angerstein's depiction of a railway down the slopes of the Severn gorge suggests that the engineering of the jetty was minimal (Angerstein 2001, 338). Staithes in the north-east of England were substantial structures, and their operation is understood from documentary and cartographic sources, though there are few illustrations. Their scale was in part dictated by the large Tyneside wagons, by the size of the ships they were loading and to the fact that they served tidal waters. Bennett, Clavering and Rounding illustrate Derwenthaugh staiths in 1752, the best known example of their operation, with their off-gates for empty wagons and their 'turnrails' (turntables) (Bennett, Clavering and Rounding 1990, ex Durham University Department of Palaeography CG/Bute e5).

Infrastructure

Infrastructure on railways of this period was minimal. The archaeological discovery in 2013 of a soak pond on the Willington waggonway is particularly revealing, as enabling understanding of a site-type previously only known to exist from documentary sources, where wagons were immersed in water to prevent the wooden wheels from cracking (The Archaeological Practice, 2013).

3.3 The early iron railway – 1770 to 1830

Context

The period 1770 to 1830 saw the remarkable and sudden development of railways in England from mineral handling systems built almost entirely out of organic materials and relying on animal power, to a mechanical technology using cast- and wrought-iron components, with the capacity to move not only primary products and manufactured goods but also passengers – furthermore, to do so at an inter-regional or even national level.

This development was encouraged by comparatively stable internal relations after 1745, by military need during the Seven Years' War (1754-1763), the American War of Independence (1775-1783), and the Revolutionary and Napoleonic wars (1793-1815), by easier access to capital and by the opportunities offered by the growing British trade network.

Traffic patterns become more complicated as railways were called upon to do more than serve a mineral export sump. Coal remained all-important to the development of railways in this time-period but crucially railways were increasingly being built to supply it to an industrial point of end-use rather than purely move it from pits to navigable water. As a consequence, railways were being installed as internal systems within a wider variety of carbon-based industrial undertakings such as lime-kilns, gasworks, blast-furnaces and chemical works, and were coming to be found within other types of concern such as lead, copper and ironstone mines, dockyards and farms. Quarries came increasingly to depend on railways; inclined planes connected limestone outcrops to the Kennet & Avon Canal at Conkwell (1801), Murhill (1803) and Bathampton (1808), and the Burlington slate quarries in Cumbria were connected to tidal water from 1808 (Elton 1963; Geddes 1975)

This period is therefore not only characterised by the construction of more railways that were over 10 miles in length, but also by the increased adoption of very short systems within manufactories. The Conkwell incline in Wiltshire, for example, was only some 500 yards long and its life was short as the limestone from the quarry it served was of poor quality. The archaeological evidence of the alignment however is impressive.

Like the wooden waggonway, the early iron railway developed in different ways in different regions of England, one based to a great extent on the newer transport economy of the canal system, the other centred around the collieries of the north-east.

Canal and other railways

The development of the English canal system, from the building of the Bridgewater and the Sankey canals in the 1740s through the 'canal mania' of the 1790s, to the golden age of the inland waterways up to 1830, led to the construction of many miles of tributary railway. Canal acts often permitted the laying of a feeder railway even without a landlord's approval. In addition, railways continued to be built to connect with the sea-coast, a river or a road, as their predecessors had done.

Many of these initially used wooden rails but in 1767 Coalbrookdale took the step of laying iron strips along the top of the wood ('strap rail') on its existing railways leading to the Severn and to the road system. The next stage was casting all-iron edge rails, by 1787 in South Wales (van Laun 2003) and their spread to England by 1791-1792 (Lewis 2003).

Another development was the use of 'plateways', cast-iron L-section rails for flangeless wheels, from 1788. This particular technology had its precedents in wooden track technology, and became the dominant type of railway in England from the late 18th century to the 1820s. The plateway has been described as 'a cul-de-sac in railway development' (Lewis 1970, 294) but proved an effective means of moving goods for many years. As a loose-fit technology it was robust and supremely fit for purpose. Engineers and investors who compared its merits with those of other systems certainly saw its advantages. However, plateways were difficult to operate with heavy locomotives once these were introduced. The one region of England which largely resisted this technology was the north-east; here, only the Wylam waggonway was rebuilt for plateway operation, in 1808. Plateways were widely adopted in Wales and to a very limited extent in Scotland, but were rarely found outside the British Isles.

Many early iron railways were designed and constructed by canal engineers, with the result that their technologies influenced each other – for instance the use of locks and inclined planes.

The north-east of England

This region stood outside the trend of developments elsewhere in the period 1770-1830. It did not invest in canals, for which the terrain was ill-suited. Other than the Wylam, it did not abandon the broader-gauge edge railway model using chaldron wagons that had already served it well for many years. Instead, the coal industry of the north-east set out to improve its existing transport technology, and did so to remarkable effect, creating a system that lies at the heart of the railway to this day.

Waggonways were gradually adapted, rebuilt and re-aligned so that from the late 18th century, wagons could be coupled in twos or threes rather than singly, along iron rails. New railways were constructed which instead of descending to the Tyne on precipitous 'runs', ran on near-level

formations interspersed with inclined planes – one respect in which its evolution was similar to canal-inspired systems. Where the descent favoured the load, these inclined planes were counter-balanced, a practice noted from 1784. Otherwise they were powered by steam, from 1805, the same year that the first experimental locomotives in England were being assembled at Gateshead (Mountford 2013, 2, 25; Rees and Guy 2006, 195-197). Blenkinsop's rack engines on the Middleton at Leeds were the first practical steam locomotives but it was in the north-east of England that the first all-steam railway was built, using both locomotive and fixed engines, in 1822, to connect Hetton colliery with the River Wear. The Stockton & Darlington in 1825 combined locomotive-haulage of coal with the carriage of passengers (by horse-drawn vehicle), and demonstrated the possibilities of wrought iron ('malleable') rails.

Roads and national networks

The increased adoption of railways in England in this period must be seen in the context not only of the expanding canal system but also of improvements to roads.

Growing demands on the road system encouraged greater engineering sophistication, particularly from the mid-18th century onwards. Improved trunk roads such as the London to Holyhead route were conceived as national transport systems (Quartermaine, Trinder, Turner 2003). The use of stoneways with deliberately created wheel-ruts suggests that the distinction between railway and road might not have been one that contemporary observers would have maintained. A parliamentary committee in 1808 considered trunk roads with ruts laid with iron strips on the bottom, and proposals to operate steam coaches on rutted stoneways were being touted in the 1830s (Parliamentary Papers, *First Report from the Committee on the Highways of the Kingdom*, 1808, 42-44; Smith 2014). The longest stoneway, and perhaps the most successful, operated along Commercial Road from the West India Docks to London from 1830 to 1871 (Smith 2014).

In some places, roads and railways shared formations, for instance on the course of the Gloucester & Cheltenham (Bick 1987, 28, 30, 72, 74).

By the 1820s however such was the extent of the network of turnpike roads – albeit improved largely as the result of local initiatives rather than part of any national plan – that for the first time point-to-point timings of mail and stage coaches were largely limited by the capacity of the horse rather than the state of the road-surface (Albert 1972, Austen 1981, Barker and Gerhold 1993). Increased numbers of coaching inns, and reductions in the lengths of stages at which horses were changed, made road travel for passengers, while expensive, superior to anything to be found elsewhere in Europe. Improvements in design of passenger road vehicles and their wheels, contributed to speed and reliability (Fry 1820, Fuller 1828).

Carriage of freight by road however was laborious, hence the willingness to invest in river, canal and coastal trade and the various railway systems that were adjuncts to them (Chartres 1977, Hey 2001, Gerhold 2005)

The possibility that railways might form an effective system of national communication is suggested as early as 1768 (Edgeworth 1768). This had not been achieved by 1830, though it was clear that both the technological capacity and the capital were available. By then there were plenty of advocates for the railway. In 1825 Thomas Gray in his *Observations on a General Iron Rail-Way or Land Steam Conveyance* supported his claims on the title page for rail-roads and locomotive engines '… to supersede the necessity of horses in all public vehicles; showing its vast superiority in every respect, over all the present pitiful methods of conveyance by turnpike roads, canals and coastal-traders'. Gray's book sold well and went to several editions (those from 1820 were published anonymously), such was the new enthusiasm for the steam railway. Importantly, Gray's assertions

and the interest with which they were received, came before the steam locomotive had proved itself capable of long haul performance or of speeds and reliability significantly superior to the horse. Several horse-drawn railways connecting market towns were already in operation (the Gloucester & Cheltenham, the Stratford & Moreton, the Hereford), but it was the Liverpool & Manchester, a locomotive-worked main-line serving a global trade, that showed how railways would develop as a national network. After 1840 long distance passenger road services were a thing of the past, though short-haul road traffic on roads expanded exponentially throughout the 19th century to serve the railway system.

Traffic and organisation

The use of iron rails made possible a development which is now universal on railway operation, the coupling together of vehicles to form a train, for which there is growing evidence from the end of the 18th century (Lewis 1970, 201, 207, 275, 294). Another significant change was that Acts of Parliament sanctioning canals also made it possible to construct tributary railways to them which had to be open to the public to use. This meant that systems came into being on which several different freighters might be running their own trains with their own horses (and ultimately their own locomotives) on what was in effect a public railway.

Distribution and 'take-up'

Take-up of iron railways varied considerably from one part of industrial England to another. London seems not to have had very many, perhaps because the Thames provided a natural transport route (Guy 2014). Cornwall and the West Country, though innovative in terms of other forms of mining technology, and with good access to capital, built only three overland railways in the period before 1830 (Messenger 2015). By contrast, the northern coal-fields built some remarkably ambitious systems, and rebuilt many wooden waggonways as iron railways.

This period also sees the adoption of English-inspired iron railway systems elsewhere in Great Britain/the United Kingdom,[1] the United States of America, British North America, France, Wallonia (successively part of France, the Netherlands and Belgium), Prussia, the Austrian empire and New South Wales.

As noted above, one area outside England which does not fit neatly into a conventional narrative of technical diffusion is Wales, both in its extensive mileage of railways by 1830 and in its capacity for independent technical and commercial innovation. Well-established trading links in copper ore across the Severn channel enabled Neath Abbey Ironworks to market its products in the south-west of England, including the preserved Portreath passenger car. The use of narrow gauge iron edge railways in the limestone areas of South Wales from the 1790s was adopted in the slate industry of north-west Wales in 1801, from which they became the model for public narrow gauge railways all over the world after 1870.

Attributes

Formation

Early iron railways were constructed as much on a level as possible, and where this was not an option, used inclined planes. In this respect at least, early iron railways more closely resemble contemporary canal engineering, with their combination of contour formations and locks, than they

[1] This form of words recognises the constitutional changes of 1800-1801.

do earlier wooden waggonways with their fierce 'runs', or the later generation of steam railways, where more powerful locomotives could cope with steep gradients.

Careful testing in the late 18th and early 19th century had established the extent to which a gradient on a railway would affect the capacity of a horse to pull a load. A horse could pull 8 tons on an iron railway laid on absolutely level ground. The equivalent figures for a pack horse are ⅛ ton; for a horse pulling a stage wagon on a 'soft' road, ⅝ ton; on a macadam road, 2 tons; on a river, 30 tons; and on a canal, 50 tons (Skempton 1953-1954, 25; see also Hughes 1990, 43). The lower carrying-capacity of a railway had to be sent against its comparative cheapness, between half and a third of the cost of a narrow-boat canal (Hughes 1990, 37).

Railways were less costly than canals because their earthworks were on a smaller scale, though Benjamin Outram advised against 'sharp turns and circuitous tracts' if possible and suggested that 'in very rugged countries short tunnels may sometimes be necessary' (Outram 1801). The first railway tunnels were indeed constructed in this period, the first two being 'cut and cover' types at Flockton (by 1788 – Goodchild 1982), followed by Fritchley on the Butterley gangroad (1793). Fritchley was constructed by Benjamin Outram, who also cut the Stodhart on the Peak Forest Railway (1795), also in Derbyshire. There is a cut-and-cover 'amenity' tunnel under the approach to Calke on the Ashby & Ticknall of *c.* 1800.

A few architecturally ambitious railway bridges also came to be constructed, reflecting the sophisticated techniques developed previously by engineers such as Jean-Rodolphe Perronet and Charles Labelye. The Stockton & Darlington's bridges included the splendid masonry arch over the Skerne by the Durham architect Ignatius Bonomi (so splendid that the Quaker Edward Pease wanted something simpler), and the iron lenticular truss over the Gaunless, the first iron railway bridge in England (now preserved at the National Railway Museum, York). This is normally credited to George Stephenson, whose experience of iron structures is discussed in Fitzgerald 1980, 22-23.

Another innovation was the skew arch, a method of construction that enables an arch bridge to span an obstacle at an angle other than 90°. The earliest examples were on canals, but their use on railways in the north-east of England and their association with the engineer William Chapman are somehow referenced in the painting of the *Steam Elephant* locomotive (Rees 2001).

Track

As important as the development of mechanical traction was the introduction of iron rails. These took many forms, and their typology is complicated.

The simplest was 'strap rail' in which cast- or wrought iron strips were attached to the surface of wooden rails, as wooden top-rails had previously been. Cast-iron strips had been added to wooden rails at Coalbrookdale in 1767.

Cast-iron edge rails were first used in South Wales, in 1787. Early examples were attempts to reproduce wooden beams in cast form, but the growing sophistication of beam theory in this period led to a number of different forms evolving; the simple bar rail type that first appears in 1787 was evidently known on Tyneside by 1791 and in Lancashire by the following year. A variant had integral feet for attaching to a block or sleeper. Cast-iron rails with a 'fish-belly', a deeper vertical middle section to prevent failure in tension, were applied by William Jessop to his Belvoir Castle railway between 1813 and 1815, to his Mansfield & Pinxton Railway in 1817-1819 and to his Cromford & High Peak, devised in 1825-1827 but not opened until 1831-1832, the last significant railway in England to be built with cast-iron rails. Losh and Stephenson's patent of 1816 incorporated a bottom flange, a single cross pin and lap joints (Lewis 2003).

Cast-iron plates, for flangeless wheels on L-section rails, were first introduced by John Curr (*c.* 1756-1823), a Sheffield coal viewer, in 1786-1787 for use underground, but it was not long before plateways were introduced for surface lines as well (Curr 1797, 5; Science Museum Library: ms 588; Mott 1969-1970; Lewis 1970, 316-318). Plateways were promoted by a number of engineers, including Benjamin Outram (1764-1805) (Schofield 2000). Between the 1790s and the 1820s most important rail systems were built to this system. Plates could be laid on wooden sleepers or stone blocks, either directly or in chairs or by means of 'sills', castings which were two linked chairs, which kept the plates to gauge.

Wrought-iron edge rails ('malleable iron rails') were first used experimentally at Tindale Fell in 1808, but it is only with the opening of the Stockton & Darlington in 1825 that they were finally vindicated as the optimal form of permanent way and their use became general. Early examples are rectangular in section, being the simple 'merchant bar' of the period, but later examples are rolled to a T-section, often with a deeper 'fish-belly' between the points where the cast-iron chairs held them on to either wooden sleepers or stone blocks.

Vehicles

The basic typological distinction between the Shropshire and the north-eastern vehicles remains, though in the 1780s the Tyneside Western way introduced the overshot brake, which enabled two wagons to be run at a time (Lewis 1970; Bennett, Clavering and Rounding 1990, 179). Plateway vehicles (sometimes called 'trams') took various forms, depending on what they were called upon to transport – iron box types for limestone on the Peak Forest and high-sided wooden bodied versions with greedy-boards (a hinged flared top) for coal on the Little Eaton, both designed by Outram (Boyes and Lamb 2012, 96-104).

Motive power

In this period, fixed prime-movers, including both waterwheels and steam engines, and steam locomotive engines, become options for propelling rail vehicles. Earlier methods – animal power, gravity and counterbalance – remained important. Rope haulage became more sophisticated; as well as inclines built to overcome a fall in height, less steep and longer rope- and chain-worked systems were designed where the potential energy of the fall in height was used to transport the wagons a substantial distance.

The growing adoption by English railways of the new technology of high-pressure steam cut across the regional and technical differences that emerged as iron railways took hold. The Ketley inclined plane in the Ironbridge Gorge, built by the Shropshire ironmaster William Reynolds on the Shrewsbury Canal in 1791-92, used a compact engine of a type widely used in the area for winding colliery shafts. It did not operate the incline directly but filled a water-balance mechanism by pumping out the lock at the summit where the tub boats were placed on a railed cradle. However, several other steam engines were operating plateway inclined planes in the immediate vicinity by 1796, the first instances in the world where railed vehicles were moved by steam (Trinder 1981, 102-103)

These, nevertheless, operated short railed sections on what was otherwise a canal. The Preston plateway in the north-west of England, operational from 1803, was the first overland railway to use steam power. A Boulton & Watt engine wound its inclined plane at Avenham, but it is not clear what form the engines took on its other two inclines. The first such winding engine in the north-east was at Blackhouse in 1805, possibly a Trevithick (Mountford 2013, 23-30). Fixed winding engines operating inclined planes were an essential element of the first all-steam railway, George

Stephenson's Hetton, opened in 1822 as well as of his Bowes Railway (the Jarrow & Pontop), opened in 1826 (Mountford 1976; Mountford 2013). Later steam winding engines from the Stockton & Darlington and the Leicester & Swannington are preserved at the NRM, and the Middleton Top Engine from the Cromford & High Peak Railway, built by the Butterley Company in 1829, survives *in situ*.

Trevithick's compact high-pressure machines could also be constructed to be self-propelling. Road locomotives were nothing new; before the first railway locomotives were built, Cugnot's *fardier à vapeur* for moving artillery, dating from 1769-1770, was already an exhibit in the Conservatoire National des Arts et Métiers in Paris. However, it was essentially an experimental essay for demonstration purposes, and Trevithick's locomotives never really progressed beyond this stage either. A road locomotive to his design which was tried out at Camborne in 1802 may have been followed by an engine at Coalbrookdale the following year, but it was at Merthyr Tydfil in Wales that the first attested run of a railway locomotive took place, on Monday 13 February 1804. It is likely that similar locomotives were at work in or near Gateshead in 1805.

It was at Leeds on the Middleton railway that the first successful locomotives were built and operated (Bye 2003, 2010 and 2014). They used a rack system, not to climb a steep gradient but to enable them to pull a commercially viable load along on the two level sections without being too heavy for brittle cast-iron rails (Bye 2003, 135, 139). Locomotives to this basic design were tried out in Wallonia, possibly as early as 1814, and in Prussia in 1816 and 1819 (de Bruyn, n.d.; Clarke 2001).

In the north-east, locomotive technology was developed to become an entirely practical form of traction, by George Stephenson and his son Robert, as well as by Timothy Hackworth, John Buddle and William Chapman. The slow-moving four- and six-coupled locomotives they built from 1813 onwards operated over distances of 2½ to 3 miles in conjunction with horse traction and rope haulage. They built locomotives for railways in Scotland (from 1816), Wales (from 1819) and France (from 1828 – Dendy Marshall 1953; Paxton 2001; Reynolds 2003; Clarke 2001). The firm of Foster, Raistrick & Co. of Stourbridge in the West Midlands built its first locomotive in 1828-1829 and provided the first English locomotive exported to the USA in 1829 (Bailey 2014).

The building of the *Rocket* by Robert Stephenson in 1829 for the Rainhill trials represented a break with this existing design tradition, by creating a machine able to make journeys of 30+ miles and attain speeds of 30+ miles per hour. *Rocket* was built with a multi-tubular boiler, a separate, coke-burning fire-box and machined slide-bars. Its design lent itself to adaptation and improvement; from it followed the *Northumbrian*, then the 'Planet' and the 'Sampson' types, the mainstay of the early main line railways of England and of the USA. The *Rocket* put paid to the idea of using fixed engines for rope operation on level or near-level lengths of track, which was being actively explored in the 1820s. Rope haulage, it became clear, was best suited to gradients beyond the capacity of locomotives, but was too complicated a matter where sidings and shunting were involved. (In its use of a fixed steam engine and a transmission system to the trains, it does anticipate the abortive atmospheric railway of the 1840s and the successful electric main-line developed from the late 19th century onwards.)

Interchange

The scale and form of interchange facilities underwent significant change in this period. From the early years of the 19th century in particular, coal transhipment facilities in the north-east of England made increasing use of 'drops', whereby a wagon was lowered on a counter-balance above a vessel, and the spout system in the staithes was improved to reduce breakage (Powell 2000). Engineered wharves were constructed where railways served canals or tidal water, some of them on a significant scale, such as at the lower terminus of the Peak Forest Railway (Boyes and Lamb, 2012,

60-69), and at both canal termini of the Cromford & High Peak (Boyes and Lamb, 2012, 69-72, Rimmer 1985, 15, 18, 62-67). The Gloucester & Cheltenham connected with extensive wharves where the Severn met the Berkeley canal (Bick 1987, 19-21).

Norris 1987 28 illustrates a road-rail interchange yard on the Stratford & Moreton, and its warehouses, some of which are believed to survive.

Infrastructure: passenger stations

The carriage of passengers by rail in England predates the Stephenson main-line but only by about fifteen years, on the Severn & Wye, the Plymouth & Dartmoor, the Mansfield & Pinxton, the Stratford & Moreton and the Hereford (Lewis 2014).

Dedicated facilities for passengers are to be found on English canals from the late 18th century and on turnpike routes in the form of inns and hotels from much earlier, but there is little evidence for their existence on railways before the 1820s. The Liverpool Road terminus of the Liverpool & Manchester is the world's oldest surviving station on an inter-city main line. It contains the passenger building housing the original departure and arrival facilities and retail outlets, and the goods warehouse with under-cover goods handling, storage and distribution facilities. Along with the Irwell Bridge, where George Stephenson's initials survive in the keystone, they form the core of Manchester's Museum of Science and Industry. Public appreciation of the buildings and bridges is high.

Fitzgerald 1980 states there is no obvious precedent on any earlier railways for these elaborate facilities, and that the Stockton & Darlington's booking office and waiting room only date from 1833 (Fitzgerald 1980, 49-59). Work currently in draft by Niall Hammond and Caroline Hardie-Hammond, of Archaeo-Environment Ltd strongly suggests that in fact the Stockton & Darlington had dedicated passenger facilities from its opening in 1825, and that some of these structures survive (pers. comm.). Another possible early station building is situated on the course of the Hereford. As noted, its terminus was obliterated by a new bridge in the 1960s, but it is possible that the 'Tram Inn' in the parish of Dewsall was an intermediate station. This is a double-fronted two-storey building, latterly a public house, which survives near the operational level crossing, facing the station building erected by the successor Newport, Abergavenny and Hereford Railway. The inn was built directly by the railway company in 1829 and leased out to William Fosbrooke, a well-connected and evidently prosperous land surveyor who also contracted to repair the whole line (Cook and Clinker 1984, 33, 60, 61, 63). Whether it served any other function than serving drinks to passengers is unconfirmed, but the Hereford Railway carried people from the start, so it is likely that Fosbrooke was in on this venture and that it was here that he also sold the right to travel, in his own carriages.

More puzzling is another Tram Inn in the same county, in the centre of the village of Eardisley, a few minutes' walk from the meeting point of the Hay and the Kington railways, where a weighing machine was installed in 1822. This timber-framed building, still a public house but not necessarily built as such, clearly long predates the railways. The Hay carried passengers from 1824, but there is no evidence that the Kington ever did, and beyond the name there is no evidence that the inn ever had any relationship with either railway.

Harwood 1994 wisely observes of early stations on the Baltimore & Ohio that it is hard to be certain of what constitutes a 'station' and that received wisdom should be treated with extreme caution. It is not really clear whether any station actually survives from the first decade of this railway's operations, and some of the facilities may have functioned in the same way as we suggest did the Dewsall pub, as a semi-independent venture. Another non-English parallel here is the former Stags Head in Pen y Groes (Gwynedd) on the Nantlle Railway in Wales where the publican was apparently

running a passenger service by 1829 – Gwyn 2000). Some fine station-depots remain on the course of the Linz-Budweis railway, including one at Holkov in the Czech Republic, but with no definitive history of this important system, it is rash to assume that they date to the line's first opening.

Infrastructure: depots, administrative buildings

The growing complexity of traffic on railways in the period 1770-1830, and the requirement by many systems that those who wished to use them should provide their own rolling stock and motive power meant that offices and weighbridge-houses came to be needed. The Silkstone plateway had 'tally houses' as well as a tommy shop (ArcHeritage 2011, 31). The Stratford & Moreton had weighbridges at Moreton and doubtless elsewhere as well (Norris 1987, 28). A row of quarrymen's houses built in 1798 with a platform alongside the Peak Forest Railway, perhaps for unloading stores and food, is possibly the oldest known railway platform (Boyes and Lamb 2102, 126). Railways carrying lime needed sheds to store quicklime (Boyes and Lamb 2012, 9).

Infrastructure: workshops

It is towards the end of this period that dedicated structures intended to facilitate railways' operations become apparent. There is little reason to believe that railways had much in the way of dedicated workshops or maintenance facilities until the late 18th or early 19th centuries. Internal systems might be serviced by whoever was responsible for the site as a whole. A plateway might keep a pile of plates in readiness for the inevitable breakages, and references to engineers being awarded contracts to maintain early iron railways make it clear that this was regarded as an important role (Skempton 2002). Horse-drawn railways needed access to carpenters, smiths and farriers. Workshops survive on the Peak Forest (Boyes and Lamb 2102, 89-90).

Two important locomotive manufactories survive. One is the Round Foundry at Leeds, where the Middleton locomotives were built (Gomersall 2006), the other is the Stephensons' Locomotive Works on South Street, Newcastle upon Tyne. This includes the original machine and erecting shops dating from 1823 which are identified by a commemorative plaque, an undertaking which continued to build locomotives and other steam engines into the 20th century.

3.4 The early railway's contribution to the Stephenson era – 1830 to 1840

Context

Sir Arthur Elton describes the opening of the Liverpool & Manchester on 15 September 1830 as one of the epochal moments which 'divide, precisely, the past from the future, the old from the new, the historic from the pre-historic, and of which nothing that came after was ever quite the same as anything gone before' (Elton 1963). This claim has been echoed in popular and academic historical literature as well as in television documentaries, though never with such eloquence.

It was not the earliest main line, as the first section of the Baltimore & Ohio had opened on 24 May 1830. This was a system inspired by English technology, and was operational within two and half years of its incorporation. If Hanoverian Britain alone possessed the technical knowledge to initiate such developments, the Adams-era United States evidently also had the intellectual, material, financial and legislative preconditions that could make them a reality. So, it became clear, did other countries – Belgium and the German Confederation acquired main lines in 1835, France, Russia and Austria in 1837, the Netherlands in 1839 and Naples in 1840. Of European capitals, both Dublin and Brussels had main-line rail services before London, in the form of the London & Greenwich.

Yet Elton's view of the significance of the Liverpool & Manchester is not over-stated. This railway represented a shift in scale and ambition that surpassed both the earlier generation of iron railways and the longest canals and turnpikes. It represented a break with most predecessor railways in that it was not built to carry coal, but to serve the globalized economy of cotton. It anticipated passenger traffic on a significant scale, but even so found that this formed an unexpectedly high proportion of the railway's revenue. It connected two buoyant cities, one a port and the other a manufacturing town. It represented a step-change in the way that passenger facilities were set out and managed. It was mainly locomotive-operated, and the locomotives themselves were the design-precursors of nearly all steam locomotives that followed. The traction system represented by the Liverpool & Manchester has been identified as 'a triumph of Enlightenment rationalism, the method which identifies successful solutions to technical problems', and as 'a machine ensemble of which the chief characteristics endured for some 120 years' (Duffy 1982-1983, 56). This is undoubtedly true, and many of its elements endure to this day. The only significant departure from the Stephenson model for main lines in the period 1830-1840 was Brunel's London & Bristol/Great Western Railway, with its 7' 0¼" gauge and its 'baulk road', effectively a heavy form of strap-rail, which lasted until 1892. However, the enduring and extraordinary accomplishment that the Liverpool & Manchester represents should not obscure the significance of all that had preceded it over nearly three centuries, nor of systems displaying 'early railway' characteristics which remained to be built after 1830.

Typically these used wrought-iron rail and were laid to standard gauge, but were not exclusively locomotive-operated, as they made use of horses and inclined planes as well. Coal carriers included the Avon & Gloucestershire (1830), the Rainton & Seaham (1831), the Leicester & Swannington (1832-1833), the South Hetton Railway or Braddyll's Railway, the Clarence Railway (both 1833) and the Stanhope & Tyne Railway (1834). The Cromford & High Peak connected two canals across Derbyshire's 'limestone dome', linking the north-west with the east Midlands, England's answer to the Budweis-Linz railway.

The Canterbury & Whitstable, opened in May 1830, claims the distinction of being the first railway in the world to carry fare-paying passengers on an advertised service hauled by a steam locomotive but it was hardly a main line, and had no significant industrial base to sustain it. Its final demise in 1952 is referenced in the Ealing comedy film 'The Titfield Thunderbolt', where the town clerk reminds the railway-enthusiast vicar of its closure, only to be told 'Perhaps there were not men of sufficient faith in Canterbury' (Fellows 1930). More successful was the Bodmin & Wadebridge (1834), exceptional in that the bulk of its traffic was carried inland from the harbour – sea-sand from the Fowey estuary as agricultural fertiliser, and some general merchandise, though there was mineral traffic down the line as well (Messenger 2012). The Whitby & Pickering (1836) was built to revive Whitby's whaling and shipbuilding industries, just as the Baltimore & Ohio and the London & Bristol/Great Western were intended to turn round the fortunes of declining ports.

Attributes

Formation

From 1830 onwards, innovative approaches to formation-building were to be found on the new main lines rather than on mineral-carrying and secondary systems. The Liverpool & Manchester had had to cross Chat Moss but otherwise the route presented little difficulty; the London & Birmingham by contrast required significant earthworks.

The most significant formations from this period are to be found on upland railways such as the Cromford & High Peak (1833) and the Whitby & Pickering (1836). There is a particularly fine stone-

walled and earth-fill embankment or 'causeway' at Minninglow in Derbyshire on the route of the Cromford & High Peak Railway

Track

The period 1830-1840 sees the wrought-iron rail proving itself against all other track-types. The fishbelly profile came to be recognised as unnecessary, and straight T-section rail held in cast-iron chairs became commonplace by the end of the decade.

From the 1840s wrought-iron fishbelly rails and T-section rails were replaced by rolled 'double bullhead' section designed to be turned over when the running surface had become worn. This was not found to be successful as wear from the cast iron chairs meant that when turned over the newly exposed surface produced a rough ride. Bullhead rail, with a defined head and foot and mounted in cast-iron chairs, had become standard by the mid-1840s. Improvements in wood preservation (tanalising, initially with salts of copper, potassium and arsenic) and the improved quality of ride that wooden sleepers provided, meant that stone sleepers were not used on main lines by the early 1840s.

Vehicles

The growth of the main-line systems from 1830 onwards led to a greater variety of vehicles being used on railways, including the distinctive passenger coaches which were built by fusing several stage-coach bodies on one underframe and various types of goods vehicles which were to become the mainstay of the rail network until recent times – livestock wagons and general goods trucks. The most common single rail vehicle type in the period 1830-1840, however, remained the coal-carrying north-east of England chaldron. By 1840 the 3-ton capacity bottom-emptying 'black wagon' variant was in widespread use. These were the mainstay of the area's coal-carriers for many years, and some remained in service until the late 1960s (Darsley 2006, 238-241).

Motive power

After 1830 the steam locomotive became a 'typical' rather than an 'exceptional' technology, but established technologies such as horse-traction and rope-haulage on inclined planes remained commonplace. Systems that used these methods are invariably categorised as 'early' railways, but they remained the most effective means of moving rail vehicles in many circumstances for years to come. The Cromford & High Peak, opened in 1830-1831, made little use of locomotives until the 1850s, but did not retire its last horse until 1954, and used fixed engines on inclined planes until 1963 (Rimmer 1985, 12, Hodgkins 2003, 61).

Although the new generation of locomotives of the 'Planet' and 'Sampson' type swept the board on the main lines, Timothy Hackworth and his successors continued to build slow-moving 0-6-0 goods engines with return-flue boilers into the 1840s, which gave good service for many years (Young 1923; Bailey 2014, 184-192).

Interchange

Railways continued to be built to move coal and other mineral products to the sea long after 1830, though less commonly to canals or tidal rivers. The vertical drops installed at Seaham harbour in 1832 and adopted on the Clarence in 1834, the Stanhope & Tyne's bottom-pivoting jib at South Shields of the same year and the ten drops installed by the Stockton & Darlington at Middlesbrough in 1842 represent developments in existing technology in response to the growing trade. Whitehaven harbour was rebuilt in 1837, Hartlepool and Maryport in 1840 (Powell 2000). A coal

drop from Seaham harbour constructed *c.* 1850 (Atkinson 1968), the only remaining example, is in Beamish museum but has not been re-assembled.

Infrastructure: passenger stations

Mineral-carrying railways built in the 1830s seem to have made little investment in facilities for passengers, if they even bothered to carry them at all. The Stockton & Darlington improved its station provision in 1833, but it was the first generation of main lines that followed the Liverpool & Manchester's lead in devising lavish station facilities. Early provision for travellers on the Cromford & High Peak, the Canterbury & Whitstable and the Bodmin & Wadebridge by contrast was rudimentary.

Infrastructure: depots, administrative buildings

The growing complexity of traffic on railways in the period 1770-1830, and the freedom for freighters on public railways to run their own trains, meant that offices and weighbridge houses came to be built, reflecting canal practice.

Infrastructure: workshops, maintenance facilities, loco sheds

The period 1830-1840 sees the construction of the first major repair and servicing facilities on main-line railways at Wolverton on the London & Birmingham (1838), Derby on both the Midland Counties (1839) and the North Midland (1840) (Cattell and Falconer 1995, 11). The Liverpool & Manchester had built locomotive facilities known as 'Melling's shed' at Edge Hill and also stored its engines in a tunnel; John Melling had charge of locomotive repair works first at the Manchester end of the line and then at Liverpool, but in 1840 left to set up the Rainhill Iron Works (Thomas 1980, 108, 136-138). More immediately relevant to the early railway story is the development of Timothy Hackworth's Soho works, now part of the NRM's Shildon site in Co. Durham. The first part may have been constructed in 1831-1832. In 1833 Hackworth entered into a contract with the Stockton & Darlington Railway in which he became responsible for the working of the locomotives and workshops but remained free to operate his own business as a builder of locomotives and stationary engines. He opened new workshops, foundry and built houses for workers. The site includes a shed, stables and cottages (Hopkin 2010; see also Lamming 2003).

3.5 Historical development – conclusions

- 'Early railways' in England went through many different forms from the mid-16th century to the late Hanoverian period.
- Early railways functioned both as internal systems in industrial undertakings, and also as overland systems to move output nearer to a point of sale
- Overland early railways mostly acted as feeders to water-borne transport systems
- Early railways increasingly came to be built as alternatives to roads and canals
- The technology of early railways went hand-in-hand with the engineering of canals, industrial roads and turnpike roads, and with the evolution of other forms of handling systems in ports and harbours
- The construction and operation of early railways contributed enormously to the development of the coal trade and to other forms of economic activity

- Railways evolved in this period from mineral handling systems into regionally-significant public transport systems; by 1830 it was clear that the Stephenson railway had the potential to function as a national carrier

- Though early railways evolved into the outstanding technological achievement that is the Stephenson railway, this should not obscure their significance in their own right

- By 1830 the technology of these railways was being imitated elsewhere in the United Kingdom, as well as in continental Europe; in the United States of America; in British North America; and in Australia.

- Although after 1840 the steam railway led to the rapid extinction of long distance passenger road coaches, such was its enormous and positive impact on industry, trade and commerce that short-haul horse traffic on roads expanded exponentially throughout the 19th century.

4 KEY ATTRIBUTES FOR ASSESSMENT AND PROTECTION

4.1 Policy and assumptions

4.1.1 Statutory protection

Historically, cultural assets have been assessed by monument type in order to identify candidates for designation. This section reviews the statutory protection of key features of early railways. In England, this means *listing* or *scheduling*.

HE Listing Selection Guide on Transport Buildings notes of structures:

> When it comes to purpose-built railway structures, most pre-1840 buildings will often be of international significance as being among the earliest railway structures in the world, and even partial survivals need to be carefully assessed and designated accordingly.

It further notes of viaducts:

> The best listed viaducts are notable feats of engineering, striking in the landscape. A significant number are listed, 33 at Grade ll* and four at Grade l. As with other railway buildings, those erected before 1840 will be serious candidates for listing, but increasing selectivity is necessary for later periods ... Where viaducts are early in date, on one of the pioneering lines such as the Liverpool and Manchester, and designed by one of the great railway engineers such as the Stephensons, Brunel or Locke, listing at a higher grade should be considered.

HE's *Scheduling Selection Guide: Transport Sites* notes the following:

> WAGONWAYS TO RAILWAYS
> Built structural features will typically be more appropriately protected via listing. Good runs of sleeper stones marking courses of wagonways may be considered for scheduling, especially if associated with engineered cuts or embankments or other contemporary features. However, simple earthwork embankments and cuttings are unlikely to be deemed to be of national importance in their own right because they are relatively common nationally. Rarer earthwork features, such as non-locomotive hauled inclines, may exceptionally be of national importance.
>
> UNDERGROUND
> Many railways and canals (such as the Bridgewater Canal) include tunnels. In general, only the portals, where of architectural interest, are designated, through listing. However, some tunnels actually start underground within mine workings, often with loading and other facilities. Such remains should be included in designation assessments despite difficulties in access and identifying ownership; the Dudley Tunnels on the Dudley Canal (West Midlands) is an example of such a scheduling. However, difficulties in mapping underground remains – often complex and three-dimensional – can often constrain designation aspirations. Nor will scheduling necessarily be appropriate even if the remains are deemed nationally important; other management options may be more beneficial. Careful consideration will be needed on a case-by-case basis.
>
> VEHICLES AND AIRCRAFT
> Under the 1979 Act it is possible to schedule the remains of a transport-related item such as a vessel, vehicle or aircraft. No such designations have taken place to date, save for the

exceptional scheduling of some vessels. These are considered in the Ships and Boats selection guide. Civil aircraft and vehicles have never been hitherto considered for scheduling, and it is hard to think of any circumstances in which this would be an appropriate response.

Section 2.5 of the present document observes that despite the significant amount of research that has been undertaken on early railways in England, there are many gaps in knowledge; 3.5 notes that these assets take many different forms. Current designation is therefore unlikely to be representative of surviving Early Railway sites and of monuments of national and international importance.

4.1.2 Planning controls

The re-framing of English National Planning Policy and alterations to Planning Legislation in recent decades has changed both the tone and detail of the planning process. The intention is to simplify and expedite the granting of planning consent, and to discourage applications in areas where consent is unlikely to be granted. There is an increasing presumption of consent for development. The former onus on the developer to provide justification and mitigation strategies for damage to any environmental resource before consent is granted has been modified to an increased requirement for local councils and national parks to prepare, justify and publish detailed documentation providing information on their statutory position with regard to potential development on all land within their area of responsibility (variously referred to as Local Plans or Local Development Frameworks). With regard to the Historic Environment, these Plans are primarily underpinned by means of Local Lists and Conservation Area designation, although Historic Environment Records are still acknowledged as valuable sources of information.

Local Lists

Local Lists have been a potential factor in local planning decisions since the 1970s, and were intended as an index of structures which did not merit Statutory Designation but which were of particular value to the heritage and development of the relevant community. This added value was expected to be taken into consideration during the formulation of Local Plans and of planning consents. In practice, however, Local Lists were heavily compromised as a tool to inform planning decisions. Many local planning authorities have yet to produce lists of locally important sites and buildings. The majority of those which do exist were initially compiled in the 1970s and 1980s, and due to resource constraints are unlikely to have been reviewed regularly thereafter. Where present, Lists tend to be weighted in favour of buildings, and may be of limited use in the protection of the type of non-structural landscape features associated with the archaeology of early railways.

Nonetheless, current legislation adopts Local Lists as a prime plank of heritage management by means of development control, and it would be imprudent to ignore their potential. Local historians and early railway specialists could work together to determine the current state and format of Local Lists in the areas of known significance. Where a Local List exists, arrangements could be made to submit to the List curators all information from a Heritage Assessment Audit relevant to any sites not meriting statutory designation. Where a Local List has yet to be prepared, the relevant information would then be submitted to the local planners in the character of a first step towards formulating such a list.

We note that it is unlikely that local councils will be provided with additional resources to evolve and curate Local Lists. Care will therefore need to be taken to submit all data in a form appropriate to the mapping and database software in use by the relevant councils, since material unsuited to immediate assimilation and use is unlikely to have any real impact on local decision making.

Conservation Areas

Conservation Areas (CAs) are intended to preserve the special architectural and historical character of the area designated, and form a second plank of the Heritage element of the revised Planning Policy. Although primarily map-based, each Conservation Area is intended to be supported by a detailed document identifying the individual features and landscapes within the Area which contribute to its special character (Conservation Area Appraisals or CAAs). In common with Local Lists, the majority of Conservation Areas date from the 1970s and 1980s; as a result, most Conservation Areas lacked CAAs at the beginning of the 21st century. In the intervening period, substantial steps have been taken to redress this situation, but statistics published by Historic England suggest that around 20% of CAs still require preparation of appropriate Appraisals. In addition, an informal survey of the available material suggests that in some councils, fewer than half of the completed CAAs have so far been published. Few in any case are likely to have been informed by detailed knowledge of early railways. As with Local Lists, there is still potential to influence the content and intent of the CAAs which have yet to be completed or published, and where appropriate it should be possible to supply Planning Authorities with content of significance to an understanding of Early Railways.

We note, however, that inclusion within a Conservation Area may not be the most appropriate means of protecting significant Early Railway sites. There are a number of reasons for this. First, CAs are most likely to have been designated in urban or suburban settings, and may not be available as a mechanism for site management in the type of rural or brownfield sites with which much Early Railway archaeology will be associated. Second, appearance and visual quality forms a large part of the special character associated with most Conservation Areas. Industrial and Transport features in poor condition and of questionable architectural quality, such as those highly likely to characterise Early Railway sites, may be considered by planners and the general public to detract from rather than to enhance the special interest of a Conservation Area.

Finally, the primary mechanism for development control within a Conservation Area – the removal of Permitted Development Rights by means of an Article 4 Direction – may be unsuitable for the protection of features of the type likely to be found on early railway sites. It is possible to conceive of a scheme which 'preserves' the location, scale and general appearance of a feature of archaeological interest while destroying or materially altering details of archaeological significance. Finally, it should be noted that there are limits on the extent to which Article 4 Directions can be used to withdraw Permitted Development Rights from a statutory undertaker – a material consideration when dealing with land that may border, or form part of, an active railway line.

Historic Environment Records

Under previous Planning practice, Historic Environment Records (HERs) served as the primary source of archaeological data supplied to the Local Planning Authorities. The re-drafted National Planning Policy has not accorded HERs statutory status, although acknowledging their value as a resource. In practice, however, consultation by Local Planning Authorities of the UK's Historic Environment Records remains the most practical and flexible mechanism for providing protection to sites of archaeological and historical interest.

It seems likely, therefore, that Planners will continue to rely on HERs as their primary source of information. As with Local Lists and Conservation Areas, local historians and early railway specialists could provide all relevant HERs with content of significance to an understanding of Early Railways. We note that the requirement to submit data in a form consistent with rapid assimilation into the existing database is particularly crucial with HERs.

Museum policy

The curatorial policies of the museums which have significant early railway holdings appear comprehensive and adequate. Crompton 2003 discusses how a curator's responsibility for a museum item can prompt investigation into its history; Scott 2006 considers the optimal ways of presenting the early railway 'story' in the NRM.

4.2 Attributes

This section summarises what is known of early railways attributes in the light of policy and presumptions relevant to their protection and conservation.

Formation

Extent of the resource

An early railway formation might be a Cornish foreshore, the floor of a mine, a large Tyneside 'battery', the barely-visible trace of a short-lived and small-scale system across a Shropshire field, a stone causeway striding across upland Derbyshire, or a street in a genteel spa town. It might well not be a linear route at all, but a trunk and branches in plan, in which different lengths of track from mineral-extraction sites joined together to form a route to navigable water. An early railway site might therefore more truly constitute a landscape rather than purely a linear feature.

In terms of archaeological survival and the need to assess and protect, the formation is often the only surviving evidence for an early railway, yet at the same time it can be difficult to recognise – many have simply been ploughed out where they crossed good agricultural land, and the course often has to be inferred from archive maps or from discontinuities in field-boundaries. Others have disappeared under industrial and housing estates.

Because it can be the most costly part of any overland railway system, it is often re-used by a later railway or another transport system or become a footpath. Some early railway systems, in particular the early iron railways of the north-east coal-field, remained operational until the 20th century, much modernised but retaining essential characteristics such as inclined planes, and preserving the character of their original conception.

The formations of early railways in England undoubtedly run into many hundreds of miles, which is one reason why no consistent attempt has been made to map them. They include earthworks, bridges and tunnels.

Existing protection

Listing covers very few examples of early railway formation – parts of the Surrey Iron Railway and of the Avon & Gloucestershire, a length of the Haytor granite railway, and some bridges, including the Causey Arch and the Skerne bridge on the Stockton & Darlington (see **Appendix 1**). Other than the Causey Arch, these are all of the 'early iron railway' period.

Track

Extent of the resource

Formations undoubtedly survive on which buried lengths of track will be uncovered, but there is no known length of pre-1830 railway where track remains *in situ*. Early railway track items held in

museums represent a material contribution to understanding of the early railway. Particularly important examples include the Stretton collection at Leicester City Museum, and Michael Lewis' collection at Ironbridge.

Existing protection

Michael Lewis' collection at Ironbridge has recently been cleaned, stabilised, protected, boxed up and catalogued, including OS co-ordinates and is protected by the Museum's collection policy. It is not clear what level of protection has been extended to other collections in other museums.

Vehicles

Extent of the resource

Few items of early rolling stock survive, and these are mainly from the 'early iron railway' period.

- The Portreath passenger carriage, probably built at least in part by the Neath Abbey Ironworks in South Wales, in existence by 1812, is preserved in the Royal Cornwall Museum at Truro (Lewis 2014).
- A wagon from the Stratford & Moreton, presented to the town by the Great Western Railway. Faded lettering on the side of the wagon reads 'THOMAS HUTCHINGS, NEWBOLD LIME WORKS'.
- A wagon from the Peak Forest Railway, no 174, is preserved in the NRM. It is one of a type introduced in 1833, but in the opinion of the railway's historians, unlikely to be much different from the ones constructed in 1796 (Boyes and Lamb 2012, 101).
- The NRM preserves the remains of a Little Eaton gangroad coal wagon believed to date from *c.* 1798 (object number 1995-7783).
- A horse dandy at the NRM (object number 1975-7060) is included here, as although it is believed to date from 1845-1855, it may be typical of earlier technology.

Existing protection

All these items are protected by the curatorial policy of the museums by which they are held.

Motive power

Extent of the resource

Six English-built locomotives from this early period survive. These are:

- *Puffing Billy*, built by the Wylam colliery workshops for the Wylam waggonway in 1814 and preserved at the Science Museum, London
- *Wylam Dilly*, built by the Wylam Colliery workshops for the Wylam waggonway in 1814 and preserved at the National Museum of Scotland
- *Billy*, built by the Killingworth colliery workshops for the Killingworth waggonway *c.* 1815-1820 and preserved at the Stephenson Railway Museum
- *Locomotion*, built by Robert Stephenson and Co. for the Stockton & Darlington Railway in 1825 and preserved at Darlington Railway Museum (Head of Steam)
- *Agenoria*, built by Foster, Rastrick and Co. for the Shutt End colliery railway in 1828-1829 and preserved at the National Railway Museum
- *Sans Pareil*, built by Timothy Hackworth for the Liverpool & Manchester Railway in 1829 and preserved at Locomotion Museum, Shildon

Three locomotives from the early main line period survive. These are:

- *Rocket*, built by Robert Stephenson and Co. as a demonstration locomotive in 1829, bought by the Liverpool & Manchester and preserved at the Science Museum, London
- *Invicta*, built by Robert Stephenson and Co. for the Canterbury & Whitstable Railway in 1830 and preserved at Canterbury Heritage Museum
- *John Bull*, built by Robert Stephenson and Co. for the Camden & Amboy Railroad in 1831 and preserved at the National Museum of American History, Smithsonian Institution, Washington DC.

It has been suggested, but it remains unconfirmed, that the Trevithick-derived stationary engine in the Science Museum in London is the demonstration locomotive of 1808.

Early English-built locomotives of which significant components survive are the *Stourbridge Lion*, *The Pride of Newcastle* and *Novelty*. In addition, four later locomotives which retain some very conservative features should be mentioned. These are *Samson*, built at Timothy Hackworth's Soho works in 1838, preserved in Nova Scotia, *Nelson*, by an unknown builder in 1839, *Derwent*, built in 1845 by Alfred Kitching, and the Hetton *Lyon* of 1852 (Bailey 2014).

Despite being part of the moveable heritage of the railway, understanding of early steam railway locomotives is critical to a full appreciation of the railways on which they ran. Issues of tractive effort, axle loadings, capacity to negotiate bends and pointwork, flange and rail types, *etc* can be determined from detailed analysis of locomotives, as Bailey 2014 has demonstrated. These mechanical survivors from the earliest period of locomotive-hauled railways offer vividly illuminate how these systems operated.

Inclined planes and their prime movers are also a significant part of the story of the evolution of the railway. Rollers, discs and sheaves frequently survive either complete or in fragmentary form on inclines. Water-wheel driven winding systems have been identified at Morwelham quay. Steam winding engines from the Stockton & Darlington and the Leicester & Swannington are preserved at the NRM, and the Middleton Top Engine of the Cromford & High Peak Railway survives *in situ*. The Bowes Railway, a Scheduled Monument, includes inclined planes originally constructed in the 1820s which were operational until recent times and which could be returned to working order.

Existing protection

All the locomotive and fixed steam engine items are protected by the curatorial policy of the museums by which they are held.

Interchange

Extent of the resource

Interchange facilities between early railways and navigable water took many forms. These include coastal harbours such as Whitehaven, and the staithes on north-eastern systems. In several places, canal wharves served by early railways survive. Bugsworth basin on the Peak Forest canal and railway has been protected and conserved, similarly the canal wharves at both ends of the Cromford & High Peak Railway – at Whaley Bridge, a stone-built transit shed, at Cromford an open shed and warehouse incorporating an engine shed. Rail-road interchange facilities are less recognised, eg Wollaton, or the Coalbrookdale systems, which connected not only with the Severn but with Watling Street. Warehouses survive at the Moreton terminus of the Stratford & Moreton .

Existing protection

Bugsworth basin on the Peak Forest canal and railway has been protected, conserved and designated as a Scheduled Monument. The canal wharves at both ends of the Cromford & High Peak are listed grade II.

4.3 Key attributes for assessment and protection - conclusions

- Thematic initiatives have sought to assess cultural assets by monument type in order to identify candidates for statutory designation; this has had the benefit of providing an authoritative contextual platform from which to defend threats to individual assets. However current designation is patchy and is unlikely to represent the known chronological and geographic spread of early railway sites and of monuments of national and international importance.

- Early railway development in England was extensive; there is therefore considerable archaeological potential for the discovery of further significant early railway sites.

- Though early railway development in England was extensive, it was also to a great extent localised; it should therefore be possible to identify with reasonable accuracy areas most likely to contain structures and below-ground remains which merit consideration for statutory protection or preservation by record. Consultation with specialists in the subject, and with local and regional experts, will identify areas likely to repay more detailed examination.

- Consultation with specialists in the subject, and with local and regional curators, will establish whether levels of protection are appropriate where statutory designation exists.

- Inclusion within a Conservation Area may not be the most appropriate means of protecting significant Early Railway sites, since:

  - most are likely to have been designated in urban or suburban settings, rather than the rural or brownfield sites with which much early railway archaeology will be associated.
  - appearance and visual quality forms a large part of the special character associated with most Conservation Areas.
  - the removal of Permitted Development Rights by means of an Article 4 Direction may be unsuitable for the protection of early railway features.

- Consultation by local planning authorities of the HERs remains a practical and flexible mechanism for protecting sites of archaeological and historical interest.

- Consultation with specialists in the subject will provide HERs with content of significance to an understanding of early railways and inform supplementary planning guidance.

- The work of local Amenity Societies, Preservation Trusts and sub-national Special Interest groups is likely to prove crucial in the long-term preservation, management and interpretation of early railway Sites.

- Consultation with specialists in the subject will provide local Amenity Societies, Preservation Trusts and sub-national Special Interest groups with content of significance to an understanding of early railways.

- Specialists in the subject will identify exemplars of good practice.

- Consultation with specialists in the subject will examine options for making an appropriate contribution to characterisation exercises.

5 DISCUSSION

A technology evolved in the great north-eastern coalfield of England had a world-wide impact, and had already begun to 'go global' within the early railway period. By the late 1820s, it was clear that the future lay with locomotive haulage, on a gauge of 4' 8½" or so, that passengers could be carried profitably, that railways could connect cities, that they would supersede canals and turnpikes rather than serve them, and that they would require capitalisation on a very significant scale. There is a clear and evident line of descent from the Tanfield waggonway through later coal-carrying railways like the Stockton & Darlington and the Bowes, to England's first main line, the Liverpool & Manchester. The St-Étienne (1827) and the Baltimore & Ohio (1830) are early offshoots. The Japanese Shinkansen and the French TGV follow directly in this tradition, as does HS1 (the Channel Tunnel Rail Link) and as will HS2.

The significance of England's early railways extends well beyond technical achievement. By evolving into the major industrial-era land transport system, their long-term impact on human society across the world is incalculable. They profoundly affected the high politics of global finance, diplomacy, empire-building and warfare, and the no less important matters of the daily round – travel to and from work, diet, family and gender relations, identity and belonging.

Our knowledge and understanding of these systems reflects a growth of interest in the subject from slow beginnings in the 19th century to the quickening enthusiasm of the last twenty years. Research into early railways in England has been carried out in many different ways, and by a wide variety of people and interest-groups. A consequence is that it is now clear that there is still much scope for further work. Statutory designation and other forms of protection for important early railway assets do not at the moment reflect the extent of the resource, and a further expansion of knowledge is likely only to emphasise this.

The story of England's early railways has at times been told as a linear narrative of progress, and in such a way as to suggest that the railway was England's gift to the world, gratefully and unquestioningly accepted by its recipient cultures. Recent research suggests that the reality is more interesting and more complex. Railways in the USA adapted the basic technology in the way that is exemplified by the preserved Newcastle-built *John Bull* locomotive in the Smithsonian. Supplied in 1831, it acquired in America a pony truck to negotiate rougher track, and a spark-arrestor, essential for it to burn the abundant timber of the new world rather than Pennsylvania anthracite. The reconstructed French St Etienne Seguin-designed locomotive, with its enormous tender-mounted fans to provide an air-blast, shows a similar process of adaptation from the English prototype in order to use a different type of coal.

By the same token, apparently 'dead-end' territories also merit serious consideration and the respect of historians. The plateway was a dominant technology only for about thirty years from 1790 to 1820, yet as a type of railway it proved enormously effective within that time-frame for moving minerals and secondary products. Like other forms of technology, it made the most effective use of the material available at the time. Rope haulage is a technology associated with early railways but which had a long afterlife.

The relationship between England and Wales in terms of technology transfer is in many ways the most interesting and the most telling, in that a shared technical culture emerges, whilst at the same time local and regional differences also become more pronounced and evident. The early railway narrative is one with enormous potential to show how different countries, regions and technical cultures can compete, collaborate and learn from each other whilst maintaining their own distinctive identities, particularly relevant at a time when the relationship between the constituent parts of the United Kingdom and with neighbouring countries is put under examination and is redefined.

6 CONCLUSIONS

The commissioning of this report has come at an opportune and auspicious moment. For the first time it has been possible to understand the role of early railways in England and the extent of the material evidence that reflecting it. Especially important has been the work of the Early Railways Committee, under whose auspices five conferences on early railways, beginning in 2000, have for the first time brought the issues relating to early railways into scholarly focus.

This study has been able to draw on the accumulated knowledge and expertise of the Early Railways Committee, the publications emanating from the conferences, as well as wider consultation across what in the last twenty years has come to be a new and significant body of scholars.

As a result some clear conclusions have been drawn:

Railways in England were numerous and well developed before 1830. They made a significant contribution to the rise of the new industrial economy of the period 1550 to 1830.

They were important in their own right and as precursors to the railway revolution of the second half of the 19th century.

The material evidence of these early railways, in terms of formations, engineering structures and buildings, is more extensive than previously thought. As a body of evidence it is still to be the subject of systematic scholarly analysis.

That evidence is seriously under-represented in the corpus of designated heritage assets administered by Historic England. Much of it is not well recognised and as a result at risk of degradation or destruction through lack of awareness. Some very important material – including important designated assets – is at serious risk, most notably the Bowes Railway.

Further, there are important museum collections of items assembled from the sites of early railways – mainly items of rail and associated objects. These present a body of archaeological evidence that has not hitherto been assessed or subjected to co-ordinated scholarly research.

The recommendations set out in 8 below derive from these conclusions.

7 WORLD HERITAGE CONSIDERATIONS

An important aspect of the early railways study is to determine whether there are sites that meet UNESCO's criteria of Outstanding Universal Value and that might justify inclusion on the United Kingdom government's Tentative List as prelude to a submission for potential inscription.

In the discussions leading up to the publication of the 1999 Tentative List it was determined that an early railway site should if possible be included in the group of industrial heritage sites that formed a central theme of the List. Interest centred around an early locomotive-hauled railway that demonstrated innovative engineering and architectural features of real substance, and had not been unduly degraded by modern interventions. It was also felt that such an early line could underscore the fact that steam locomotive traction was pioneered in Britain, resulting in a number of well engineered and early lines, of which substantive remains survive.

There are a number of extant structures on the Stockton & Darlington and the Liverpool & Manchester but it was decided that these were not sufficient in terms of their completeness to form the basis for a convincing serial nomination. Similarly, remains of early railways in the north east of England were deemed too fragmentary and widely distributed to form credible elements for inclusion on the Tentative List.

Consideration of first generation main lines resulted in interest centring around the London & Birmingham and the Great Western main line between Paddington and Bristol. Although there are a considerable number of substantially intact remains of the London & Birmingham (Curzon Street Station, Kilsby Tunnel, Primrose Hill Tunnel portals, and a number of viaducts, for example) the effects of electrification in the 1960s were considered so intrusive as to exclude the L&B from inclusion on the Tentative List.

The Great Western main line however still retained a significant number of sites that were substantially original or contained important original elements. This resulted in a sequence of key features of the GWR line being included in the 1999 List (*eg* Paddington Station – while not of the 1839/40 period, it reflects the work of IK Brunel [1806-1859]), Hanwell Viaduct and Maidenhead Bridge [both later widened], the railway village at Swindon, Box tunnels, the approach to Bath through Sydney Gardens, and the Brunel train-shed at Temple Meads, Bristol). It was decided that the whole line would not be a practical proposition for World Heritage status, hence the 'beads on a string' basis for a serial railway nomination.

(The Newcastle & Carlisle, as an alternative to the Great Western main line, was later proposed by Gordon Biddle, as an early main line on which much of the civil engineering and architectural features remained intact. The Newcastle & Carlisle was formed in 1825 with an Act of Parliament passed in 1829 and opened between Carlisle and Gateshead, south of the River Tyne in 1837, and to Newcastle two years later. The line had begun operating mineral trains between Blaydon and Hexham as early as 1834 and passengers were carried from 1835. The suggestion that the Newcastle & Carlisle might be placed on the UK Tentative List has not been pursued.)

The Great Western proposal was received sympathetically by Network Rail and was the subject of widespread and supportive public consultation, a first for a UK World Heritage proposal. In the event, changes in Network Rail management and, most importantly, the onset of electrification meant that the idea was dropped.

However, railways were also represented on the 1999 Tentative List in the form of the Liverpool Road, Manchester terminus of the Liverpool & Manchester Railway. The station formed one of the elements in a proposed 'Manchester, first industrial city' World Heritage proposal that also included

the Castlefields and Ancoats areas of the city and the Bridgewater Canal at Worsley. Uniquely, among the sites included on the 1999 List, the Manchester proposal did not receive effective local support, and was dropped from consideration for inclusion on the subsequent Tentative List.

With one notable and spectacular exception, railways, and crucially material evidence of the early steam railway, are thus absent from the United Kingdom's series of World Heritage sites that form the current Tentative List, published on 22 March 2011. The exception is the Forth Railway Bridge, inscribed by UNESCO in 2015.

Despite the omission of early railways from the current Tentative List, work resulting from this initial study on early railways should revive consideration of a United Kingdom World Heritage site devoted to the emergence of the railway as the critically important innovation in land transport during the late 18th and throughout the 19th century.

A recommendation to this effect forms **8.9** below.

8 RECOMMENDATIONS

8.1 Carry out a comprehensive survey of the material evidence of pre-1830 railways in England, together with a selective survey of railways down to 1840, beginning with a pilot study in a selected area.

8.2 Carry out an 'at-risk' assessment to be run in parallel with this survey and conducted by the same survey teams.

8.3 Identify, as a priority, those early railway sites where current management and security considerations are inadequate and the at-risk factors are critical.

8.4 Compile designation assessment after the comprehensive survey is complete.

Methodology: to establish a working arrangement with the NRM and identified experts to define a standardised survey format and provide support/co-ordination for volunteer-led survey teams, to be brigaded and costed as a management project and submitted to the Heritage Lottery Fund/Leverhulme/Wolfson/private sponsorship/Railway Heritage Trust for grant support.

The ultimate objective will be to have secured a comprehensive record of extant early railway remains in England, a list of proposals for designation, an assessment of those sites at risk, including priorities for action.

8.5 Commission an authoritative book-length publication on early iron railways, informed by the results of the survey but international in scope, as a follow-on from Lewis 1970, to be published in the same style and format as the present Early Railways series.

Methodology: NRM and heritage bodies to discuss options with identified early railway experts to undertake this study, to be brigaded and costed as a management project and submitted to the Heritage Lottery Fund/Leverhulme/Wolfson/private sponsorship/Railway Heritage Trust for grant support.

The ultimate objective will be to make available a comprehensive, scholarly but accessible account of the early iron railway, to inform World Heritage discussion.

8.6 Support in principle a comprehensive survey of all early railway material held in museum collections in England, to be undertaken under the guidance of a 'lead museum'.

8.8 As a further objective, to encourage Historic Environment Scotland and Cadw to conduct surveys based on similar methodologies.

8.9 Give consideration to World Heritage options on the basis of the scholarly account.

9 CONSULTATION

The following people and organisations were consulted/offered advice during the preparation of this report. Their help is gratefully acknowledged.

Early Railways Conference Committee, 29 February 2016 and subsequently
Mike Chrimes, formerly ICE's Director of Engineering Policy and Innovation, various dates
Anthony Coulls, National Railway Museum, 7 March 2016 and subsequently
Niall Hammond, Archaeo-Environment Ltd, Barnard Castle and Caroline Hardie-Hammond, Archaeo-Environment Ltd (currently engaged in heritage audit of Stockton & Darlington Railway)
Helen Gomersall, formerly Senior Archaeological Advisor, West Yorkshire Archaeology Advisory Service, 9 March 2016
Dr Ron Fitzgerald, 11 March 2016
Alan Jackson, Secretary, Hetton Local & Natural History Society, 16 August 2016
Dr Michael J.T. Lewis, 16 March 2016
Professor Marilyn Palmer, 17 March 2016
Dr Paul Belford, Director of the Clwyd-Powys Archaeological Trust, formerly of the Ironbridge Institute, 20 April 2016

10 BIBLIOGRAPHY

ER1, ER2 etc refer to the volumes of published papers from the Early Railways conferences.

10.1 Published material

Abbot R 1955 'The railways of the Leicester Navigation Company', *Transactions of the Leicestershire Archaeological and Historical Society* 31, 51-61

Achard F and L Seguin 1926-1927, 'Marc Seguin and the Invention of the Tubular Boiler', *Transactions of the Newcomen Society* 71, 97-116

Agricola G 1556, *De Re Metallica libri XII* (Basileae: Froben)

Albert W 1972, *The Turnpike Road System in England 1663-1840* (Cambridge: Cambridge University Press)

Alfrey J and C Clark 1993, *The Landscape of Industry: Patterns of Change in the Ironbridge Gorge* (London: Routledge)

Allison W, S Murphy and R Smith 2010, 'An early railway in the German mines of Caldbeck' in *ER4*, 52-69

Andrieux 1815 'DESCRIPTION d'un chariot à vapeur (steam carriage) ... pour le transport du charbon de terre', *Bulletin de la Société d'encouragement pour l'industrie nationale* 130, 80, 84 (plate)

Angerstein RR 2001, *RR Angerstein's Illustrated Travel Diary, in 1753-1755* (London: Science Museum)

Ashforth P 2014, 'The Harrington waggonway and copperas works and the Curwen collieries', *ER5*, 22-35

Atkinson F 1968 *The Great Northern Coalfield 1700-1900* (University Tutorial Press)

Austen B 1981 'The impact of the mail coach on public coach services in England 1784-1840', *Journal of Transport History* 3rd series 2**,** 25-37

Ayres IM, J Nolan and A Durkin 1996, 'The archaeological excavation of wooden waggonway remains at Lambton D Pit, Sunderland', *Industrial Archaeology Review* 20, 5-22

Baader J von 1822, *Neues System der fortschaffenden Mechanik* (Munich)

Bailey MR 2003 (ed.), *Robert Stephenson – The Eminent Engineer* (Aldershot: Ashgate)

Bailey MR 2014, *Loco Motion: The World Oldest Steam Locomotives* (Stroud: The History Press)

Bailey MR and JP Glithero 2000, *The Engineering and History of* Rocket (London, York: NRM)

Bailey MR and JP Glithero 2001, 'Learning through restoration: the *Samson* locomotive project', *ER1*, 278-293

Bailey MR and JP Glithero 2010, 'Turning a blind eye to *Braddyll*', *ER4*, 259-297

Barker T and Gerhold D 1993, *The Rise and Rise of Road Transport 1700-1900* (Cambridge: Cambridge University Press)

Barritt S 2000, *Preston to Walton Summit: The Old Tram Road* (Lancaster: Carnegie)

Baxter B 1966, *Stone Blocks and Iron Rails (Tramroads)* (Newton Abbot: David and Charles)

Bennett G, E Clavering and A Rounding 1990, *A Fighting Trade* (Gateshead: Portcullis Press)

Bick D 1987, *The Gloucester & Cheltenham Tramroad* (Abingdon: Oakwood)

Birkinshaw J 1821, 1822, 1824, *Specification of John Birkenshaw's patent for an improvement in the construction of malleable iron rails* (Newcastle: E. Walker)

Bodman M 2012, *Inclined planes in the South West: a gazetteer of over 200 cable-, rope- and chain-worked sites* (Truro: Twelveheads)

Boyes G 2001, 'An alternative railway technology; early monorail systems', *ER1*, 192-207

Boyes G 2014, 'Working the Peak Forest Railway: some revised interpretations', *ER5*, 250-259

Boyes G and B Lamb 2012, *The Peak Forest Canal and Railway* (Derby: Railway & Canal Historical Society)

Brotchie AW and H Jack 2007, *Early Railways of West Fife* (Catrine: Stenlake)

Bruyn de A n.d., *Histoire des Rues et des Lieux-Dits de la Commune de Saint-Nicolas* (no publisher given)

Burman P and Stratton M 1997, *Conserving the Railway Heritage* (Spon)
Burton A 2002, *Richard Trevithick Giant of Steam* (London: Aurum)
Bye S 2003, 'John Blenkinsop and the patent steam carriages', *ER2*, 134-148
Bye S 2010, 'Regarding old rails: a Middleton Railway miscellany', *ER4*, 141-150
Bye S 2014, 'As others saw us: some views of *Salamanca'*, *ER5*, 243-249
Caldwell R, D Campbell and J Brougham 2014, 'Australia's first railway - an entrepreneurial adaptation of skill and technology from leading international collieries', *ER5*, 54-73
Carter I and E Carter 2014, 'Space, time and early railways: oddities from the other end of the world', *ER5*, 74-96
Cattell J and K Falconer 1995, *Swindon: Legacy of a Railway Town* (London: HMSO)
Chartres JA 1977 'Road Carrying in England in the Seventeenth Century: Myth and Reality', *Economic History Review* 2nd series 30, 73-94
Clarke M 2001 'The first steam locomotives on the European mainland', *ER1*, 219-232
Clinker CR and Hadield C 1958 'The Ashby-de-la-Zouch Canal and its Railways' *Transactions of the Leicestershire Archaeological and Historical Society* 34, 53-76
Cook RA and CR Clinker 1984, *Early Railways between Abergavenny and Hereford* (Oakham: Railway & Canal Historical Society)
Cossons N 1997 'An Agenda for the Railway Heritage', Burman and Stratton 1997, 3-17
Cossons N 2001, 'Keynote address', *ER1*, 1-6
Coste L and A Perdonnet 1830, *Mémoire sur les chemins à ornières* (Paris: Bachelier libraire)
Cowburn I 2001, 'The origins of the St Etienne rail roads, 1816-38; French industrial espionage and British technology transfer', *ER1*, 233-250
Crompton J 2003, 'The Hedley mysteries', *ER2*, 149-164
Curr J 1797, *The Coal Viewer, and Engine Builder's Practical Companion* (Sheffield: John Northall for the author)
Darsley R 2006, 'Some considerations on the origins of the chaldron wagon in the northeast of England ', ER3, 221-241
Dendy Marshall CF 1938, *A History of British Railways down to the Year 1830* (London, New York, Toronto: Oxford University Press)
Dendy Marshall CF 1953, *A History of Railway Locomotives down to the End of the Year 1831* (London: Locomotive Publishing Company)
Desaguliers JT 1734, *A Course of Experimental Philosophy*, 1st edition, I (London)
Dilts JD 1993, *The Great Road: The Building of the Baltimore and Ohio, the Nation's First Railroad, 1828-1853* (Stanford: Stanford University Press)
Divall C 2003, 'Beyond the History of Early Railways', *ER2*, 1-9
Duffy MC (1982-1983), 'Technomorphology and the Stephenson Traction System', *Transactions of the Newcomen Society* 54, 55-78
Dufrenoy A, É de Beaumont 1827, *Voyage Metallurgique en Angleterre* (Paris: Mme Huzard)
Dutens J-M, *Mémoires sur les travaux publics de l'Angleterre* (1819)
Edgeworth RL 1768, 'On the practicality and advantages of a general system of rail roads' in *Nicholson's Journal of Natural Philosophy*, new series 1 (1802)
Elton A 1963, 'The pre-history of railways with particular reference to the early quarry railways of North Somerset', *Proceedings of the Somersetshire Archaeological & Natural History Society* 107, 31–59
Ewans MC 1977, *The Haytor Granite Tramway and Stover Canal* (Newton Abbot: David and Charles)
Ferguson N 2006, 'Anglo-Scottish transfer of railway technology in the 1830s', *ER3*, 176-190
Fitzgerald R 1980, *Liverpool Road Station, Manchester: An historical and architectural survey* (Manchester: Manchester University Press)
Flach D 1974 (1661), *Der große Grubenriß des Oberbergmeisters und Markscheiders Daniel Flach* (Westfalia: Lünen)
Forward EA 1943-1944, 'Stephenson Locomotives for the St. Etienne-Lyons railway, 1828', *Transactions of the Newcomen Society* 24, 89-98

Fry JS 1820, *An Essay on the Construction of Wheel-Carriages* (London)
Fuller T 1828, *An Essay on Wheel Carriages* (London)
Gallois de L-G (de Gallois-Lachappelle) 1818, 'Des Chemins de fer en Angleterre, notamment à Newcastle dans le Northumberland', *Annales des Mines*, Mai, 129-144
Gamst FC 1997, *Early American Railroads* (Stanford: Stanford University Press)
Gamst FC 2001, 'The transfer of pioneering British railroad technology to North America', *ER1*, 251-265
Geddes RS 1975, *Burlington Blue Grey* (Kirby in Furness, for the author)
Gerhold D 2005, *Carriers & Coachmasters: trade and travel before the turnpikes* (Phillimore)
Gibson J 1787, *Plan of the Collieries on the Rivers Tyne and Wear* (u/k)
Glover G 2005, 'Rainton Bridge South Waggonway', *Industrial Archaeology Review* 27 2, 235-244
Gomersall H 2006, 'The Round Foundry of Leeds', *ER3*, 260-269
Gomersall H and Guy A 2010, 'A Research Agenda for the Early British Railway, *ER4*, 327-353
Goodchild J 1982, 'The Old Flockton collieries c.1772 to 1893', *British Mining* 19, 97-122
Gray T 1825, *Observations on a General Iron Rail-Way or land steam-conveyance* (London: Baldwin, Cradock, and Joy)
Grenter S 1993, 'A Wooden Waggonway Complex at Bersham Ironworks, Wrexham', *Industrial Archaeology Review* 15, 195–207
Guy A 2001, 'North eastern locomotive pioneers 1805 to 1827: a reassessment', *ER1*, 117-144
Guy A 2010, 'Just add boiling water. The elusive railway kettle, 1804-25', *ER4*, 302-314
Guy A 2014, 'Missing links: some atypical early railways in Britain', *ER5*, 171-198
Guy A and J Rees 2011, *Early Railways 1569-1830* (Oxford: Shire)
Gwyn D 1984, 'Richard Eden, Alchemist and Cosmographer', *The Sixteenth Century Journal* 15, 13-34
Gwyn D 2000, 'Transitional Technology – the Nantlle Railway', *ER1,* 46-62
Gwyn D 2004, 'Tredegar, Newcastle, Baltimore: the swivel truck as paradigm of technology transfer', *Technology & Culture* 45, 778–94
Gwyn D 2010, '"What passes and endures": the early railway in Wales', *ER4*, 125-140
Gwyn D in progress, *Railways in Wales 1697 to 1850*
Hair TH and M Ross 1844/1987, *Views of the Collieries in the Counties of Northumberland and Durham* (Newcastle upon Tyne: Davis Books)
Hartley RF 1994, 'The Tudor Miners of Coleorton, Leicestershire', *Mining Before Powder* (Peak District Mines Historical Society 123, 91-101
Hartley RF 2010, 'The Coleorton Railway', *ER4*, 151-166
Hartley RF 2014, 'Early iron railways and plateways in Leicestershire', *ER5*, 260-269
Harwood HH 1994, 'The early Baltimore & Ohio Railroad and its physical remains', *Common Roots – separate branches (*London: NRM, Science Museum), 48-62
Hatley VA 1962-3, 'The Blisworth Hill Railway 1800-1805', *Reports and Papers of the Northamptonshire Antiquarian Society* 5
Hey D 2001, *Packmen, Carriers & Packhorse Roads* (Landmark Publishing)
Hodgkins D 2003, 'Success and failure in making the transition to a modern railway: the Liverpool & Manchester and Cromford & High Peak', in *ER2*, 52-63
Hopkin D 2010, 'Timothy Hackworth and the Soho Works, circa 1830-1850', *ER4*, 280-301
Hopkin D 2014, 'William Brunton's walking engines and the Crich rail-road', *ER5*, 221-242
Hughes S 1990, *Brecon Forest Tramroad* (Aberystwyth: Royal Commission on the Ancient and Historical Monuments of Wales)
Hughes S 2000, *Copperopolis* (Aberystwyth: Royal Commission on the Ancient and Historical Monuments of Wales)
Jars G 1774-1781, *Voyages métallurgiques* (à Lyon: chez Gabriel Regnault)
Jones NW 1987, 'A wooden wagon way at Bedlam Furnace, Ironbridge', *Post-medieval Archaeology* 21, 259-262
King P 2010, 'The first Shropshire railways', *ER4*, 70-84
King P 2014, 'Seventeenth century footrails: a confusion of terminology', *ER5*, 12-21

Kirby MW 1993, *The origins of railway enterprise: the Stockton and Darlington Railway 1821-1863* (Cambridge University Press)
Kitching C 1971, 'Alchemy in the Reign of Edward VI: an Episode in the Careers of Richard Whalley and Richard Eden' *Historical Research* 44-110, 308-315
Lamming C 2003, 'Retour aux origines et aux années 1820: de l'atelier de charronnage primitif anglais aux premiers dépôts organisés en France par Marc Seguin' in *Revue d'histoire des chemins de fer* 28-29
Lee CE 1940-1 'Early Railways in Surrey', *Transactions of the Newcomen Society* 31, 49-79
Lee CE 1943, *The Evolution of Railways* (London: Railway Gazette)
Lee CE 1960-61, 'Some Railway Facts and Fallacies' in *Transactions of the Newcomen Society* 33, 1-16
Lee CE and KR Gilbert 1971, *Railways in England 1826 and 1827* (Cambridge: Heffer for Newcomen Society – translation by EA Forward of C von Oeyenhausen and H von Dechen 1828, *Ueber Schienenwege in England*, qv)
Lewis MJT 1970, *Early Wooden Railways* (London: Routledge and Kegan Paul)
Lewis MJT 1996, 'The Railway in Industry', RW Ambler (ed), *The History and Practice of Britain's Railways: A New Research Agenda* (Aldershot: Ashgate), 77-95
Lewis MJT 2001, 'Railways in the Greek and Roman world', *ER1*, 8-19
Lewis MJT 2003, 'Bar to fish-belly: the evolution of the cast-iron edge-rail', *ER2*, 102-117
Lewis MJT 2006, 'Reflections on 1604', *ER3*, 8-22
Lewis MJT 2014, 'Early passenger carriage by rail', *ER5*, 199-220
Lewis MJT and G Rattenbury 2004, *Merthyr Tydfil Tramroads and Locomotives* (Railway & Canal Historical Society)
Longridge M 1822, *Specification of John Birkinshaw's patent: for an improvement in the construction of malleable iron rails, to be used in rail roads, with remarks on the comparative merits of cast metal and malleable iron rail-ways* (Newcastle: Walker)
Longworth J and P Rickard 2014, 'Early Australian railed-ways: 1788-1855', *ER5*, 36-53
MacDonald H 2001, 'The Albion mines railway of 1839-40: some British roots of Canada's first industrial railway', *ER1*, 266-277
MacDonald H 2003, 'Reconsidering the origins of Canada's first locomotive-powered railway: the Champlain & St Lawrence, 1825-34', *ER2*, 252-276
Macnair M 2007, *William James (1771-1837) The Man who Discovered George Stephenson* (Oxford: Railway & Canal Historical Society)
Messenger M 2012, *The Bodmin & Wadebridge Railway 1834-1983* (Truro: Twelveheads Press)
Messenger M 2014, 'Sources of finance for early Cornish railways', *ER5*, 132-139
Minard C 1833-1834, *Cours de construction – chemins de fer* (Ecole des Ponts-et-Chaussees)
Morand J-FC 1774, *L'Art d'exploiter les mines* 2 (Paris: Saillant et Nyon, Desaint)
Mott RA 1969-1970, 'Tramroads of the eighteenth century and their originator: John Curr', *Transactions of the Newcomen Society* 42, 1-23
Mountford C 1976, *The Bowes Railway* (London: Industrial Railway Society and Tyne and Wear Industrial Monuments Trust)
Mountford C 2001, 'Rope haulage: the forgotten element of railway history', *ER1*, 171-191
Mountford C 2003, 'Researching rope-haulage — a case study: the Lambton Railway, 1800-1835', *ER2*, 118-133
Mountford C 2010, 'The Bank Top engine, Burnhope, Co Durham', *ER4*, 320-326
Mountford C 2013, *Rope and Chain Haulage* (Melton Mowbray: Industrial Railway Society)
New J 2014, 'Wollaton or Broseley – the Gap Narrows', *ER5*, 1-11
Norris J 1987, *The Stratford and Moreton Tramway* (Guildford: Railway & Canal Historical Society)
Northover P 2014, 'Buying iron – the case of the Plymouth and Dartmoor railway, *ER5*, 140-154
Oeyenhausen C von and H von Dechen 1828, *Ueber Die Schienenwege in England: Bemerkungen Gesammelt auf einer Reise in den Jahren 1826 und 1827* (Berlin)
Ottley G 1983 *A Bibliography of British Railway History* (London: HMSO)
Ottley G 1986 *A Bibliography of British Railway History: Supplement* (London: HMSO)

Ottley G 1998 *Ottley's Bibliography of British Railway History: Second Supplement* (York: NRM)
Outram B 1801, 'Minutes to be observed in the Construction of Railways', *Recreations in Agriculture* (February)
Overton G 1825, *A description of the faults or dykes of the mineral basin of South Wales. Part 1 Introductory observations on the mineral basin, tramroads, railways* (London: Knight and Lacey)
Palmer M and Neaverson P 2002, 'Pre-locomotive railways of Leicestershire and South Derbyshire', in Evans and Gough (eds), *The Impact of the Railway on Society in Britain. Essays in Honour of Jack Simmons* (Aldershot: Ashgate)
Paxton R 2001, 'An engineering assessment of the Kilmarnock & Troon railway (1807-1846)', *ER1*, 82-102
Plymley J 1803, *General View of the Agriculture of Shropshire* (London: Board of Agriculture)
Powell T 2000, *Staith to Conveyor* (Chilton Ironworks)
Proctor J, J Nolan and J Vaughan 2013, 'Waggonways and brickworks: insights into the industrial heritage of Walker', *Archaeologia Aeliana*, 5th Series, 42
Quartermaine J, B Trinder, R Turner 2003: *Thomas Telford's Holyhead Road* (York: CBA Research Report 135)
Rankin WJM 1883, *A Manual of Civil Engineering* (London)
Rattenbury G and R Cook 1996, *The Hay and Kington Railways* (Gwernymynydd: Railway & Canal Historical Society)
Redvers-Higgins N, L Willies and I Wain 2011, *'Finished labour of a thousand hands': the archaeology of the Combe Down Stone Mines, Bath, Somerset* (Oxford Archaeology)
Rees A 1819-1820, *The Cyclopaedia, or Universal dictionary of arts, sciences and literature* (London: printed for Longman, Hurst, Rees, Orme and Brown)
Rees J 2001, 'The strange story of the Steam Elephant', *ER1*, 145-170
Rees J 2003, 'The Stephenson standard locomotive (1814-1825): a fresh appraisal'*, ER2*, 177-201
Rees J and A Guy 2006, 'Richard Trevithick and Pioneer Locomotives', *ER3*, 191-220
Renwick J 1830, *Treatise on the Steam Engine* (New York: G and C and H Carvill)
Repertory of Arts and Manufactures/Patent Inventions, various dates
Reynolds P 2003, 'George Stephenson's 1819 Llansamlet locomotive', *ER2*, 165-176
Riden P 2016, 'Waterways history research: an alternative view', *Journal of the Railway & Canal Historical Society* 225, 426-440
Rimmer A 1985, *The Cromford & High Peak Railway* (Oakwood)
Ripley D 1993, *The Little Eaton Gangway and Derby Canal* (Wallingford)
Robertson CJA 1983, *The Origins of the Scottish Railway System* (Edinburgh: John Donald)
Rödel V (ed) 2005, *Eisenbahn in Hessen* (Theiss for Kulturdenkmäler in Hessen)
Rolt LTC 1960, *George and Robert Stephenson* (London: Longman)
Rosenberg N 2015 'An eighteenth century timber waggonway', *Industrial Archaeology News* 165, 7
Schofield RB 2000, *Benjamin Outram 1764-1805* (Merton Priory Press)
Scott A 2006 '"First impressions" – some reflections on 2005, Early railways' year of anniversaries', *ER3*, 1-7
Simmons J 1991, *The Victorian Railway* (London: Thames and Hudson)
Skempton A 1953-1954, 'The engineers of the English river navigations, 1620-1760', *Transactions of the Newcomen Society*, 29, 25-54
Skempton A 2002 (ed.), *Biographical Dictionary of Civil Engineers* (London: ICE)
Skempton A and C Hadfield 1979, *William Jessop Engineer* (Newton Abbot: David & Charles)
Smiles S 1857, *Life of George Stephenson* (London)
Smith RS 1957, 'Huntingdon Beaumont: adventurer in coalmines', *Renaissance and Modern Studies* 1, 121
Smith RS 1960, 'England's first rails: a reconsideration', *Renaissance and Modern Studies* 4, 119–34.
Smith T 2014, 'Stoneways', *ER5*, 295-311
Smith-Grogan G 2010, 'Rutways in Cornwall', *ER4*, 48-51

Stapleton DH 1978, 'The origin of American railroad technology, 1825-1840', *Railroad History* 139, 65-77
Stokes W 2001, 'Early railways and regional identity', *ER1*, 311-324
Stretton C E 1905 *'The Little Eaton Outram-way', A paper read at Little Eaton on 29 July 1905* (privately published)
Strickland W 1826, *Report on canals, railways, roads and other subjects* (Philadelphia: H.C. Carey and I. Lea)
Tew DH 1951-1953, 'Canal Lifts and Inclines with particular reference to those in the British Isles', *Transactions of the Newcomen Society* 28, 35-58
Thomas RHG 1980, *The Liverpool & Manchester Railway* (London: Batsford)
Tredgold T 1825, 1835, *A Practical Treatise on Rail-roads and Carriages* (London: printed for Josiah Taylor)
Trevithick F 1872, *Life of Richard Trevithick* (London: Spon)
Trinder B 1981, *The Industrial Revolution in Shropshire* (London and Chichester: Phillimore)
Trinder B 2005, *'The Most Extraordinary District in the World: Ironbridge and Coalbrookdale'* (Chichester: Phillimore)
Van Laun J 2001a, 'Pre-1840s trackways in South Wales', *ER1*, 27-45
Van Laun J 2001b, *Early Limestone Railways* (London: Newcomen Society)
Van Laun J 2003, 'In search of the first all-iron edge-rail', *ER2*, 93-101
Van Laun J 2006, 'New light on the wooden waggonways at Whitehaven harbour', *ER3*, 23-39
Vaxell L de 1805, *Opisanie čugunnoj dorogi (iron railway) učreždennoj v'' Grafstvѣ Surrej, v'' Anglii v'' 1802 godu* (*Description of the iron road [iron railway] established in the County of Surrey [in] England in 1802* (St Petersburg: at the medical printing house)
Villefosse H de 1810-1819, *Traité de la richesse minerale* (Paris)
Young R 1923, *Timothy Hackworth and the Locomotive* (London: Locomotive Publishing Company)
Waterhouse R 2014, 'The Tavistock Canal Plateways and Edge Railways, West Devon', *ER5*, 270-294
White J 1978, *The American Railroad Passenger Car* (Johns Hopkins: Johns Hopkins Studies in the History of Technology)
White J 1995, *The American Railroad Freight Car: From the Wood-Car Era to the Coming of Steel* (Johns Hopkins University Press)
White J 1997, *American Locomotives: An Engineering History* (Johns Hopkins University Press)
Winstanley D 2014, 'The evolution of early railways in Winstanley, Orrell and Pemberston, Lancashire, England 1770s-1870s', *ER5*, 112-131
Young R 1923, *Timothy Hackworth and the Locomotive* (London: The Locomotive Publishing Company)

10.2 Unpublished material

Archaeo-Environment (Hardie C and N Hammond), forthcoming, *The 1825 Stockton & Darlington Railway: Historic Environment Audit. Volume 1: Significance & Management* for Durham County Council, Darlington Borough Council and Stockton on Tees Borough Council
Archaeological Practice 2013, unpublished excavation report, Willington waggonway
ArcHeritage 2012, *Silkstone Waggonway, South Yorkshire Survey Report Volume 1: Text & Figures*
South-West Landscape Investigations (Phil Newman) 2014, *Archaeological Excavations at Ventiford Basin on the Stover Canal, Teigngrace, Devon May 10th-19th 2014 First Interim Report*
Tees Archaeology (R. Daniels) 2014, *An Introduction to the Archaeology & Heritage of the River Tees Rediscovered Landscape Partnership Area*
Pre-Construct Archaeology 2010, *An Archaeological Excavation at the Former Goodyear Dunlop Tyre Factory: Assessment Report*
Pre-Construct Archaeology 2011, *An Archaeological Excavation at the Former CPS Haulage Site, Hawks Road, Saltmeadows, Gateshead*

Tyne and Wear Museums 2005, *Killingworth Waggonway, north of Great Lime Road, Killingworth, Tyne and Wear: Archaeological Evaluation*

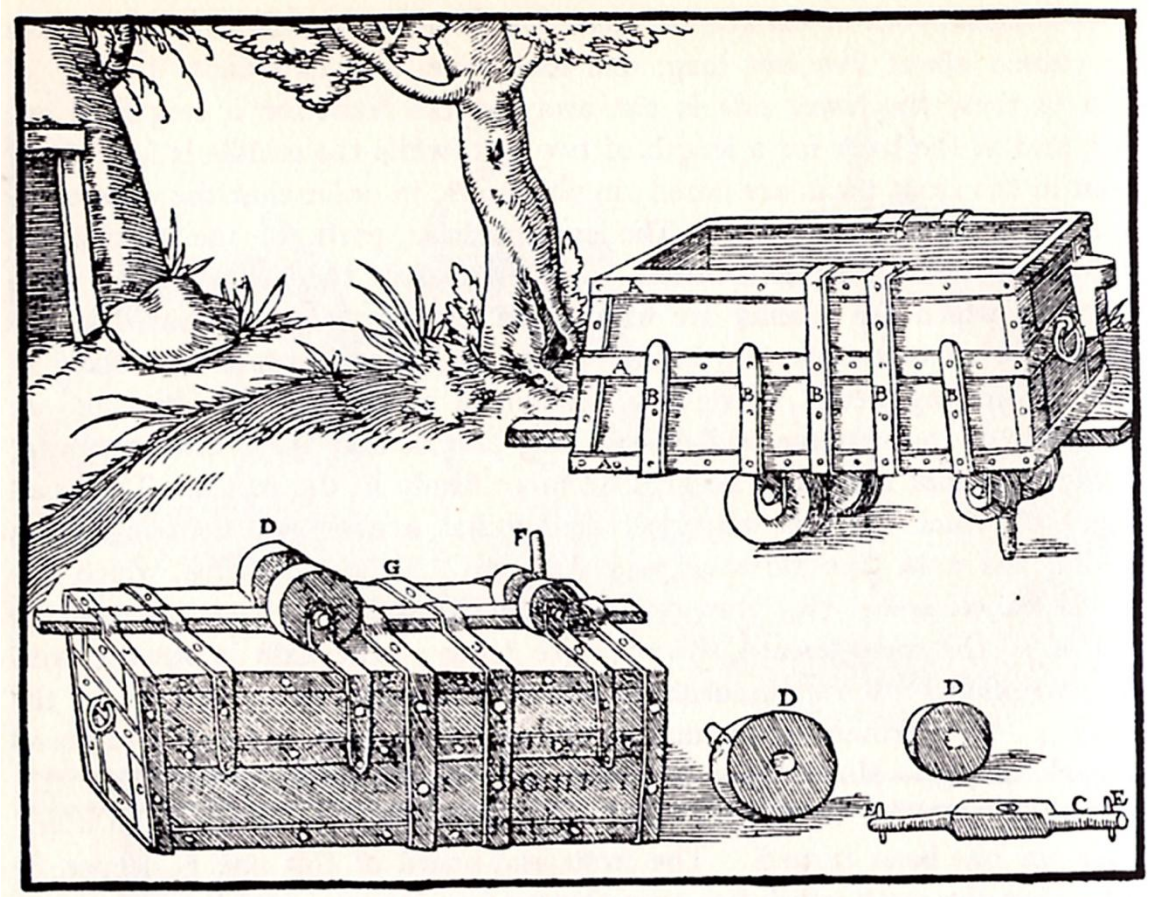
10.3 Additional material

The authors of this report have been given to understand that additional material may be contained in:

Verein Zur Beforderung Des Gewerbfleisses In Preussen, of which a copy is held at the British Library

See also:

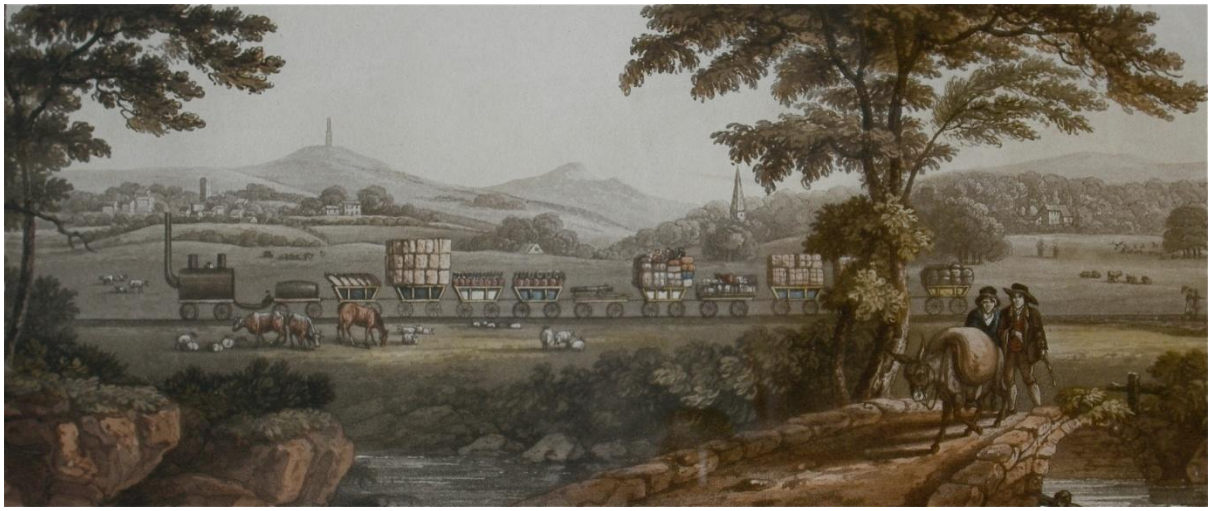
David & Charles *Regional Railways* series
Journal of the Railway & Canal Historical Society
Railway & Canal Historical Society Early Railways Group Occasional Papers



The German mine railway and the *hund* were used at Caldbeck mine in the 1560s.

Rails might be made of stone as well as of wood and iron, as this photograph of the Haytor system shows. © Neil Cossons

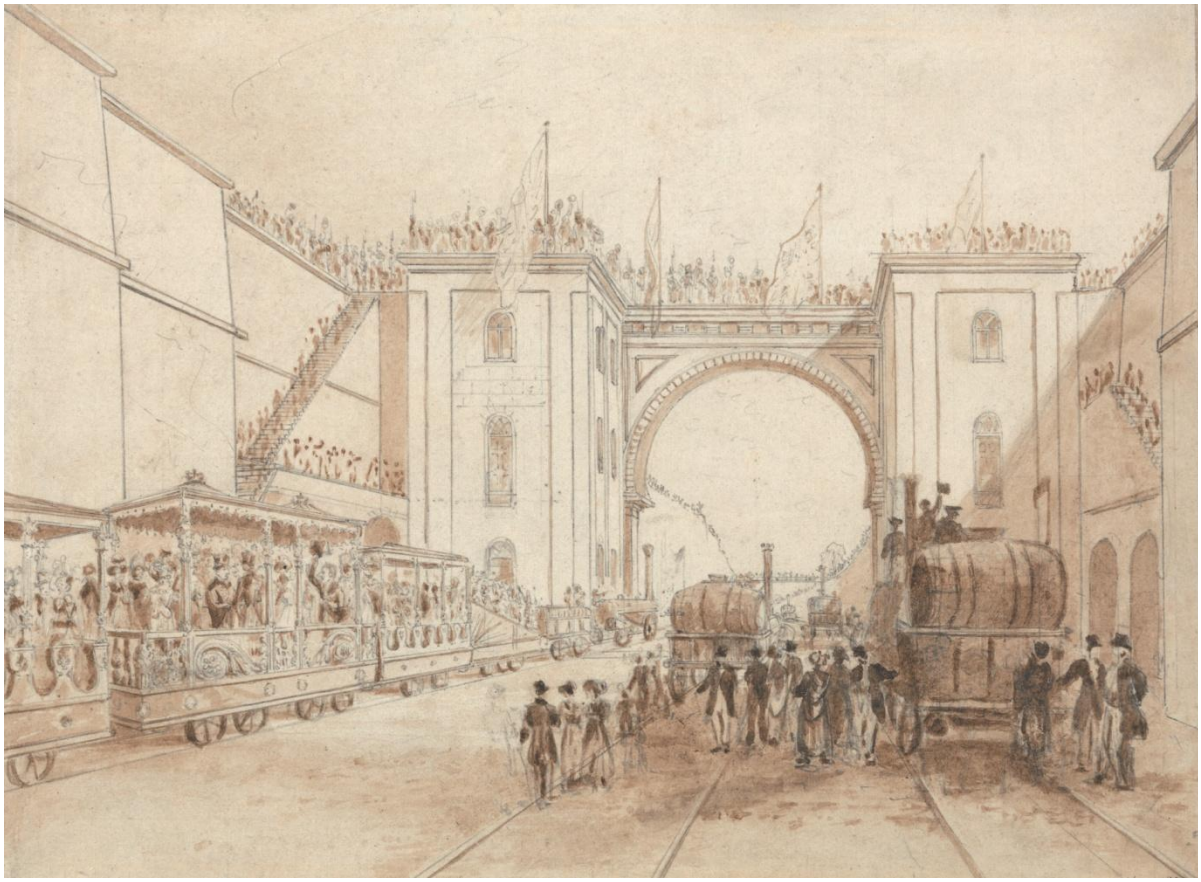
Railway and canal technology influenced each other considerably from the 1790s onwards; the Hay incline in the Severn Gorge is a railed incline connecting two stretches of canal.



This view of the proposed Liverpool & Birmingham Railway of 1825 by S. Bourne, engraved by Smart and Reeve, shows the evolution of the 'main-line' concept.

Replicated early railway items ensure public enjoyment and appreciation of this technology; here Beamish Museum's *Puffing Billy* reconstruction operates on a heritage railway in Holland.

Stone blocks were commonly used to support cast- or wrought-iron rails, as in this view of the Brusselton incline on the Stockton & Darlington. © Julia Elton



The architectural ambition of the Liverpool & Manchester, unprecedented in railway terms, is evident in Isaac Shaw's depiction of its opening day - Yale Center for British Art.

APPENDIX 1: CURRENTLY DESIGNATED SITES

Historic England's lists were reached within the date-range of 1500-1840 under the following HE Monument types. The summaries are reproduced verbatim from the HE website.

Colliery railway

- No entries

Dockyard railway

- No entries

Mineral railway

Name	**Earthworks of Surrey Iron Railway**
Summary	Two cuttings of Surrey Iron Railway near Harps Wood, north of Mertsham.
County	Surrey
District	Reigate and Banstead
SAM	√
Listing	/
List entry number	1005932

Railway

Name	**Milestone and section of track of granite tramway**
Summary	Milestone and section of track of granite tramway on north-west side of road to Haytor, about 90m north-east of junction with road to Green Lane
County	Devon
District	Bovey Tracey, Teignbridge
SAM	/
Listing	Grade II
List entry number	1317471

Name	**Section of Surrey Iron Railway**
Summary	Short section comprising iron rails attached to 3 square stone sleepers on south side of track and iron rails attached to 4 stone sleepers on north side of track. Short description on notice board nearby: "Opened in 1803, ran from Wandsworth to West Croydon and had a branch from Mitcham which terminated in this Borough in 1804. 'It was the first public railway in the world, was horsedrawn, carried only freight and operated until 1846'. Copy of opening announcement also displayed nearby.
County	Greater London
District	Shotfield, Wallington
SAM	/
Listing	Grade II
List entry number	1357610

Name	**Lime kilns 400m south west of Furlands**
Summary	The lime kilns 400m south west of Furlands survive well. In addition to

	the kiln block itself there are also remains of the stone yard and mineral railway, all of which adds to the understanding of the technology and working methods. Taken as a whole the monument is important for the understanding of the workings and developments in the 19th century commercial lime industry.
County	North Yorkshire
District	Borrowby, Hambleton
SAM	√
Listing	/
List entry number	1021190

Name	**Section of Surrey Iron Railway**
Summary	Short section comprising iron rails attached to 3 square stone sleepers on south side of track and iron rails attached to 4 stone sleepers on north side of track. Short description on notice board nearby: "Opened in 1803, ran from Wandsworth to West Croydon and had a branch from Mitcham which terminated in this Borough in 1804. "It was the first public railway in the world, was horsedrawn, carried only freight and operated until 1846". Copy of opening announcement also displayed nearby.
County	Greater London
District	Shotfield, Wallington
SAM	/
Listing	Grade II
List entry number	1357610

Name	**Bowes Railway**
Summary	Not available
County	Tyne and Wear
District	Gateshead
SAM	√
Listing	/
List entry number	1003723

Railway bridge

Name	**Railway bridge 225 yards to south west of Cross Roads**
Summary	Circa 1825. A simple beam bridge of single span which formerly carried the Cromford and High Peak Mineral Line over the road-way. Abutments of coursed stone subble, the wooden superstructure supported by 3 tapered and flanged cast iron beams made by Butterley at his Ripley iron-works. One of the earliest bridges of the type to have survived.
County	Derbyshire
District	Derbyshire Dales
SAM	X
Listing	II
List entry number	1109597

Name	**Railway bridge, 365 metres west of Elstob Crossing**
Summary	Circa 1830 for the Clarence Railway Company. Squared sandstone with tooled-and-margined dressings. Symmetrical east face has central segmental tunnel

	arch with chamfered voussoirs and quoins. Flanking walls each with 3 battered piers. Continuous solid parapet, defined by band and chamfered coping, breaks forward above piers and has central, worn and illegible plaque. Identical west face without plaque.
County	Durham
District	County Durham
SAM	X
Listing	II

Name	**Accommodation bridge 10 metres west of Brusselton Lane**
Summary	Railway accommodation bridge. 1825. Built for the Stockton to Darlington Railway Company. Dressed stone. A single span, round arched bridge topped by a plain stone parapet with stone coping and square stone piers. Either side are sloping embankment walls with stone coping, which terminate in small square piers. To the west stone steps carry a footpath over the incline. This bridge is one of very few of the original bridges on this, the first ever railway line, to survive unaltered. The building is also a Scheduled Monument.
County	Durham
District	County Durham
SAM	√ DU 108.
Listing	II
List entry number	1160402

Name	**Causey Arch**
Summary	Wagonway bridge. 1727 by Ralph Wood for Mr. Wortley and Col. Liddell; dated on stone at foot of west abutment signed B. Horne; formerly also dated on sundial signed Ralph Wood. Coursed squared sandstone with ashlar dressings. 105' long and 80' high, on round arch of 3 courses of voussoirs, the inner recessed; wide buttresses. Probably originally without parapets; C20 railing added. Considered to be the first railway bridge in the world; an example of the early technological skills of the Northumberland and Durham coalfield engineers. Source: J.C. Mann, 'Causey Arch - a Note' in *Archaeologia Aeliana* 5 XII (1984), 223-6. T.J.M. Lewis *Early Wooden Railways*, 1970 pp 150, 155, 156. W.W. Tomlinson *North Eastern Railway*, 1914, second ed. K. Hoole, Newton Abbott, 1967, p.9.
County	Durham
District	County Durham
SAM	X
Listing	I
List entry number	1240816

Name	**Railway bridge, Longcliffe**
Summary	Bridge, formerly railway bridge. c1830. Rock faced squared coursed limestone abutments. Fish-bellied, cast iron beams carrying wooden decking between. C20 metal railings above. Early example of cast iron for structural use. Listed for its historic interest, as part of the Cromford and High Peak Railway.
County	Derbyshire
District	Derbyshire Dales
SAM	X

Listing II
List entry number 1335149

Name **Plateway bridge west south west of Gipsy Hall**
Summary Plateway bridge. Circa 1820; for the Kington Railway. Coursed stone. Small single-span bridge with elliptical arch with dressed stone arch ring. Part of the springing of the arch and a section of the adjacent abutment on the downstream side has collapsed. The Kington Railway [1816-20] was a plateway which ran from near Kington to Brecon, where it joined the canal. Burnt limestone was brought from Kington to the canal basin at Brecon, and the horse-drawn trams would return with coal and iron. SOURCE: *The Kington Railway*, pp. 88 and 89.
County Herefordshire
District County of Herefordshire
SAM X
Listing II
List entry number 1388380

Name **The Beverley Farm footpath arch**
Summary Constructed by 1830 as part of the Canterbury and Whitstable Railway. George Stephenson was the major engineer from 1826 with Joseph Locke and John Dixon as assistants.

MATERIALS: Constructed of red brick, partly in stretcher bond and partly in header bond.

PLAN: Round-headed pedestrian arch set about 20 feet from the south eastern end of a section of earthen former railway embankment in St Stephen's Field.

DESCRIPTION: Only the top of the arch was visible at the time of survey (2010) because of later rubble back-filling. It comprises a round-headed pedestrian arch with voussoirs formed of three courses of handmade red bricks. The inside of the arch was visible across the entire width, constructed partly in stretcher bond and partly in header bond. The remainder of the arch is likely to survive underneath the back-filling, possibly with some brick buttresses shown in a 1953 photograph, but the original parapet above the arch has not survived. The brickwork of the north eastern side of the arch was in good condition but the south east side more decayed.
County Kent
District Canterbury
SAM X
Listing II
List entry number 1393936

Name **Skerne Railway bridge**
Summary The monument includes a railway bridge, designed in 1824, spanning the River Skerne in the centre of Darlington. The single span bridge is constructed of sandstone and comprises a large central arch with curving wing walls containing smaller pedestrian arches,. The south side of the

bridge retains its parapet, but the north side has been widened. The bridge was designed by Ignatius Bonomi in order to carry the Stockton and Darlington railway across the River Skerne.

County	/
District	Darlington
SAM	√
Listing	X
List entry number	1002331

Railway carriage shed

- No entries

Railway carriage works

- No entries

Railway control centre

- No entries

Railway cutting

- No entries

Railway embankment

- No entries

Railway engineering works

- No entries

Railway engineering workshops

- No entries

Railway inclined plane

Name	**Throston engine house and wall adjoining**
Summary	Housing for hauling engine, 1830's, limestone ashlar; gabled Welsh slate roof added later after removal of header tank. Single storey, with basement fully exposed on south-east and north-east sides, other two sides concealed by railway embankment. Each face has Tuscan pilasters and clasping pilasters, rising from floor string, and with entablature. Rebuilt gables to north-east and south-west sides, which together with south-east side are each of 3 bays. 2 windows and central doorway to south-west side; 3 windows to south-east side, all round-headed, with moulded architraves continued to floor string, and lacking doors and glazing. 4 blocked round-headed openings, that to left being later, on south-east face of basement. Lower part of north-west side obscured by

remains of contemporary adjoining building, above which, pilasters define single-bay returns on this side, at each end. Extending from north angle: a low wall, with string course below parapet, of 2 bays defined by single pilaster strip on north-east face, and having 2 round-headed openings without glazing. Contains remains of bed of hauling engine used to draw coal wagons up railway incline to top of former coal staithes. Dispute between railway companies over use of these coal-shipping facilities was major factor leading to founding of new town of West Hartlepool in 1840's.

County	/
District	Hartlepool
SAM	X
Listing	II
List entry number	1250389

Railway Junction

- No entries

Tramway

Name	**Newdale Tramway Bridge**
Summary	Circa 1759 bridge which carried an early plate railway from Coalbrookdale via Horsehay and Ketley to Donnington Wood. Used for transporting materials to and from the iron- works at Horsehay. Consists of 2 small round arches of brick over a stream, with remains of stone facing the spandrels. It is virtually all that remains of the large network of tramlines that existed in the area during the Industrial Revolution
County	Telford and Wrekin
District	Lawley and Overdale
SAM	X
Listing	II
List entry number	1025096

Name	**Bridge and Section of Haytor Granite Tramway Crossing Bovey Pottery Leat about 250 Metres South-East of Chapple Farm**
Summary	Bridge and section of track. 1820s. Granite. Bridge has plain rubble abutments supporting a series of pieces of roughly dressed granite about 1 metre above the leat. Upon the bridge and extending at either side of it is a section of granite trackway about 6 metres long. About 3 metres to the north is a further section about 4 metres long. The north-eastern side of the trackway, nearest the road, is almost completely exposed, but most of the south-western side is covered with earth. The Granite Tramway was opened in 1820 for horse-drawn wagons carrying granite from Haytor quarries to the Stover canal, whence it was taken by barge to the port of Teignmouth. Source: M C Ewans, *The Haytor Granite Tramway*, 1964.
County	Devon
District	Teinbridge
SAM	X
Listing	II

List entry number 1097435

Name **Tramway Embankment, Bobbinmill Hill**
Summary Former tramway embankment. c1780. Raised embankment with coursed rubble side walls, shallow rubble parapets with projecting through stones and edge bedded irregular coping stones. 70 metres in length. Part of the Fritchley tram road linking the limestone producing Hilts Quarry in Crich with lime kilns adjacent to the Cromford Canal at Bull Bridge.
County Derbyshire
District Amber Valley
SAM X
Listing II
List entry number 1109195

Name **Old Tramway Bridge**
Summary Tramway bridge, now footbridge. 1823 with later parapets. John Rastrick, engineer; for Stratford and Moreton Tramway. Brick with ashlar dressings. 8 elliptical arches, that to south east end a flood arch, with piers on cutwaters to both sides. Ashlar-coped brick parapets. Built to carry a horse tramway from the Stratford Wharf to Moreton-in-Marsh. The tramway, which was originally intended to be extended to London, had a branch to Shipston-on-Stour. It was bought by the Oxford, Worcester and Wolverhampton Railway in 1847 and closed, except for the branch line, in 1881; details of history given on a restored truck (not included) preserved approx. 60m to north of bridge. The bridge is an important element in the landscape around the Shakespeare Memorial Theatre. (Fogg N: *Stratford-upon-Avon: Portrait of a Town*: Chichester: 1986-: 120-4, 156, 167N; Buildings of England: Pevsner N: *Warwickshire*: Harmondsworth: 1966-: 416).
County Warwickshire
District Stratford-on-Avon
SAM X
Listing II
List entry number 1187828

Name **Tramway house**
Summary Toll house at the north-west end of the tramway bridge (qv). 1825-6. For the Stratford and Moreton Tramway. Brick; slate roof. 2 storeys; 2-window range. Top modillioned brick cornice. Small-paned windows to ground floor have C20 metal small-paned glazing; segmental-headed windows to 1st floor have 2-light small-paned casements. Right return facing bridge has gate connecting house with parapet of bridge; segmental-headed entrance with gabled canopy and half-glazed door to right of segmental-headed window with 2-light small-paned horizontally sliding sash; similar 1st-floor window; lateral stack. Left return has wall-mounted lantern. (Norris J: *The Stratford and Moreton Tramway*: Guildford: 1987-: 44).
County Warwickshire
District Stratford-on-Avon
SAM X
Listing II
List entry number 1187829

Name	**Tramway Terminus (that part in Ipstones Civil Parish) and Retaining Walls approximately 20 Metres east of Head of Caldon Canal**
Summary	Retaining walls to former tramway terminus. Circa 1783. Rock-faced ashlar approximately 8m high x 40m. Slightly corbelled out at coping; 2 buttresses to left, either side of small round-arch water channel; further round arch to centre; retaining wall ramped down on right side in a concave curve. The tramway was built to bring down lime- stone from Caldon Low to the canal. It was originally conceived to run the canal up to the quarry; the gradient however being so considerable must have determined that the tramway should be built. The terminus forms a close group with Froghall Forge (q.v.), warehouse (q.v.) and canal bridge (q.v.).
County	Staffordshire
District	Ipstones Moorland
SAM	X
Listing	II
List entry number	1189068

Name	**Former Severn and Wye Railway Tramway Bridge**
Summary	Former Severn and Wye Railway Tramway Bridge - II Tramway bridge. Built c1810 for Lydney and Lydbrook Canal Company (later Severn and Wye Railway). Squared and coursed stone with ashlar parapet, set on a curved alignment with voussoirs to semi-circular arch. A complete and rare example of a structure associated with a horse-drawn tramway, preceding the introduction of steam-powered locomotion. The tramroad was built to improve the export of Forest of Dean coal, both up the Wye to Hereford and to the Thames Valley via the basin at Lydney and the Severn. (Hadfield C, *The Canals of South Wales and The Border*, Cardiff, 1967, pp 208-17)
County	Gloucestershire
District	Forest of Dean
SAM	X
Listing	II
List entry number	1249702

Name	**Avon and Gloucestershire Tramway, Retaining Walls and Junction with California Incline, Causeway and Bridge over Siston Brook near Cherry Garden Lane**
Summary	Retaining walls and junction with 'California Incline', Causeway and bridge over Siston Brook ST 67 SE 4/207 near Cherry Garden Lane II 2. Opened 1832 California Junction 1869. Impressive pennant stone embankment about 200 yds long. The California Incline Railway meets this at an angle and is composed of a raised causeway about 20 ft high, buttressed on south side and crossing Siston Brook with a plain arch. The parapet of the causeway has a soldier course. Closed 1904. Important remains of this tramway from Rodway Hill to the Avon include wharfs near Londonderry Farm and Avonside (qv).
County	/
District	South Gloucestershire
SAM	X
Listing	II
List entry number	1278157

Name	**Milestone and Section of Track of Granite Tramway on North-West Side of**

	Road to Haytor, about 90m North-East of Junction with Road to Green Lane
Summary	Milestone and section of track belonging to former granite tramway from Haytor quarry to Stover Canal. 1820s. Granite. Low granite post with roughly shaped head, carved with the figure 6 which represents the number of miles from the canal. About 1½ metres in front of it a short stretch of granite trackway. The Granite Tramway was opened in 1820 for horse-drawn wagons carrying granite from Haytor quarries to the Stover Canal, whence it was taken by barge to the port of Teignmouth. Source: M C Ewans, *The Haytor Granite Tramway*, 1964.
County	Devon
District	Teinbridge
SAM	X
Listing	II
List entry number	1317471

Name	**Mangotsfield North Station and Tramway Tollhouse**
Summary	Tollhouse c1830, built at junction of the Avon and Gloucester and Bristol and Gloucestershire tramways; railway station built 1844 for the Bristol and Gloucestershire Company. Coursed and dressed lias with ashlar sills and lintels; gabled Welsh slate roof with stone stacks and carved bargeboards to station building, and pyramidal Welsh slate roof to toll house. Domestic Tudor style. 2 storeys. Main NW elevation of 2-window range with label moulds over first-floor windows to left-hand gabled projection with Tudor-arched doorway and to large central gabled projection with coved cornice to shallow bay window. This central gabled bay is flanked by Tudor-arched doorways; that to right is in lean-to, which adjoins tollhouse with lintels over openings to front canted bay. Interior not inspected but noted as having retained original plan form and some joinery. The horse tramways were built after 1828 in order to supply coal from Orchard Colliery in Coalpit Heath to Bristol and Bath. The railway station of 1844 was built to serve the first dual gauge railway in Britain, the Bristol and Gloucester having converted their tramway to a railway: the line was sold to the Midland Company in 1845.
County	Gloucestershire
District	South Gloucestershire
SAM	X
Listing	II
List entry number	1320002

Name	**Middlebere Tramway Tunnel Portal**
Summary	Plateway tunnel portal, on disused line. Dated 1807. Coursed limestone with dressed limestone arch-ring with a keystone, inscribed; BF 1807. This is the south portal of the tunnel; the north portal was buried in the road widening of the A351 in 1965. The plateway was constructed by B. Fayle to transport clay from Norden to Middlebere Wharf and Goathorn Pier on Poole Harbour. The trucks would have been horse drawn originally, but later in the C19 small narrow gauge tank engines were introduced. The line was in use until 1936. A rare surviving example of a plateway tunnel portal. SOURCE: St John Thomas, D.: *A Regional History of the Railways of Great Britain, Vol.1 The West Country*; p.194.
County	Dorset
District	Purbeck

SAM X
Listing II
List entry number 1390910

Name **Offham tramway tunnels, portals, parapets and retaining walls**
Summary The tunnels and portals of the Offham funicular railway/tramway built in 1809 are listed at Grade II for the following principal reasons: * Architectural and technological interest: the eastern portal is a monumental structure displaying engineering skill and adroit construction. The parallel tunnels bear witness to the operational method of the funicular tramway/railway; * Historic interest: the tunnels and portals are the standing remains of a funicular tramway/railway dating to the early years of rail transport; * Relationship with setting: the portals and tunnels relate to the remains of other contemporary (but undesignated) structures associated with the Offham lime works.
County East Sussex
District Lewes
SAM X
Listing II
List entry number 1413082

Name **Haytor granite tramway**
Summary The monument includes a stone built tramway connected with the granite quarries of Haytor and Holwell Tor, situated on Haytor Down. The tramway utilised stone sets instead of iron rails and was opened in 1820 by George Templer. It survives as a series of parallel lines of rectangular granite sets with flanges and rebates cut along the upper outside edges placed end to end on a level track bed. Individual sets vary in length to allow for curves in the track. The gauge of the tramway measures 1.25m. Originally, it extended over eight and a half miles in length connecting the granite quarries to Ventiford Basin where the stone was transferred to barges. The steep gradient of some stretches of the route as well as other natural and artificial obstructions had major implications in engineering for several sections of the track bed requiring the use of cuttings and embankments. At several places points were used to divert wagons onto different branches. The tramway remained in use until about 1858.
County Devon
District Teinbridge
SAM √
Listing /
List entry number 1002528

Name **Tramway embankment**
Summary No details
County Derbyshire
District North-east Derbyshire
SAM √
Listing /
List entry number 1004601

Name **Murhill tramway and wharf**
Summary No details

County	/
District	Wiltshire
SAM	√
Listing	/
List entry number	1004693

Name	**Brow Pit mine shaft, gin circle, spoil heap and tramway, 270m south west of Catherine Slack Farm**
Summary	The monument includes the earthworks and the standing and below ground remains of Brow Pit, including a sample of an associated tramway. The site is situated 270m south west of Catherine Slack Farm on the top of a scarp overlooking Holmfield to the west and Calderdale to the east. The site is an early 19th-century coal pit head which served the Howcans Pottery located at the foot of the escarpment. The pit head was physically linked to the pottery by way of a stone-lined track or tramway which still survives to the west of the pit head enclosure wall. The precise date of the pit is unknown but it is documented as being disused by 1908.
County	/
District	Calderdale
SAM	√
Listing	N/a
List entry number	1017568

Name	**Bugsworth canal basin, tramway, quarry and limekilns**
Summary	Bugsworth canal basin became one of the largest inland ports on the English narrow canal network. It remains unique as the only complete example of a canal and tramway terminus in Britain. The standing and buried remains combined with the available documentary sources provides a clear picture of the layout and importance of the canal basin. The surviving remains and documentary sources provide evidence that Bugsworth developed into a port of considerable capacity, fulfilling an important role as a major source of local and regional employment. Continuing expansion of the basin complex indicates a substantial increase in the transport of limestone, gritstone and production of lime throughout most of the 19th century. As a focal point for the Derbyshire lime trade for nearly 90 years the basin was clearly integral to the commercial activities of the Peak Forest Canal Company. It contributed significantly to the local and regional economies, but declined principally as a result of nationwide changes in transport and economic geography.
County	Derbyshire
District	High Peak
SAM	√
Listing	N/a
List entry number	1021384

Name	**Bridge over dramway approximately 200 metres south west of Carsons Road**
Summary	Former road bridge over the former Avon and Gloucestershire Tramway (known locally as the Dramway); route truncated by later adjacent railway. Opened 1831. Pennant rubble battered abutment walls, curved on plan, with lias string and quoins and elliptical arch with plain keystone. Known locally as the Ghost bridge. One of a number of structures associated with a horsedrawn tramway taking in all the local

coal pits. (R Barber, *The Dramway*, 1986, Avon Industrial Buildings Trust).

County /
District South Gloubestershire
SAM X
Listing II
List entry number 1116361

Name **Approximately 63 yards of retaining wall to wharf and steps at Avonside Wharf**
Summary Approximately 63 yds of Retaining wall to Wharf and steps at ST 6669 14/136 Avonside Wharf II GV 2. Some way from Avonside House and wharf buildings. Terminus of the Avon and Gloucester Tramway opened 1835. Large rubble embanked retaining wall with metal cramps to parapet. About 20 yds long. Steps to water. Three big mooring rings.
County /
District South Gloucestershire
SAM X
Listing II
List entry number 1116799

Name **Bridge over Siston Brook and approx 100 yards of wharf retaining wall and steps immediately south of bridge at Londonderry Wharf**
Summary Bridge over Siston Brook and approximately 100 yds of Wharf retaining wall and steps immediately south of bridge at Londonderry Wharf ST 6669 14/132 II GV 2. One of the termini of the Avon and Gloucester Tramway opened 1835. The bridge serves the towpath (and may therefore have been built circa 1720s); apparently early C19, rubble with ashlar voussoirs and keystone, single arch. Band at path level and coping. Links with wharf to south: rubble retaining wall. Stone steps to water at north end. About 25 yds long.
County /
District South Gloucestershire
SAM X
Listing II
List entry number 1116824

Name **Avonside House**
Summary Probably circa 1835. Connected to the Avon and Gloucester Tramway opened 1835 to move coal from Siston and Oldland to the Avon. Square plan villa. Two storeys, rendered. 3 X 2 windows, glazing bar sashes. Band over ground floor. Paired wooden brackets to flat eaves of hipped slate roof. Two large chimneys. Central arched doorway with 6 panel door, one bay extension to left. Rear elevation similar, plus a circle and teasdrop pattern fanlight; lean-to to right.
County /
District South Gloucestershire
SAM X
Listing II
List entry number 1116827

Name **Portreath incline (raised lower section only)**

Summary	Part of tramroad incline. 1809, forming the final descent of a tramroad running from Carn Brea mining area to Portreath Harbour. Retaining walls of coursed granite and uncoursed killas rubble with granite dressings. North-south axis approx. 200 metres long, crossing a public road by a semicircular bridge which has granite voussoirs, shallow battered buttresses, a simple band and a parapet with brick coping, and slightly constricted near the bottom where it crosses a stream by a smaller but similar bridge. History: one of the few surviving built structures of the horse-drawn tramway by which the mine engines were supplied with fuel before the introduction of steam-powered locomotives; a prominent feature of the landscape in Portreath. Reference: Michael Tangye *Portreath* (1968).
County	/
District	Cornwall
SAM	X
Listing	II
List entry number	1142580

Name	**Avon and Gloucestershire Tramway, retaining walls and junction with California incline, causeway and bridge over Siston Brook near Cherry Garden Lane**
Summary	Retaining walls and junction with 'California Incline', Causeway and bridge over Siston Brook ST 67 SE 4/207 near Cherry Garden Lane II 2. Opened 1832 California Junction 1869. Impressive pennant stone embankment about 200 yds long. The California Incline Railway meets this at an angle and is composed of a raised causeway about 20 ft high, buttressed on south side and crossing Siston Brook with a plain arch. The parapet of the causeway has a soldier course. Closed 1904. Important remains of this tramway from Rodway Hill to the Avon include wharfs near Londonderry Farm and Avonside (qv).
County	/
District	South Gloucestershire
SAM	X
Listing	II
List entry number	1278157

Name	**Ticknall arch**
Summary	Arch carrying the tramway from the Ticknall lime-workings to Ashby. 1794. Rubble sandstone with brick and sandstone dressings. Single segmental, almost horseshoe arch. Brick lined. Coped parapet, ramped to centre. the retaining walls curve out slightly on either side.
County	Derbyshire
District	South Derbyshire
SAM	X
Listing	II
List entry number	1281697

Name	**Weighouse at Avonside Wharf**
Summary	Weighouse at Avonside Wharf ST 6669 14/135 II GV 2. Circa 1835. Terminus of the Avon and Gloucester Tramway opened 1835. Small square ashlar building with hipped slate roof. Shuttered window to west.

County /
District South Gloucestershire
SAM X
Listing II
List entry number 1319756

Name **Weighhouse at Londonderry Wharf**
Summary Weighouse at Avonside Wharf ST 6669 14/135 II GV 2. Circa 1835. Terminus of the Avon and Gloucester Tramway opened 1835. Small square ashlar building with hipped slate roof. Shuttered window to west.
County /
District South Gloucestershire
SAM X
Listing II
List entry number 1319756

Name **Mangotsfield North Station and tramway tollhouse**
Summary Tollhouse c1830, built at junction of the Avon and Gloucester and Bristol and Gloucestershire tramways; railway station built 1844 for the Bristol and Gloucestershire Company. Coursed and dressed lias with ashlar sills and lintels; gabled Welsh slate roof with stone stacks and carved bargeboards to station building, and pyramidal Welsh slate roof to toll house. Domestic Tudor style. 2 storeys. Main NW elevation of 2-window range with label moulds over first-floor windows to left-hand gabled projection with Tudor-arched doorway and to large central gabled projection with coved cornice to shallow bay window. This central gabled bay is flanked by Tudor-arched doorways; that to right is in lean-to, which adjoins tollhouse with lintels over openings to front canted bay. Interior not inspected but noted as having retained original plan form and some joinery. The horse tramways were built after 1828 in order to supply coal from Orchard Colliery in Coalpit Heath to Bristol and Bath. The railway station of 1844 was built to serve the first dual gauge railway in Britain, the Bristol and Gloucester having converted their tramway to a railway: the line was sold to the Midland Company in 1845.
County /
District South Gloucestershire
SAM X
Listing II
List entry number 1320002

Tramroad

- No entries

Plateway

Name **Norden tunnel 1**
Summary Plateway tunnel. Dated 1807. Coursed stone rubble with dressed stone arch rings. Round arch tunnel, about 23 metres long, the keystone of the west portal inscribed: B.F. 1807. The tunnel was built for Benjamin Fayle, a London based shipping agent and insurance broker, who leased the

	Norden clay pits from William Morton Pitt in 1804. By 1806 he had constructed a plateway from the clay pits to Middlebere Quay, on Poole Harbour. Clay was taken from the pits to the quay by horse drawn train. The plateway remained in use as a horse drawn tramway until about 1905, when a new line was built. Middlebere Plateway was one of the earliest railways in southern England. The tunnel now carries a watercourse. SOURCE: Wilmott, M. Unpublished research based on documentary records in Dorset Records Office and Wedgwood Archive, Keele.
County	Dorset
District	Purbeck
SAM	X
Listing	II
List entry number	1376767

Name	**Norden tunnel 2**
Summary	Plateway tunnel. Circa 1807; 1848 plaque, date of partial rebuilding. Coursed stone rubble with dressed stone arch rings. Round arch tunnel, about 23 metres long. The tunnel was built for Benjamin Fayle, a London based shipping agent and insurance broker, who leased the Norden clay pits from William Morton Pitt in 1804. By 1806 he had constructed a plateway from the clay pits to Middlebere Quay, on Poole Harbour. Clay was taken from the pits to the quay by horse drawn train. The tunnel became disused in 1845, and was rebuilt in 1848. The plateway remained in use as a horse drawn railway until about 1905, when a new line was built. Middlebere Plateway was one of the earliest railways in southern England. The tunnel now carries a watercourse. SOURCE: Wilmott, M. Unpublished research, based on documentary records in Dorset record Office and Wedgdood Archive, Keele.
County	Dorset
District	Purbeck
SAM	X
Listing	II
List entry number	1376768

Tunnel

Name	**Stodhart tunnel**
Summary	Tramway tunnel entrance. 1796 designed by Benjamin Outram, the engineer to the Peak Forest Tramway. Coursed squared and rockfaced gritstone. Concave walling with ashlar coping, 4 metres high having segment headed archway 2 metres high in the centre. Archway has rock-faced jambs and voussoirs. The tunnel itself is lined with rock-faced gritstone, and it extends some 200 yards into the hillside. The tunnel at the other end has been filled in and the tunnel portal demolished.
County	Derbyshire
District	High Peak
SAM	X
Listing	II*
List entry number	1334843

Name	**Tunnel at SW 762419 SW Part of the Redruth and Chasewater Railway**
Summary	Tunnel for stream through railway embankment. Circa 1824. Killas rubble except for dressed granite voussoirs to round-arched tunnel entrances to north and south. single span with taller keystone to middle of each arch and vertical rubble walling over flanked by battered and splayed embankment retaining walls. The Redruth and Chasewater Railway, 1824-1915, was constructed to carry mineral ore to the port of Devoran from the mining hinterland and was horse drawn until 1854, when steam locomotives were introduced. This tunnel or bridge is the main feature of the tall embankment which enabled the railway to cross the valley and also provided efficient outlet for water from for THE GREAT ADIT, a remarkable C18 feat of engineering which facilitated the draining of mines for an area of several square miles.
County	Cornwall
District	Cornwall
SAM	X
Listing	II
List entry number	1140856

Incline winding engine

- No entries

Inclined plane

Name	**Coalport Inclined Plane the Hay Inclined Plane**
Summary	1793. Built by William Reynolds. The inclined plane connected the Shropshire Canal with a lower canal which ran through the China Works at Coalport to the River Severn. Consists of an incline rising from the lower canal up the hillside for a distance of approximately 200 ft to the disused upper canal. It is the best preserved of the 7 inclined planes of Shropshire. Used for the last time in 1894. Restored in 1968 and 1975. The Rails have been restored. At the upper end are some remains of a slipway and the brick shell of a building (engine house?) with a chimney stack. Scheduled A.M.
County	/
District	Telford and Wrekin
SAM	√
Listing	II
List entry number	1054161

Name	**Incline plane, bridge and wheel pit to east of Plane Cottage**
Summary	Incline plane, incorporating bridge over road and wheelpit. Circa 18209. Incline plane of stone rubble, the surface of which is now partly grassed with stone rubble bridge over road below and wheelpit constructed of stone rubble at the upper end. The plane was built instead of a lock for the Bude Canal (opened 1823). The tub boats which were used on the canal were fitted with iron wheels. When they arrived at the incline plane they were floated out of the water and put onto one of the two sets of rails which enabled the boats to ascend and descend the plane at the

same time. The narrow stepped path alongside the plane was use by the horses and pedestrians. The integral bridge on the lower end carries the incline plane over the road which runs roughly parallel to the canal for much of its course through Werrington parish. The bridge has a dressed stone segmental arch and stone rubble parapets. The plane was worked by a continuous chain over a winding drum, the boats being hooked to the big chain by a smaller 10 link chain. The water wheel which stood in the water pit at the top of the plane provided the necessary power. The wheel has been removed, but the entrance to the pit remains unaltered. Rendell. J. *The Story of the Bude Canal*, 1987.

County	/
District	Cornwall
SAM	X
Listing	II
List entry number	1142845

Waggonway

Name	**Flockton Waggonway Tunnel and Entrance Portal approximately Mid-Way between Junctions of Hardcastle Lane and the New Hall Farm**
Summary	Waggonway tunnel and entrance portal. 1772-5. The portal rebuilt c.1986. Rubble flanking walls and vaulted tunnel. The tunnel extends northwards for about 50 metres but is then blocked. It represents the remains of a wooden waggonway from Flockton colliery to the canal staithes at Horbury Bridge. Rails were used later and route alterations were made over the years. The colliery closed during a strike in 1893 and never re-opened. A rare survival. R. C. N. Thornes. *West Yorkshire 'A Noble Scene of Industry' The Development of the County 1500-1830*, 1981. J. Goodchild. *Wakefield Canal Trail*. 1975 (Wakefield EAHY Committee).
County	/
District	Wakefield
SAM	X
Listing	II
List entry number	1135523

Daniel Adamson coach house

Name	**Daniel Adamson coach house**
Summary	Former railway coach house. Circa 1831 for Daniel Adamson. Hammer-dressed sandstone and renewed Welsh Slate roof. Tall, single-storey building with flush quoins. Gabled front has blocked semicircular-arched opening with flush voussoirs and impost bands. Inserted late C20 boarded door with replaced 4-pane sash above. Roof has renewed coped gables and shaped footstones. 2-bay left return has low plinth and 2 similar blind arched openings. Gabled rear has similar blocked openings. In 1827 Daniel Adamson pioneered a horse-drawn railway coach, Perseverance, which ran between Shildon and Darlington. In 1831, when the Surtess Railway was opened, Adamson built the coach house to act as both a station and a shed. The building is probably the earliest surviving railway coach house in the world. (R.Corkin, *Shilton, Cradle of the*

	Railways, 1975)
County	/
District	County Durham
SAM	X
Listing	II
List entry number	1365641

APPENDIX 2: SUMMARY LIST OF SIGNIFICANT EARLY RAILWAYS

Significant Dates

- 1758: First railway built under its own Act of Parliament (Middleton Railway, Leeds)
- 1767: First known use of cast-iron rails, at Coalbrookdale
- 1786: Use of cast-iron plate-rails
- 1787: First confirmed use of all cast-iron edge rails (in Wales)
- 1790s: the notion of running vehicles coupled together to form a train
- 1803: First public railway authorised under its own Act (Surrey Iron Railway)
- 1803-5: Steam haulage, both locomotive and fixed engines (possibly at Coalbrookdale, confirmed at Merthyr Tydfil [Wales] in 1804, confirmed at Gateshead)
- 1807: First known use of wrought-iron rails
- By 1823: The introduction of passenger transport (following earlier services in Wales and Scotland)
- 1825: The opening of the Stockton & Darlington Railway
- 1830:
  - use of locomotives to haul regular commercial passenger trains
  - operation of railways to connect large urban centres
  - creation of dedicated passenger facilities

Some Significant Early Railways

The following have been identified to exemplify key stages in the development of the railway and the proprietary, legal and commercial context of their building and operation.

1560s to 1600

The *Caldbeck mine railway* is the first rail system in England for which both documentation and material evidence survives and may be the earliest installed. It was a *hund* guide-pin system installed by the Company of Mines Royal under Daniel Höchstetter in the 1560s (Allison, Murphy and Smith 2010).

1600 to 1770

The *Wollaton waggonway*, near Nottingham, built by Huntingdon Beaumont in 1603-1604 on land leased from Percival Willoughby of Wollaton Hall, is the first known overland railway in England. It ran for two miles from the Strelley pits to Wollaton Lane, where the factors had long been accustomed to collect their coal (Smith 1960; New 2014). Its course has not been identified.

Wilcox and Well's waggonway is the first known waggonway in the Severn gorge, Shropshire. It was built in 1605 to connect coal pit in the parish of Broseley to a wharf at Calcutts, and was about a mile long (King 2010). Its course has not been identified.

The *Tanfield way* was the most famous of the Tyneside waggonways and was the work of the 'Grand Allies', a cartel made up of the Russells of Brancepeth, the Brandlings of Gosforth, the Liddells of Ravensworth and the Bowes family (Earls of Strathmore). The main part of the route from the staithes on the south bank of the Tyne was built in 1724-1725, with later extensions, including the Causey arch, added shortly afterwards. The waggonway's construction was on a massive scale by the standards of 18th century engineering. It confirmed for a generation the Grand Allies' near-monopoly of the region's coal trade until their position was weakened by growing demand, and by

the opening of collieries outside their control on the north bank of the Tyne once steam pumping technology became practical. The Causey arch still carried rail traffic in the 1770s but by 1804 it was being depicted in conventional classical terms as a noble ruin (Lewis 1970; Bennett, Clavering and Rounding 1990).

The first significant overland system in England to handle a material other than coal was Ralph Allen's wooden railway of 1731 at *Prior Park* near Bath which connected his Combe Down quarries to the river Avon. It was integrated with the use of river-boats and cranes to form a complete industrial handling system. The railway is depicted in a well-known engraving of 1750 by Anthony Walker (1726-1765) showing wagons descending by gravity along a route shared with a roadway, with Allen's Palladian mansion in the background (Redvers-Higgins, Willies and Wain 2011; Lewis 1970).

The *Coalbrookdale ironworks railway* in Shropshire connected the foundry with a road wharf to its north on Watling Street as well as with a wharf on the river Severn to the south. In 1767 the botanist Joseph Banks (1743-1820), observed that the oak rails wore out and that cast-iron had been substituted for the upper rails (Trinder 2003).

1770 to 1830

The *Middleton railway* was the first railway built under an Act of Parliament (31 Geo.2, c.xxii, 9 June 1758), by Charles Brandling to supply Leeds with coal – unusually for a pre-1830 coal-carrier, it did not connect with navigable water. Around 1799 the wooden rails began to be replaced by cast-iron edge rails. In 1812 John Blenkinsop, the Brandling family's viewer at Middleton colliery, introduced a steam locomotive operating on a rack and pinion. This development has frequently been misunderstood as indicating that Blenkinsop thought that a smooth wheel would not grip a smooth rail; in fact it illustrates his concern to build a locomotive light enough for cast-iron rails but also with sufficient traction. The Middleton was the first railway to make consistent and commercially successful use of steam locomotives (Bye 2003, 2010, 2014).

The *Peak Forest Railway* (or tramway) was a 6-mile long 4' 2" gauge plateway built by Benjamin Outram (1764-1805) to connect quarries in Derbyshire with the Peak Forest canal at Buxworth basin. It opened in 1796, and operated until the 1920s, carrying limestone for use as a fertiliser and gritstone as setts and paving. Much of the route and the structures associated with the line remain evident, including an inclined plane. In 1803 most of the route was doubled; the Peak Forest functioned as an intensively-used mineral-carrying plateway, and was an early instance of the bulk movement of quarried stone by rail. It may be one of the earliest examples of the movement of goods by long trains of up to 40 vehicles, rather than the individual chaldron wagons used in the coal industry (Boyes and Lamb 2012).

The *Lake Lock Rail Road* carried coal to the Aire & Calder Navigation but its claim on history is that it was the first railway in England funded by a joint stock company, in 1796 and operated by them from its opening two years later, under the provisions of a trust deed. In 1804 the route was changed to avoid a steep gradient, which meant relocation of the terminus from Lake Lock itself to Bottomboat. It operated until 1836 (Goodchild 2006)

The *Surrey Iron Railway* was England's first railway authorised by Parliament independently of a canal, and the first railway company, though it was not the first public railway. It was a double-track plateway, engineered by William Jessop (1745-1814), with George Leather as resident engineer, and joint contractor with Benjamin Outram. It opened in 1803, running from a wharf on the Thames at Wandsworth, through Tooting and Mitcham to Pitlake Mead in Croydon. Branches ran to oil-cake mills at Hackbridge, and to other industrial undertakings. A nominally independent extension, the

Croydon, Merstham and Godstone Railway, opened in 1805. It lost traffic to the Croydon Canal, opened in 1809, but remained operational until 1846 (Lee 1940-1941).

The *Wylam waggonway* ran for 5 miles from Wylam Colliery to staithes on the Tyne at Lemington. It is thought to have been built in 1748, possibly to the design of William Brown of Throckley, for John Blackett. It ran for much of its way on a near-level formation parallel to the north bank of the river. Its timber rails were replaced by plates in 1808, the only railway in the north-east to make use of them, as the region otherwise remained faithful to the edge rail. Thus rebuilt, it was the scene of some early locomotive experiments, notably those of Thomas Hedley (d 1834) in 1813. The plates were themselves replaced by iron edge rails in about 1830, to 5' gauge. Much of its route was incorporated into the Scotswood, Newburn and Wylam Railway completed in July 1875, and part of the route remained in use until 1968 (Guy 2001).

The *Silkstone plateway* in Yorkshire is an example of the many canal feeder railways that were built in the last years of the 18th century and the early years of the 19th. It was built to carry coal to the Barnsley Canal in 1809 partly following an earlier railway of 1802, and branches were constructed to it from the various collieries. It is unusual in that it has been the subject of a detailed desk-based assessment and measured landscape survey which has revealed the archaeological potential of sites such as this (ArcHeritage 2012).

The *Gloucester & Cheltenham Railway* was a 3' 6" gauge horse-drawn plateway granted parliamentary approval in 1809 and opened the following year. It ran from the docks on the river Severn at Gloucester to a depot at Cheltenham with a branch to quarries at Leckhampton Hill. It is of interest for several reasons. Its traffic was two-way; as well as the typical 'early railway' function of moving mineral products to navigable water, it carried material inland – building stone from the Avon Gorge and coal arriving by boat and barge at Gloucester. It is also an early example of railway intrusion into a polite townscape; some of the streetscape of both Gloucester and Cheltenham grew up around the railway. An unsuccessful trial took place in 1831-1832 of a locomotive named *The Royal William* built by Neath Abbey Ironworks. It was purchased by main-line interests in 1836 in order to secure access to Gloucester Docks, and was abandoned between 1859 and 1861 (Bick 1987).

The *Hetton colliery railway* was an 8 mile long edge railway, opened in 1822 by the Hetton Coal Company connecting their colliery at Hetton Lyon in Co. Durham with a staithe on the River Wear. It was the first railway to be designed and built entirely for mechanical operation, and was George Stephenson's first completely new railway. It used both locomotives and fixed engines operating inclined planes. It operated until 1959 (Mountford 2012).

The *Haytor granite railroad* (or tramway) was opened in 1820 to carry stone to the Stover canal. Its use of granite blocks to form what was effectively a stone plateway does not have many parallels, though the Baltimore & Ohio (see below) initially used stone blocks with wrought-iron strap rails attached to them on its main line (Ewans 1977).

The *Stockton & Darlington* opened in 1825 and represents a significant step-change in the evolution of railways as the first public system to combine steam locomotive traction with passenger operation and with the use of wrought-iron rails. It was built to the 4' 8" gauge which was becoming standard in the north-east of England. The line was 26 miles long, and ran from collieries near Shildon to Darlington and to Stockton-on-Tees, where coal was loaded onto sea-going vessels. It also carried general merchandise and passengers. Its moving force was the influential Quaker merchant, Edward Pease (1767-1858), who anticipated a horse-drawn system. George Stephenson persuaded Pease, on the day that the Act received Royal Assent, to allow him to resurvey the route and work it

in part by locomotives. For a number of years horses worked the passenger trains as well as a short section at the western end between two inclined planes.

Passengers were initially carried on an informal basis, but in October 1825 it applied for a licence and a service between the two towns was operated directly by the company. In the following year, Richard Pickersgill, a haulier on the Great North Road, operated the service, and thereafter the line was thrown open upon payment of a toll. The S&DR was very early in the field in the provision of dedicated passenger facilities.

Its civil engineering included the masonry Skerne bridge in Darlington, the oldest railway bridge still in use in England, and a cast iron bridge over the Gaunless river at West Auckland. This was replaced in 1901 and the components are now displayed in the NRM.

The S&DR proved a significant financial success. It was absorbed into the North Eastern Railway in 1863, which in 1923 merged into the London & North Eastern Railway (Dendy Marshall 1938). Part of its route remains in operation.

The *Bowes Railway*, also known as the Pontop & Jarrow Railway, opened from Springwell Colliery to Jarrow in 1826. Its route included a self-acting incline from the colliery to Lingey Lane, which was still operational, under the aegis of the National Coal Board, in the 1960s. Locomotives were used from Lingey Lane to the staithes at Jarrow. The original line near Jarrow was abandoned when new staithes were built at Hebburn. The railway was extended from Springwell to collieries to the east at various stages. Part of the railway has been the focus of preservation attempts (Mountford 1976).

The *Hereford Railway* was a horse-drawn 3’ 6” gauge plateway over 12 miles long, incorporated in 1826 and opened in 1829, making an end-on junction just over the Welsh border with the Grosmont Railway which in turn connected with the Llanvihangel Railway from Abergavenny, a total of 24 miles, thereby linking the Wye with the Usk and with the Brecknock & Abergavenny Canal. It carried timber, corn and cider from Herefordshire, and coal, iron and limestone from Wales, and also offered a passenger service. In this respect, it is the immediate predecessor of the Liverpool & Manchester Railway (see below) as a system serving a region rather than a locality.

Along with the Grosmont and the Llanvihangel, it was bought by the Newport, Abergavenny & Hereford Railway in 1846 and dismantled in 1853 (Cook and Clinker 1984).

The transition to main line railways

For the purposes of this document, the *Liverpool & Manchester Railway* is not regarded as an early railway but is included here in order to place other railways in context.

The Liverpool & Manchester Railway represents a further step-change in function and purpose, in that it was an inter-urban system, built to connect one of the world’s busiest ports with a manufacturing town, thereby forming an important link in cotton-production, a global trade which more than any other secured British economic hegemony in the 19th century and gravely weakened the economy of Asia.

Passenger services intended from the start, and the provision was vastly more ambitious than anything that had been entertained hitherto.

In terms of civil engineering and capital, the Liverpool & Manchester Railway was on a far grander scale than any railway built previously and was more akin to the world of canal building. As well as its passenger stations, its warehousing capacity was on a novel scale.

In its architectural and engineering ambition, the Liverpool & Manchester Railway is the clear forerunner of all main line systems, and marks a decisive break with the workaday structures of previous railways (Fitzgerald 1980).

The Liverpool & Manchester Railway not only clearly demonstrated the superiority of steam locomotive traction to the use of fixed haulage engines and to horses for main-line railways covering significant distances, but also initiated the crucial second phase of locomotive development, making use of coke as a fuel in a multi-tube firebox (Bailey and Glithero 2000). Its wider influence was profound and recognised immediately, not only as a technically innovative and very profitable venture but in stimulating Liverpool investors – the 'Liverpool Party' – who became one of the main sources of capital for numerous railway ventures.

Post-1830

The *Rainton & Seaham Railway* opened in 1831 to take coal from the Londonderry pits to the new Seaham Harbour, making use of inclined planes at various locations. It closed in 1896.

The *South Hetton Railway* or Braddyll's Railway opened in 1833 to South Hetton Colliery to Seaham Harbour. Later branches led to Haswell Colliery (1835) and Murton Colliery.

The *Clarence Railway* opened in 1833 from Port Clarence to Simpasture Junction on the Stockton and Darlington Railway, using horses and later locomotives. A branch ran from Norton to Stockton on Tees. In 1834 a branch opened from Stillington Junction to Sedgefield, Ferryhill and Coxhoe. In 1837 a branch opened to Spennymoor and Byers Green (Stokes 2001). Its assets include the listed Throston winding-engine house.

The *Stanhope & Tyne Railway* was opened in 1834 to provide the limestone quarries above Weardale and coal mines in north Durham with an outlet to the Tyne down-river of any bridges. It also supported the growth of the Derwent Iron Company, the origins of Consett steelworks. It used locomotive, fixed engine and horse haulage (Baldwin 2001).

The *Cromford & High Peak* was built as a portage railway between the termini of the Peak Forest and Cromford canals, thereby connecting Lancashire with Derby, Nottingham and the southern and eastern agricultural counties, as well as providing an outlet for lime and other quarried stone from Derbyshire. Even though it greatly reduced the distances travelled, and the limestone trade proved profitable, all the other estimates for goods on this railway were wildly optimistic. As an independent through route, the C&HPR was a failure, but it continued to justify its existence as a lengthy mineral line into the 1960s (Hodgkins 2003).

The *Leicester & Swannington* was built to serve the Leicestershire coalfield. It ran from the Swannington and Coalville pits to West Bridge at Leicester, where it connected with the Soar navigation. Its construction enabled these collieries to compete with those of Derbyshire and Nottinghamshire, which, though further away from their main markets, had profited from better transport networks. The engineer was Robert Stephenson (1803-1859), and much of the capital came from Liverpool. Opened in 1832-3, it was taken over by the Midland Railway in 1845, under whose auspices a link to the main line was built. The pits at the Swannington end were worked out as early as 1875, but the incline found a new lease of life lowering wagons of coal to a pumping

station at the foot that kept the old workings clear of water. The incline closed in 1948 when electric pumps were installed, but the winding engine was dismantled and is now at the NRM. Part of the route remains in use (Clinker 1954).

The *Canterbury & Whitstable*, opened in May 1830, may claim the distinction of being the first railway in the world to carry fare-paying passengers on an advertised service hauled by a steam locomotive. It was promoted by William James, an enthusiastic advocate for railways, to provide the cathedral city with swifter access to the sea for foodstuffs and other goods, instead of the long navigation on the Stour; without any significant industrial base to sustain it, it was soon in trouble (Fellows 1930; Macnair 2007). It weathered its financial storms until the 1840s, when it became part of the South Eastern Railway and functioned thereafter as a country branch-line.

The *Bodmin & Wadebridge* opened in 1834 was unusual in that most of its traffic was carried inland from a harbour, in the form of sea-sand from the Fowey estuary as a manure, as well as general goods, though granite for export from the De Lank quarries also provided it with revenue. It was a standard-gauge edge railway equipped with locomotives and rolling stock by the Neath Abbey Ironworks in South Wales, and continued to operate in part for 149 years (Messenger 2012).

Significant non-English railways influenced by English practice

The *Budweis to Linz railway* (Pferdebahn Budweis-Linz) was built to connect the Vltava (Moldau) river at Budweis (České Budějovice) in Bohemia with the river Danube at Linz in Austria. It was proposed by Franz Josef von Gerstner, Professor of Mathematics at the Prague Polytechnic, and was carried out by his son, Franz Anton von Gerstner, Professor of Engineering in Vienna, following his visits to England, one in 1822 and another in 1828, when he saw the Stockton & Darlington at work. Despite this, it did not entirely follow English precedent as it was operated by horses, and laid with wooden rails with wrought-iron straps. Construction began in Bohemia in 1825 and operations to Linz commenced in 1832. The railway transported salt from Upper Austria to Bohemia, and also carried passengers. It effectively united northern Europe with the Danube navigation through Habsburg territories to the Ottoman empire (Gamst 1997).

The *railways of Saint-Étienne* in Auvergne-Rhône-Alpes were built under concessions of 1823, 1826, 1828 and 1833 to connect a major bituminous coal-field and its associated iron industry with the rivers Loire and Rhône and with the town of Lyons, following French loss of the Ruhr in 1815. Their design reflects evolving English practice, following visits by Louis-Antoine Beaunier and Marc Seguin. Seguin ordered two locomotives from Stephenson & Co., and devised his own multi-tubular design. Locomotives were used to haul coal trains; passenger and goods trains were operated by horses and by gravity. Part of this network is still used by the TGV (Cowburn 2001).

The *Baltimore & Ohio Railroad* ('the Great Road') was constructed to revive the fortunes of a port that feared it was losing out to New York. It was the first main-line railway in the world, opening its first 13-mile section in May 1830. It was heavily influenced by the Stockton & Darlington, and by the Liverpool & Manchester, then under construction, following visits from the first generation of American railroad engineers. It initially departed from English precedent in its use of horse traction and of granite stringer rails with iron straps, but followed its use of masonry bridges. This did not set a precedent in the USA, where timber and later iron or steel construction became commonplace. Just as the Baltimore & Ohio Railroad adapted and disseminated established practice, it became in its turn the 'railroad university of the United States' (Dilts 1993).

APPENDIX 3: ARCHAEOLOGICAL STUDIES OF EARLY RAILWAYS

Site name:	**RAINTON BRIDGE SOUTH WAGGONWAY**
Grid reference:	**NZ 332 485**
Community:	Houghton-le-Spring
Unitary authority:	Tyne and Wear
Investigation:	Desk-top assessment; geophysical survey; excavation
Commissioned by:	City of Sunderland
Undertaken by:	Pre Construct Archaeology
Period of excavation:	2001-2002
Findings:	The excavation identified a waggonway of 1777 with diverging tracks to service a pit-head, and trackside ditches
Conclusions:	Analysis has informed aspects of waggonway construction
Publications:	Glover 2005

Site name:	**HARRATON COLLIERY**
Grid reference:	NZ 2925 5452
Community:	Washington
Unitary authority:	Tyne and Wear
Investigation:	Desk-top assessment; excavation
Commissioned by:	Cundall on behalf of Highbridge Washington Ltd
Undertaken by:	Pre Construct Archaeology
Period of excavation:	2008-2009
Findings:	The excavation recorded two waggonways which served Hall Pit of Harraton Outside; these probably date to the mid to late 18th century, possibly earlier. A huge clay embankment had been constructed to carry these routes, which likely conveyed fully laden coal wagons from the pithead to the riverside staithes. Later waggonways served Anna Bella Pit, Noel Pit and Judith Pit. Survival of the timber elements of some of these tracks was remarkable. There also was some evidence for another, later, waggonway which likely saw the introduction of iron rails, probably in the first half of the 19th century.
Conclusions:	The site has yielded considerable evidence for a sequence of waggonway construction and early iron railways.
Publications:	Unpublished report

Site name:	**WILLINGTON WAGGONWAY**
Grid reference:	NZ 2876 6672
Community:	Walker
Unitary authority:	Newcastle upon Tyne
Investigation:	Archaeological excavation
Commissioned by:	Shepherd Offshore
Undertaken by:	The Archaeological Practice
Period of excavation:	2013
Findings:	A 25m long stretch of wooden waggonway to 4' 8" gauge, dating from around 1790, built to connect Willington and Bigges Main collieries in Wallsend to staithes on the Tyne. The site includes a 'main way' with two sets of rails laid on top of each other to preserve their longevity, and a loop from the main line descending into a soak pond, where chaldrons' wooden wheels were rested to stop them drying out and cracking. In the middle of the loop is a stone elevation where the horse pulling the waggon would have stood. It is the first time such a soak pond has been

recorded, although they were previously known from maps.

Conclusions: The excavation has revealed material evidence for a site previously only known from documentation.

Publications: Unpublished report

Site name: **KILLINGWORTH WAGGONWAY**

Grid reference: NZ 2853 6992

Community: Killingworth

Unitary authority: Tyne and Wear

Investigation: Archaeological evaluation (trial trenching)

Commissioned by: North Tyneside MBC

Undertaken by: Tyne and Wear Museums staff with assistance from pupils and teachers from the George Stephenson High School, Killingworth, and members of North Tyneside Council

Date of investigation: 2005

Findings: The evaluation identified the location and alignment of the waggonway, represented by the compacted coal ballasts, and the deposited clay foundation or embankment which provided a level surface for the track bed. No evidence could be found for wooden sleepers from the 18th century waggonway, nor was there any imprint found for the stone sleepers of the later waggonway. A stone sleeper for fish-bellied rails, was found deep within a trackside coal deposit which also contained a clay pipe fragment, dated to the 1820s

Conclusions: Iron rails could have been laid down within the coal ballast deposit from an earlier wooden waggonway of which the existence can be presumed from the period when Killingworth 'East Pit' started production.

Publications: Unpublished report

Site name: **LAMBTON D PIT**

Grid reference: NZ 319 511

Community: Houghton le Spring

Unitary authority: City of Sunderland

Investigation: Archaeological excavation

Commissioned by: City of Sunderland

Undertaken by: City of Newcastle upon Tyne Archaeology Unit

Date of investigation: 1996

Findings: Over 150 metres of *in situ* timber were exposed, allowing analysis of the construction of wooden railways, and the study of individual features, including points and check rails. The related discovery of a brick rail-head platform and the masonry and brick remains of a colliery building also allowed the waggonway complex to be placed within its functional context. Observations from experts were combined with the archaeological record to provide a detailed description of this wooden waggonway and its relationship to the late 18th and early 19th century colliery.

Conclusions: The excavation confirmed some aspects of understanding but offered other challenges, such as the way points functioned.

Publications: Ayris, Nolan and Durkin 1998

Site name:	**SILKSTONE WAGGONWAY**
Grid reference:	SE 30130 08042 to 30054 03755
Community:	Silkstone
Unitary authority:	South Yorkshire
Investigation:	Desk-based assessment and survey report
Commissioned by:	East Peak Innovation Partnership on behalf of the Roggins Local History Group
Undertaken by:	York : ArcHeritage
Date of investigation:	2012
Findings:	The measured survey and desk-based assessment of the whole length of this system recorded a total of 951 features, archived in a GIS database, including sleeper blocks, bridges, canal basin, limekilns, tally houses, embankments, inclined planes, mills, furnaces, coal pits and other industrial sites.
Conclusions:	That this waggonway was constructed in several phases, and partly followed the course of the Low Moor Iron Company's 1802 waggonway, Construction took place in 1809; several private waggonways and short extensions were associated with the canal company waggonway. The waggonway's current state of preservation is relatively good; management recommendations are made.
Publications:	Unpublished report

Site name:	**BEDLAM FURNACE IRONBRIDGE**
Grid reference:	SJ 67820 03358
Community:	Ironbridge
Unitary authority:	Telford and Wrekin
Investigation:	Archaeological excavation
Commissioned by:	Ironbridge Gorge Museum Trust
Undertaken by:	Ironbridge Gorge Museum Trust
Date of investigation:	1984-1986
Findings:	A short length of oak rails pegged to oak sleepers probably dating from the 1750s to 3' 9" gauge was excavated.
Conclusions:	The discovery confirmed the evidence for north-east of England influence on railway-building practice in the Severn Gorge
Publications:	Jones 1987

Site name:	**HAWKS ROAD, GATESHEAD**
Grid reference:	NZ 2595 6379
Community:	Gateshead
Unitary authority:	Tyne and Wear
Investigation:	Assessment excavation
Commissioned by:	Prospect Archaeology, funded by Marshall Construction
Undertaken by:	Pre-Construct Archaeology
Date of investigation:	2010
Findings:	A single-track waggonway to a gauge of 4' 3", with closely spaced sleepers, suggesting the movement of heavy fuel loads to Hawk's foundry
Conclusions:	As the only excavated waggonway built to take fuel to a foundry, it has added to knowledge of the processes behind iron manufacture in the north-east of England.
Publications:	Rosenberg 2015 and unpublished excavation report.

Site name:	**WALKER WAGGONWAYS**
Grid reference:	NZ 2860 6366 and NZ 2900 6510
Community:	Walker
Unitary authority:	Newcastle upon Tyne
Investigation:	Archaeological excavation
Commissioned by:	Sir Robert McAlpine
Undertaken by:	Pre-Construct Archaeology
Date of investigation:	2009
Findings:	A late eighteenth century formation for a wooden waggonway was identified, and linear impressions filled with coal and ash located the sites of the sleepers and rails; the site of a colliery waggonway was also identified.
Conclusions:	These excavations provide evidence of waggonway construction
Publications:	Proctor, Nolan and Vaughan 2013

APPENDIX 4: ARTISTIC DEPICTIONS OF EARLY RAILWAYS IN ENGLAND

This list confines itself to 'artistic' representations of railways in England pre-1830, and does not include cartographic depictions or cartouches.

Artist	U/k
Title	**Portrait of William Reynolds**
Medium	U/k
Size	U/k
Signature	U/k
Date	U/k
Location	Ironbridge Gorge Museum Trust (IGMT)
Accession number	U/k
Description	Portrait of William Reynolds with Ketley inclined plane in background

Artist	Joseph Constantine Sadler after Joseph Atkinson
Title	**A View of Tanfield Arch**
Medium	Aquatint, coloured
Size	43.7 X 60.6
Signature	U/k
Date	1804
Location	The Science Museum has the watercolour from which the engraving is derived.
Accession number	U/k
Description	A view of the Causey Arch/Tanfield Arch in disuse.

Artist	Francois Vivares after Thomas Smith and George Perry
Title	**A View of the Upper Works at Coalbrookdale**
Medium	Engraving, hand coloured
Size	u/k
Signature	u/k
Date	1758
Location	IGMT
Accession number	AE185.769
Description	Shows six horses pulling a Newcomen engine cylinder – on rails?

Artist	James Duffield Harding
Title	**Hetton Colliery, Durham**
Medium	Lithograph, hand-coloured
Size	u/k
Signature	u/k
Date	u/k
Location	IGMT
Accession number	AE185.450
Description	A rustic landscape view showing Hetton colliery (right), the railway and the staithes on the Wear (left).

Artist	James Duffield Harding
Title	**Hetton Colliery**
Medium	u/k
Size	u/k

Signature	u/k
Date	u/k
Location	Beamish Museum
Accession number	35619
Description	A view of Hetton colliery with two locomotives in steam

Artist	Anthony Walker
Title	**Prior Park, the seat of Ralph Allen Esq near Bath**
Medium	Engraving
Size	u/k
Signature	u/k
Date	1752
Location	IGMT
Accession number	AE185.792
Description	Shows Allen's quarry railway with loaded wagons on a designated alignment shared by a coach and perambulating gentlepersons; Allen's Palladian mansions and grounds in background

Artist	J. Bousefield
Title	**View of the Opening of the Stockton & Darlington Railway**
Medium	Lithograph
Size	u/k
Signature	u/k
Date	?1825
Location	IGMT
Accession number	AE185.327
Description	Three views

Artist	J. Pass
Title	**Middleton Colliery Railway**
Medium	Engraving
Size	U/k
Signature	U/k
Date	1816
Location	IGMT
Accession number	AE185.339
Description	Loco and wagons

Artist	Philip James de Loutherbourg
Title	**Coalbrookdale by Night**
Medium	Oil
Size	68 cm × 107 cm (27 in × 42 in)
Signature	U/k
Date	1801
Location	Science Museum
Accession number	u/k
Description	Bedlam Furnaces in Madeley Dale, showing team of horses and rail wagon.

Artist	George Robertson, Francis Chesham
Title	**A View of the Mouth of a Coal Pit near Broseley, in Shropshire**

Medium	Copper engraving
Size	405 x 550mm. 16 x 21½"
Signature	U/k
Date	1788
Location	IGMT
Accession number	u/k
Description	Wagon on rails at surface of a colliery

Artist	William Williams
Title	**Morning View of Coalbrookdale**
Medium	U/k
Size	U/k
Signature	U/k
Date	1777
Location	IGMT
Accession number	U/k
Description	The railway from Horsehay to Coalbrookdale, running down Jigger's Bank.

Artist	U/k, possibly John Buddle
Title	**The Coal Waggon**
Medium	Water-colour
Size	U/k
Signature	U/k
Date	C1815
Location	Northumberland Archives,
Accession number	ZMD 78/14
Description	Side- on view of horse, chaldron wagon and driver, with colliery and staithes in the background, probably on Willgton waggonway, with dimensions of wagon shown on surround, and armorial device

Artist	Thomas H. Hair
Title	**Burdon Main Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Byers Green Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	1840
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0002
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Pemberton Main Colliery**
Medium	Engraving
Size	23cm x 34.5 cm
Signature	U/k
Date	1841
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	E4185
Description	Colliery landscape with inclined plane

Artist	Thomas H. Hair
Title	**Whitworth Park Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	1842
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Garesfield Colliery**
Medium	Water-colour
Size	22cm x 33cm
Signature	U/k
Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0033
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Engine at Pittington**
Medium	Water-colour
Size	26.5cm x 25cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0035
Description	Crane with railway and winding house on inclined plane

Artist	Thomas H. Hair
Title	**Hebburn Colliery, The A Pit**
Medium	Water-colour
Size	21.5cm x 34cm
Signature	U/k
Date	1828
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0037
Description	Colliery landscape with wagons

Artist	Thomas H. Hair

Title	**Drops at Sunderland**
Medium	Water-colour
Size	23cm x 35.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0040
Description	Staithes with vessels

Artist	Thomas H. Hair
Title	**Benwell Staith**
Medium	Water-colour
Size	21.5cm x 34cm
Signature	U/k
Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Staithe with wagon

Artist	Thomas H. Hair
Title	**Benwell Staith**
Medium	Engraving and etching
Size	U/k
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	H9108
Description	Staithe with wagon

Artist	Thomas H. Hair
Title	**St. Hilda's, Wallsend**
Medium	Water-colour
Size	223cm x 36cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0016
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Pemberton Main Colliery**
Medium	Water-colour
Size	23cm x 35cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0019
Description	Colliery and inclined plane

Artist	Thomas H. Hair
Title	**Drops at Wallsend**

Medium	Water-colour
Size	22.5cm x 34cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0010
Description	Colliery drops with wagon

Artist	Thomas H. Hair
Title	**Broomside Colliery**
Medium	Water-colour
Size	23cm x 35cm
Signature	U/k
Date	1835
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0011
Description	Colliery landscape with wagons and passenger carriages on inclined railway

Artist	Thomas H. Hair
Title	**Gosforth Colliery**
Medium	Water-colour
Size	21cm x 31cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0028
Description	Colliery landscape with wagons on timber bridge

Artist	Thomas H. Hair
Title	**Waldridge Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with wagons and colliers' housing

Artist	Thomas H. Hair
Title	**Wideopen Colliery**
Medium	Water-colour
Size	19cm x 30.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0004
Description	Colliery landscape with horse drawing wagons

Artist	Thomas H. Hair
Title	**Pelton Colliery**

Medium	Water-colour
Size	22.5cm x 32cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0030
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Hetton Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with locomotives and wagons

Artist	Thomas H. Hair
Title	**The Phoenix Pit, Old Etherly**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0027
Description	Colliery structure with wagons

Artist	Thomas H. Hair
Title	**The A Pit, Fawden Colliery**
Medium	Water-colour
Size	23cm x 33.5cm
Signature	U/k
Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0015
Description	Colliery landscape, beam pump and wagons drawn by a horse

Artist	Thomas H. Hair
Title	**Wylam Colliery**
Medium	Water-colour
Size	23cm x 34cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0025
Description	Colliery landscape with locomotive hauling wagons

Artist	Thomas H. Hair
Title	**Percy Pit, Percy Main Colliery**
Medium	Water-colour

Size	23cm x 34cm
Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0018
Description	Colliery landscape with small wagons pushed by colliers

Artist	Thomas H. Hair
Title	**The Jubilee Pit, Coxlodge**
Medium	Water-colour
Size	22.5cm x 35.5cm
Signature	U/k
Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0008
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Clarence Drops on the Tees**
Medium	Water-colour
Size	23cm x 34.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0013
Description	Colliery drops on river, no wagons

Artist	Thomas H. Hair
Title	**Bottom of the Shaft, Walbottle Colliery**
Medium	Water-colour
Size	19cm x 27.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0001
Description	Foot of shaft with wagon

Artist	Thomas H. Hair
Title	**The Church Pit, Wallsend**
Medium	Water-colour
Size	23cm x 33cm
Signature	U/k
Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Burdon Main Colliery**
Medium	Water-colour
Size	23cm x 34cm

Signature	U/k
Date	1839
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Old Locomotive Engine, Wylam Colliery**
Medium	Water-colour
Size	19cm x 29cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0020
Description	Hedley locomotive hauling wagons

Artist	Thomas H. Hair
Title	**Whitwell Colliery**
Medium	Water-colour
Size	21.5cm x 33.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0039
Description	Multiple track railway with wagons

Artist	Thomas H. Hair
Title	**St. Helen's Colliery**
Medium	Water-colour
Size	22cm x 35cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0026
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Willington Colliery**
Medium	Water-colour
Size	20cm x 34cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0036
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Hebburn Colliery, the C Pit**
Medium	Water-colour
Size	23cm x 35.5cm
Signature	U/k

Date	1838
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0009
Description	Colliery landscape with wagons

Artist	Thomas H. Hair
Title	**Crane for loading the rollies**
Medium	Water-colour
Size	12cm x 20.5cm
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	HW.0042
Description	Colliery landscape with wagons

Artist	U/k
Title	**One of George Stephenson's locomotive engines, 'built at Killingworth about 1820'.**
Medium	Mounted black and white photograph
Size	U/K
Signature	U/k
Date	U/k
Location	Hatton Gallery, Newcastle upon Tyne
Accession number	TWCMS : 2014.651
Description	Photograph of Stephenson locomotive

Artist	U/k
Title	**No title – shows the *Steam Elephant* locomotive**
Medium	Watercolour on linen
Size	U/k
Signature	None
Date	U/k
Location	Northumberland County Record Office
Accession number	ZMD 78/15
Description	Shows the *Steam Elephant* locomotive hauling a train of chaldron wagons, colliery buildings in background; apparently a study for the painting in Beamish Museum

Artist	U/k
Title	**No title – shows the *Steam Elephant* locomotive**
Medium	Oil on canvas
Size	U/k
Signature	None
Date	U/k
Location	Beamish Museum
Accession number	1995-129
Description	Shows the *Steam Elephant* locomotive hauling a train of chaldron wagons over a skew arch bridge; colliery buildings, a gentry house, inclined plane and staithes with vessels in background

Artist	U/k

Title	**The Grave Diggers**
Medium	U/k
Size	U/k
Signature	U/k
Date	U/k
Location	Beamish Museum
Accession number	U/k
Description	Cartoon satirising the destructive power of steam; two gravediggers sitting on a steam boiler playing cards against gravestone with *Hic jacet* inscription; Brunton locomotive in background

Artist	John Claude Nattes
Title	**Part of a machine that was to go by steam ~~without horses~~ (illegible) 1808 New Road**
Medium	Wash drawing
Size	U/k
Signature	U/k
Date	U/k
Location	Guildhall Library, Print Room
Accession number	Nattes collection 50, catalogue number p5380332
Description	Depiction of Trevithick-style high pressure boiler on wooden blocks; dwellings under construction in background

Artist	John Claude Nattes
Title	**In the Pavilion Garden**
Medium	Wash drawing
Size	U/k
Signature	U/k
Date	U/k
Location	British Museum
Accession number	JC Nattes collection Portfolio of Mounted Drawings, 1939,0726.21
Description	Depiction of Trevithick-style high pressure boiler in garden

Artist	U/k
Title	**Trevithicks, Portable Steam Engine** (sic)
Medium	Engraving
Size	U/k
Signature	U/k
Date	1808
Location	Science Museum
Accession number	Science and Society Picture Library, 10247812
Description	Admission card to Trevithick railway in London, showing locomotive *Catch me who can*

Artist	U/k
Title	**Dandy cart, Stockton & Darlington Railway, 1825.**
Medium	U/k
Size	U/k
Signature	U/k
Date	U/k
Location	NRM/Pictorial Collection, Science & Society Picture Library

Accession number **10301736**
Description Elevation of dandy car, showing a horse

Artist J Fittler after I Bailey
Title **View of Newcastle-upon-Tyne**
Medium Line engraving
Size u/k
Signature u/k
Date 1783
Location Science & Society Picture Library
Accession number **Image No. 10418345, Inventory No.:** 1943-0091
Description In the foreground the Parkmore Waggonway, Gateshead, is depicted.

Artist Robert Havell after George Walker
Title **The Collier**
Medium Hand-coloured aquatint
Size U/k
Signature U/k
Date 1814
Location Science & Society Picture Library
Accession number **Image No. 10419587, Inventory No.:** 1935-0505
Description Blenkinsop's *Salamanca*, on the Middleton Railway, is shown behind the figure of the collier; in the background is a colliery steam winder and heapstead.

Artist T Owen, after a drawing by Nathaniel Whittock
Title **Christ Church and Coal Staith, Leeds**
Medium Engraving on steel
Size U/k
Signature U/k
Date 1829
Location Science & Society Picture Library
Accession number Image No. 10419829**,** Inventory No.: **1978-0356**
Description Middleton locomotive on stone bridge

Artist U/k
Title **View of the Railway from Hetton Colliery**
Medium U/k
Size U/k
Signature U/k
Date 1822?
Location Science & Society Picture Library
Accession number Image No. 10199643, Inventory No.: **1956-0203**
Description A landscape view of the Hetton railway, the colliery and staithes on the River Wear, near Sunderland in Durham. Also shown is a side elevation of a locomotive, tender and coal wagons.

Artist GB Wollaston
Title **Grand Surrey Iron Railway**
Medium Water-colour
Size U/k

Signature	U/k
Date	1823
Location	Science & Society Picture Library
Accession number	Image No. 10302421
Description	Horse-drawn train crossing stone bridge over Chipstead Valley Road

Artist	John Llewellin
Title	**Trevithick's tram engine, December 1803**
Medium	A pricked diagram
Size	U/k
Signature	U/k
Date	December 1803 (assumed)
Location	Science & Society Picture Library
Accession number	**Image No. 10316574, Inventory No.:** 1903-0102
Description	Found by FP Smith in 1862 and given by him to William Menelaus; it shows a 3' gauge plateway locomotive of Trevithick type, and is therefore generally assumed to be an elevation of the possible Coalbrookdale locomotive, but equally possibly it depicts a proposed locomotive for internal use at the Pen y Darren ironworks in Glamorgan. The fact that the drawing is pricked might suggest that it is a copy of an earlier drawing, perhaps from Coalbrookdale, but equally it could indicate that this drawing was itself copied later.

Artist	Richard Trevithick
Title	**None**
Medium	Elevation drawing (scale 1:12), believed to be by Richard Trevithick
Size	32cm x 22cm
Signature	U/k
Date	1805
Location	Science & Society Picture Library
Accession number	10316577
Description	Drawing of 5' gauge locomotive assumed to have been constructed for Wylam colliery

Artist	Richard Trevithick
Title	**Drawing of wagon engine**
Medium	Elevation drawing (scale 1:12), believed to be by Richard Trevithick
Size	32cm x 25cm
Signature	U/k
Date	3 October 1804
Location	Science & Society Picture Library
Accession number	10316576
Description	Elevation of Trevithick-type steam locomotive for 4' 6" edge railway

Artist	? George Stephenson
Title	**None (early Stephenson locomotive)**
Medium	Coloured drawing
Size	U/k
Signature	U/k
Date	c. 1815
Location	Science & Society Picture Library

Accession number	**Image No. 10316614, Inventory No.:** 1923-0545
Description	Coloured drawing of early Stephenson locomotive built for ?Killingworth colliery pulling chaldrons

Artist	U/k
Title	**Stockton and Darlington Railway Coal Train**
Medium	oil on hardboard
Size	32.5cm x 44.1cm
Signature	U/k
Date	1827-1833
Location	Preston Park Museum
Accession number	1971-0566
Description	Depicts steam-hauled coal train, stage-coach rail passenger carriage on bridge and embankment also structure built 1826-1827 to transfer goods to and from Stockton & Darlington Railway and the Great North Road, converted to a cottage in 1833 and the upper floor adapted for passengers; demolished in 1864.

Artist	Matthias Read
Title	**View of Whitehaven**
Medium	Oil on canvas Dimensions
Size	183cm x 107cm
Signature	U/k
Date	1736
Location	Beacon Museum
Accession number	U/k
Description	Bird's eye view showing town, hinterland, port and waggonway

Artist	Samuel Henry Grimm
Title	**?**
Medium	Wash
Size	U/k
Signature	U/k
Date	Late 18th century.
Location	British Library
Accession number	Add. Ms. 15548
Description	If the topography is accurate, the waggonway is on the other side of the Tyne from Ryton Church, the spire of which can be seen on the left, hence is the Heddon, Throckley or Holywell waggonways.

Artist	U/k
Title	**above Ground View of a Newcastle Coal Pit** (from dedication)
Medium	Print
Size	U/k
Signature	U/k
Date	Early 19th century
Location	Newcastle University Library Special Collections
Accession number	ILL/11/150
Description	A heapstead at a colliery showing steam pumping engine, whim and chaldrons with horses; dedication to the Duke of Northumberland on border, with armorial bearing.

Artist	Leighton brothers
Title	**Changing times**
Medium	Coloured wood engraving
Size	U/k
Signature	U/k
Date	*c.* 1850
Location	IGMT
Accession number	AE/185.780).
Description	A stage-coach has become a hen-house whilst a train passes in the background; included here in that it is referenced in Beamish Museum's 'Georgian landscape'.

Artist	John Dixon
Title	**A Coal Waggon**
Medium	U/k
Size	U/k
Signature	I Dixon
Date	23 July 1783
Location	Beamish Museum, John Dixon's notebook, 1988
Accession number	1988-320
Description	Beamish Museum, John Dixon's notebook, 1988

Artist	William Reynolds
Title	**A Drawing of Adam Heslop's Engine To worke without a beam**
Medium	U/k
Size	U/k
Signature	U/k
Date	C1790
Location	Science Museum Library and Archives
Accession number	1980-1123/19
Description	An item from William Reynolds' notebook, which is believed to contain a number of depictions of early railway technology.

Manuscripts containing illustrative material

Science Museum Archive collection: 1997-179 *The Coal Viewer and Engine Builder's Companion / John Curr of Sheffield, agent to Duke of Norfolk, 1795* (ms. of printed 1797 volume), 143pp, contains 5 hand-drawn, hand-coloured plates (not all the plates are identical to the monochrome plates of the printed 1797 edition)

Science Museum Archive collection: 1980-1123 (engineering sketchbook, compiled by Shropshire ironmaster William Reynolds, comprising 130 loose items in five boxes – sketches, prints and coloured drawings – by various hands. Most date from the 1790s, others from the early 1800s. Items most likely to depict early railways are:

5. 1792 Small engine as it worked on the hill at the [Coalbrook] Dale, made by James Sadler, 1792 (ink sketch; sectional elevation; no scale)

6. 1793 Sept S. Venables' drawing of Sadler's engine as it stood when T. Griffiths was putting it up at the Bank (pencil sketch; sectional elevation; not to scale

7. 1793 May J. Sadler's new engine sent by Dr. Beddoes, with lettered description (ink sketch; sectional elevation; no scale)

8. Drawing of an engine by Jas. Sadler before he went to London with Dr. Beddoes to which he wants to make additions, not being complete (ink drawings; scale 1.4)

9. 1794 Details of engine for J. Sadler, but which was never completed (ink drawing; no scale

10. 1796 Jan Joint for cast iron plates by Mr Betancourt (ink sketch; probably full size)

19. 1790 Adam Heslop's engine to work without a beam. Drawn by S. Venables. This was a form of atmospheric engine with two cylinders (See Heslop's Patent Specification 1790, no. 1760) (coloured drawing; sectional elevation; scale 1.12)

38. Exterior of canal incline winding engine and house(Compare to numbers 48 and 98)(pencil drawing partly inked in; no scale.

39. 1793 Sept Thought to be a Heslop engine for 1 rotative motion, by Samuel Venables. Coloured drawings; sectional elevation; no scale

48. Exterior of canal incline winding engine (compare to nos. 38 and 98) (pen and ink perspective sketch; elevation; no size)

49. 1792 'Working Gear', possibly for the portable winding engine; part of set nos. 47, 50 and 76.

52. 1795 Apr Mr Fulton's idea of moving boats [i.e. on canals]. His patent was no. 1988, 1794 (pencil sketch; elevation; no scale)

53. Brake drum and winding gear for inclined plane (pencil drawing; elevation; no scale)

72. 'Jinney for conveying wheeled corves down descents' (ink drawing; end and side elevation; scale 1.24)

1793 Sept 'Donnington Wood incline plane and engine, etc.' by William Minor (compare to 38 and 48) (perspective drawing; elevation)

119. 1793 'Plan of the intended Shrewsbury Canal, by George Young, 1793' (engraving; scale 1" = 2 miles)

121. 'A plan of the navigable canal and collateral cuts between Birmingham, the different coal-mines, and the town of Walsall, with the proposed extensions' (engraving; scale 0.4" = 1 mile)

124. 'Inclined plane at Cyfarthfa' with legend (ink drawing; elevation and plan; scale 1.48)

NRM 2005-7137 contemporary letter from John Church Backhouse to his sister giving an account of the opening of the Stockton & Darlington Railway, includes a sketch of the train.

Publications containing illustrative material

The following publications are known to have illustrations of pre-1830s railways in England. It is remarked here that whilst many of them have been digitised, any engravings are generally not digitised. Research collections in England where copies are held are noted.

Andrieux 1815; copies in Bodleian and King's College, London
Baader 1822; copy in University College, London
Birkinshaw 1821, 1822, 1824; copies in British Library, Bodleian, Institution of Mechanical Engineers, London School of Economics, National Railway Museum, Manchester University and Senate House Libraries, University of London
Curr 1797; copies in Institution of Civil Engineers, Birmingham University, British Library, Brunel University, Cambridge University, Leeds University, Manchester University, National Coal Mining Museum for England, National Railway Museum, Newcastle University, Nottingham University, Bodleian, Senate House Libraries, University of London, Sheffield University, University College, London and York University
Desaguliers 1734; copy in Cambridge University
Dutens 1819; copies in British Library, Institution of Civil Engineers, London School of Economics, Manchester University and Senate House Libraries, University of London
Gibson 1787; copies in British Library and Durham University
Gray 1825; copies in Manchester University Library, Senate House Libraries, University of London and Bodleian
Mechanics' Magazine, 1829; copies in Manchester University, Senate House Libraries, University of London and Warwick University
Minard C 1833-1834; copy in Institution of Civil Engineers
Morand 1774; copy in Bodleian
Plymley 1803; copy in British Library
Rees 1819-1820; copy in Cambridge University
Renwick 1830; copy in British Library
Repertory of Arts and Manufactures/Patent Inventions; copies at University of London Senate House, Science Museum and British Library
Strickland 1826; copy in British Library
Tredgold 1825; copies in Senate House Libraries, University of London, Bodleian, Manchester University Library, London School of Economics, Brunel University, Leicester University, National Railway Museum, British Library and Institution of Civil Engineers
Tredgold 1835; copies in Senate House Libraries, University of London; Birmingham University, London School of Economics, Bristol University, National Railway Museum, Institution of Civil Engineers, Newcastle University, Manchester University and British Library
Vaxell 1805; copy in British Library

(end of document)

Historic England Research and the Historic Environment

We are the public body that looks after England's historic environment. We champion historic places, helping people understand, value and care for them.

A good understanding of the historic environment is fundamental to ensuring people appreciate and enjoy their heritage and provides the essential first step towards its effective protection.

Historic England works to improve care, understanding and public enjoyment of the historic environment. We undertake and sponsor authoritative research. We develop new approaches to interpreting and protecting heritage and provide high quality expert advice and training.

We make the results of our work available through the Historic England Research Report Series, and through journal publications and monographs. Our online magazine Historic England Research which appears twice a year, aims to keep our partners within and outside Historic England up-to-date with our projects and activities.

A full list of Research Reports, with abstracts and information on how to obtain copies, may be found on www.HistoricEngland.org.uk/researchreports

Some of these reports are interim reports, making the results of specialist investigations available in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation.

Where no final project report is available, you should consult the author before citing these reports in any publication. Opinions expressed in these reports are those of the author(s) and are not necessarily those of Historic England.

The Research Report Series incorporates reports by the expert teams within the Investigation& Analysis Division of the Heritage Protection Department of Historic England, alongside contributions from other parts of the organisation. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series

ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)