



High Speed Rail London to the West Midlands and Beyond

A Report to Government
by High Speed Two Limited

PART 3 of 11

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Chapter 1:

ICE 3 high speed train on the Frankfurt-Cologne high-speed rail line, Sebastian Terfloth;

Eurostar, Dave Bushell www.canbush.com/ppbfrontpage.htm;

Gümmenen viaduct over the river Sarine with TGV 9288, Berne, Switzerland, Chriusha;

Tunnelling, HS1 Ltd

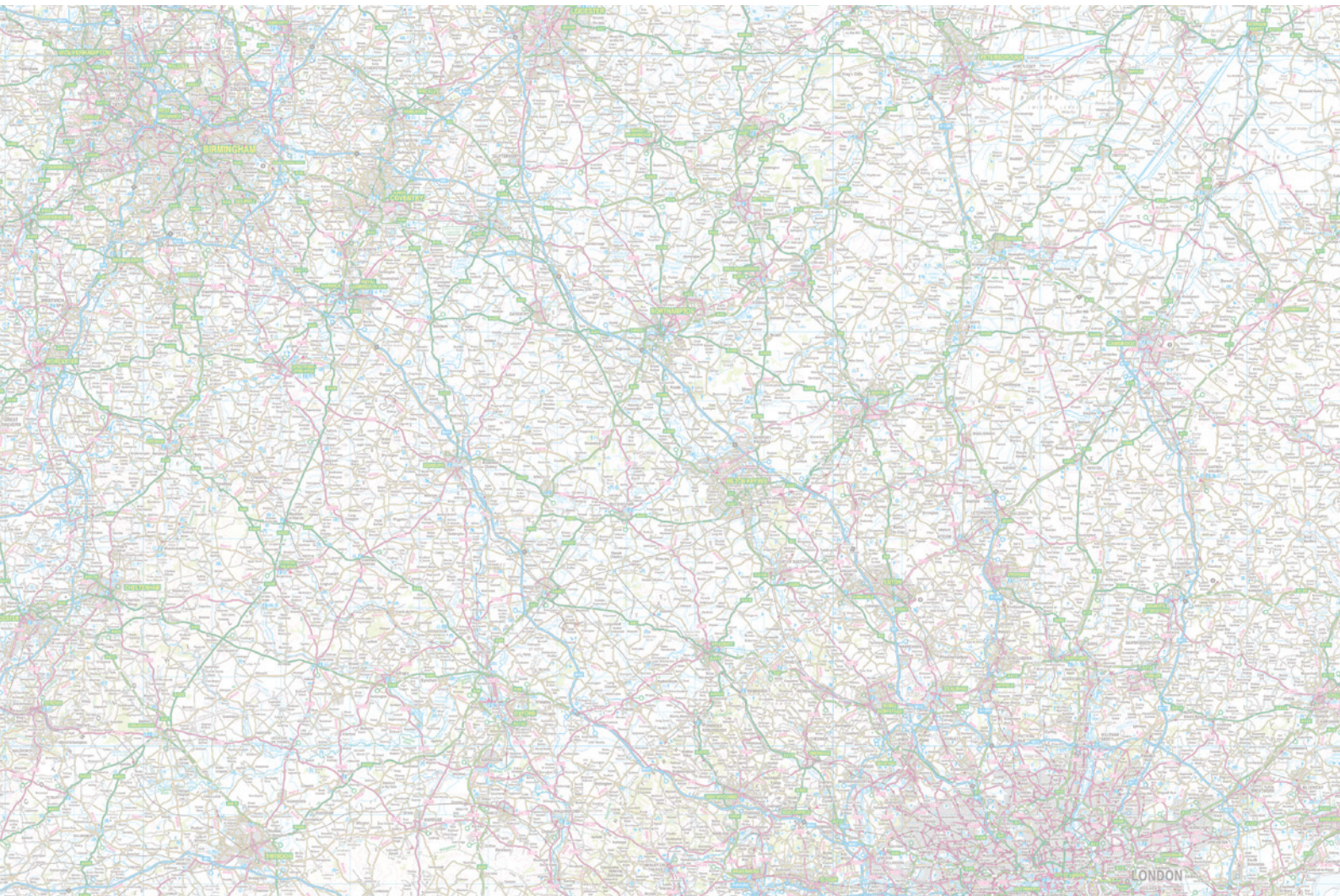
AVE Tarragona-Madrid, Fototrenes

St. Pancras Station, HS1 Ltd

Chapter 5:

Matisa www.matisa.com/matisa_ang/matisa_produits.html

Chapter 3 – Determining the Preferred Scheme



3.1 Option generation and sifting

Introduction

3.1.1 This chapter describes the process by which we have arrived at preferred options for the design of HS2 and explains the conclusions we have reached at each stage of that process. More detailed information on the design and impacts of our chosen options can be found in the:

- Route Engineering Study
- Appraisal of Sustainability Report
- Demand and Appraisal Report

Scheme development - core components

3.1.2 As our remit required, we have studied options for providing the necessary components of a London to West Midlands new high speed line. Our approach to design was driven by the factors described in the previous chapter, and began by dividing the whole package into separate components so that we could easily compare the options. For the following components we carried out a three stage process to identify what we recommend as 'preferred options' which would fit together to make a 'preferred scheme':

- London stations
- Heathrow/Crossrail interchanges (including approaches to London)
- Lines of route
- West Midlands stations and routes

3.1.3 Throughout the three stage process we took a balanced view of the criteria and in very few circumstances did one factor alone dominate a decision. The costs are given in 2009 prices.

Creating the long list and initial sifting - Stage One

3.1.4 We started with a long list of options for each category. We started with a clean sheet for our option development and reviewed existing material, invited options from our working group members, took on board recommendations from stakeholders and interested parties and drew on the knowledge of team members.

3.1.5 For each station option we analysed at a very high level its engineering feasibility, the relative likely demand and an indication of the relative costs (high, medium, low). We also captured any additional comments that might have had a bearing on the ability of the location to be considered, for example planning or environmental constraints. We identified those options that had obvious significant operational difficulties. We continued to pursue some options which, although difficult, were best in class of related difficult options and on which we needed to do further work to understand their viability. For route options we did not undertake an initial sifting process, as we had insufficient information at this stage to decide between the various options; we went straight into the more detailed assessment of stage 2 to produce the short list.

Determining the short listed options – Stage Two

3.1.6 To produce our short list of station and route options we reviewed:

- **Strategic fit.** This was used to capture whether an option met the remit sufficiently.
- **Costs.** At this early stage of option sifting broad costs were estimated sufficiently to show significant relative differences between options rather than taken as absolute.
- **Construction and operational feasibility and impacts.** This also included a description of whether new infrastructure or services would be required and whether existing services would be impacted. For stations, this included a review of passenger dispersal to and from the station, covering road, rail and public transport (including the London Underground).
- **Environment, social and spatial planning considerations.** This involved using a “simplified” sustainability appraisal framework which considered principally features of international or national significance and those which required a more refined level detail to distinguish options in sustainability terms. As with cost comparisons, much of this work was relative rather than absolute.
- **Demand.** Any relevant considerations of likely relative passenger numbers and journey times.

Selecting the preferred and alternatives - Stage Three

3.1.7 For the final stage of choosing our preferred options the level of appraisal and design intensified further. We gathered detailed evidence covering the same topics as before:

- **Construction and operational feasibility and impacts.** For the comparisons between options, we estimated costs in greater detail to give a relative assessment. The costs in this chapter exclude risk and are for comparative purposes only. For line for route the estimates were primarily derived by identifying the types of line within each route section (open route, corridor widening or tunnel) and then multiplying the length of each type of line by its generic unit rate.
- **A full appraisal of sustainability.** Using the four sustainability priorities we applied a full Appraisal of Sustainability Framework which focused on 18 specific issues and used a range of objectives and evaluation criteria to appraise each of these issues.
- **Economic analysis.** Focussed mainly on journey time comparisons.

Scheme development – additional components

3.1.8 As well as the individual components described above we also considered the following:

- **The case for an intermediate station.** A demand led approach to understanding the impact of a station between London and the West Midlands.
- **The case for an interchange station in the West Midlands.** A demand led approach again to identify and then assess potential locations for an interchange station.
- **The case for international rail connections.** A review of possible options for providing a link between HS1 and HS2 and an analysis of the likely passenger demand.

Scheme development – operational components

3.1.9 To complete our understanding of the requirements for a high speed line we developed the following:

- **A freight policy for HS2.** The possible options for running freight on a high speed line and a recommended approach.
- **A train service specification for HS2 and released capacity.** An initial view of a service specification to inform the business case.
- **Maintenance and stabling requirements.** Relevant criteria for choosing a rolling stock maintenance depot and an infrastructure maintenance depot for assessment in the business case.

Involving others

3.1.10 Throughout this process we worked closely with our working group stakeholders to help test the robustness of our decisions and ensure that they took account of the available evidence. Stakeholders were not asked formally to endorse the options taken forward. However, they did provide an effective challenge to our processes and assumptions and were important in helping to identify specific key local and regional impacts associated with the options we were considering.

3.2 London stations

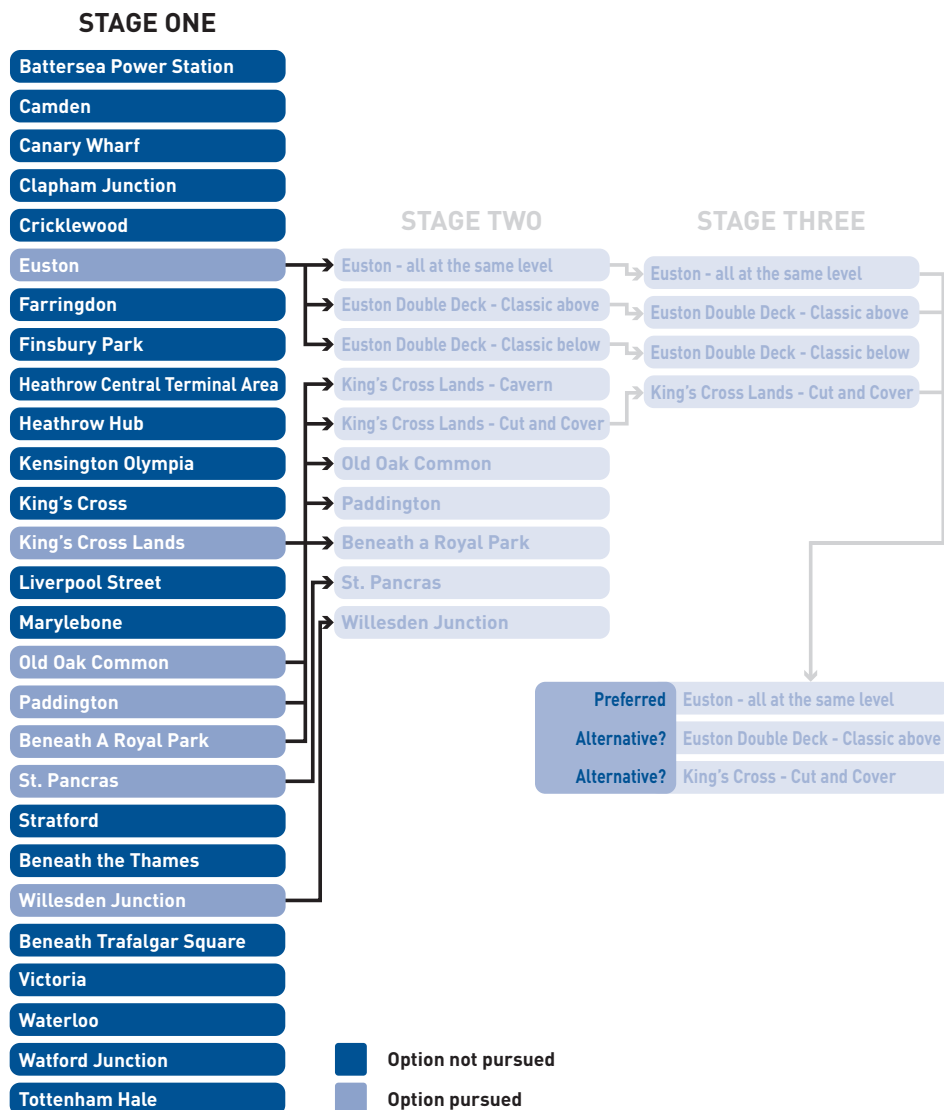
Introduction

3.2.1 This section sets out the option development process for identifying viable station options in London. We followed the process set out in section 3.1 to help us reach conclusions on components to take forward in our preferred package and viable alternatives.

Creation and initial sifting of the long list of station options - Stage One

3.2.2 Initially, we developed a long list of 27 possible sites in London, which are shown below in Figure 3.2a. The Figure shows in dark blue the sites that were sifted out at Stage One; sites shown in pale blue were considered further at the next stage.

Figure 3.2a London sifting process – Stage One



- 3.2.3** The creation of the long list of options was informed by our assumptions about the required size of London terminal, both under a Day One scenario, and in the longer term, as the root of a wider high speed network. In the future ten platforms could serve a possible 18 trains per hour, assuming greater network reliability and allowing for appropriately reduced turn around times. On Day One, without the benefit of such future improvements, ten platforms would be required to serve the 14 train paths per hour which represent the initial line capacity. This would require some optimisation of the timetable and turnaround times at the London end during peak hours and would provide some flexibility in platform operation during off-peak periods.
- 3.2.4** The list included central as well as outer London locations and for each station option we considered a surface, deep underground, or cut and cover solution as appropriate. Vacant space in and around existing stations is limited, as large areas of former operational railway land in London have been sold for commercial building developments progressively over the last 50 years.
- 3.2.5** We narrowed down the long list using the following high-level criteria:
- Overall fit with the remit.
 - Operational/Engineering feasibility. An initial view on the ability to construct a station on the site and the possible associated impacts – particularly dispersal opportunities recognising existing capacity constraints on the Underground network. Finding a location already integrated into the public transport network was a key requirement.
 - Demand. A non-modelled, broad assessment of likely scale of demand using available data including passenger access times to various locations in London – as set out in Figure 3.2b below.
 - Cost. At the level of a basic order of magnitude for relative assessments.
 - Other relevant factors, including potential planning and environmental constraints.

Figure 3.2b Number of people who live or work within 45 minutes of the major London stations, 2008

Number of people who live or work within 45 minutes of major London stations			
Location	Station name	Population	Employment
Inner London	Charing Cross	3,538,854	2,562,033
	Euston	2,858,771	2,413,397
	Farringdon	4,237,466	2,810,697
	King's Cross	2,651,242	2,278,835
	Liverpool Street	4,047,736	2,681,155
	Paddington	3,186,008	2,569,008
	St Pancras	2,560,423	2,231,384
	Victoria	3,100,706	2,472,419
Outer London	Waterloo	3,163,206	2,491,534
	Canary Wharf	2,032,821	1,908,139
	Finsbury Park	1,338,988	1,550,089
	Stratford	1,958,488	1,716,140
	Tottenham	1,822,286	1,561,869
	Watford Junction	1,313,323	1,152,734
	Willesden Junction	1,561,787	1,247,734

(Source: TfL analysis)

3.2.6 The station locations that progressed to the next stage included Euston, King's Cross Lands, Old Oak Common (railway land between Wormwood Scrubs and Willesden), Paddington, options beneath a Royal Park, St Pancras and Willesden Junction. The stations that were not pursued at this stage are described below.

- **Canary Wharf, Farringdon, King's Cross, Liverpool Street, Marylebone, Paddington, St Pancras, Trafalgar Square (Charing Cross) and Victoria.** Insufficient capacity to accommodate high speed services or lack of long enough platforms at most of the existing stations in central London means that, in effect, any expansion on the surface would require the construction of an entirely new station alongside, with most of the 10 new platforms outside the original footprint. Whilst other options remained in play, we felt that such a significant requirement for land on the surface was unacceptable as all these stations are in highly built-up locations.

- Given the difficulties of building on the surface at these locations, or using cut and cover methodology, we tested the constructability of a major cavern at Paddington (extending to the St Mary’s Hospital site) and King’s Cross Lands (the wedge of land between the stations of St Pancras and King’s Cross) as they were the closest to our approach routes. These cavern options were also chosen as examples in preference to taking forward the **Beneath the River Thames** option, given the added technical difficulties associated with building under water and the longer approach route required.
- **Battersea Power Station, Camden, Clapham Junction, Cricklewood, Finsbury Park, a location beneath the central terminal area of Heathrow, a hub near Heathrow, Kensington Olympia, Stratford, Tottenham Hale and Watford Junction.** The majority of rail passengers from London to Birmingham (and destinations beyond) start their journey in inner London. Locating a terminal station outside central London would jeopardise access to this market since it imposes significant interchange and journey-time penalties on the majority of passengers. Whilst it may be desirable to capture some of the (mainly car) trips from outer London, these trips are unlikely to be well suited for rail (few for example go to city centre locations). Nevertheless, we carried forward two options for further work – Old Oak Common and Willesden Junction.

Why are we not recommending using the former Eurostar platforms at Waterloo?

Five long platforms, capable of taking 400m long trains, already exist at Waterloo – a legacy from the original Eurostar operation pre-dating the opening of HS1. The current ‘high speed’ lines serving these platforms point south west and access for high-speed trains from the north would require either a newly tunnelled route under the Thames, the parallel construction of lines alongside the existing West London Line, or the extensive gauge clearance of (and removal of existing capacity from) the West London Line to accommodate the larger trains. The latter would also be a low-speed option. Both approaches would be highly expensive, and we would expect a surface route to require significant land take. An additional five platforms would also be required either here or elsewhere to meet the needs of a ten platform station.

Furthermore, the platforms are currently earmarked for integration with the rest of Waterloo providing necessary additional capacity on the South West Main Line suburban network. We would expect that growth in demand to Waterloo from areas served by the South West Main Line will be such that, were HS2 services to take over these platforms, alternative platforms would be required elsewhere to accommodate rising demand. Waterloo is a constrained site and both it and its approaches are on viaducts. There is limited scope for building additional platforms alongside or above the station.

Determining the short listed options - Stage Two

3.2.7 For those options that made it past the long list stage, we intensified our work to cover the following areas:

- Costs – based on an initial evaluation of the high-level scope with a generic unit rate applied.
- Construction and operational feasibility.
- Environmental, social and spatial considerations – using the simplified appraisal framework.
- Demand – where relevant.

3.2.8 Through this further work, we identified our short list of options as Euston and King’s Cross Lands (cut and cover). The following locations, as noted in Figure 3.2c were not pursued any further:

- **Beneath a Royal Park.** In the spirit of looking at possible options, we investigated the potential for developing a station underneath one of the central London Royal Parks. We looked at possible sites in Green Park, Hyde Park and Regent’s Park. We envisaged using a cut and cover methodology so that the park would be reinstated after construction with the only visible structures within the park being a station entrance, associated access provision, emergency exits and the vent shafts that would be necessary to provide ventilation and a means for smoke to escape in case of fire. Construction of this nature in a green-field site poses relatively few engineering issues, mainly associated with aligning the underground box to fit with existing tunnels. Of the Royal Park locations, Regent’s Park offered better connectivity than Green Park or Hyde Park. This option had made it through stage one on the basis that we required further information from a planning and sustainability perspective.

Gaining permission to build in any Royal Park would require a significant shift in the protection afforded to these sites, which have remained largely unchanged for nearly 200 years. We took the view that further consideration of a terminal station in any Royal Park should only be undertaken as a matter of last resort. We recognise that there would be significant opposition to building in these open spaces that have been safeguarded for the enjoyment of Londoners and visitors alike and which are London landmarks. We therefore concluded that no options to build beneath the Royal Parks should be taken forward.

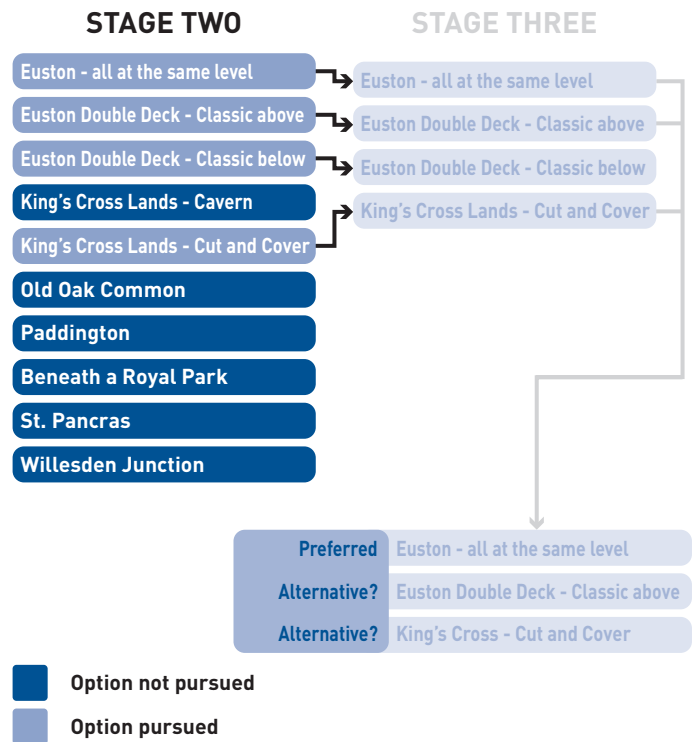
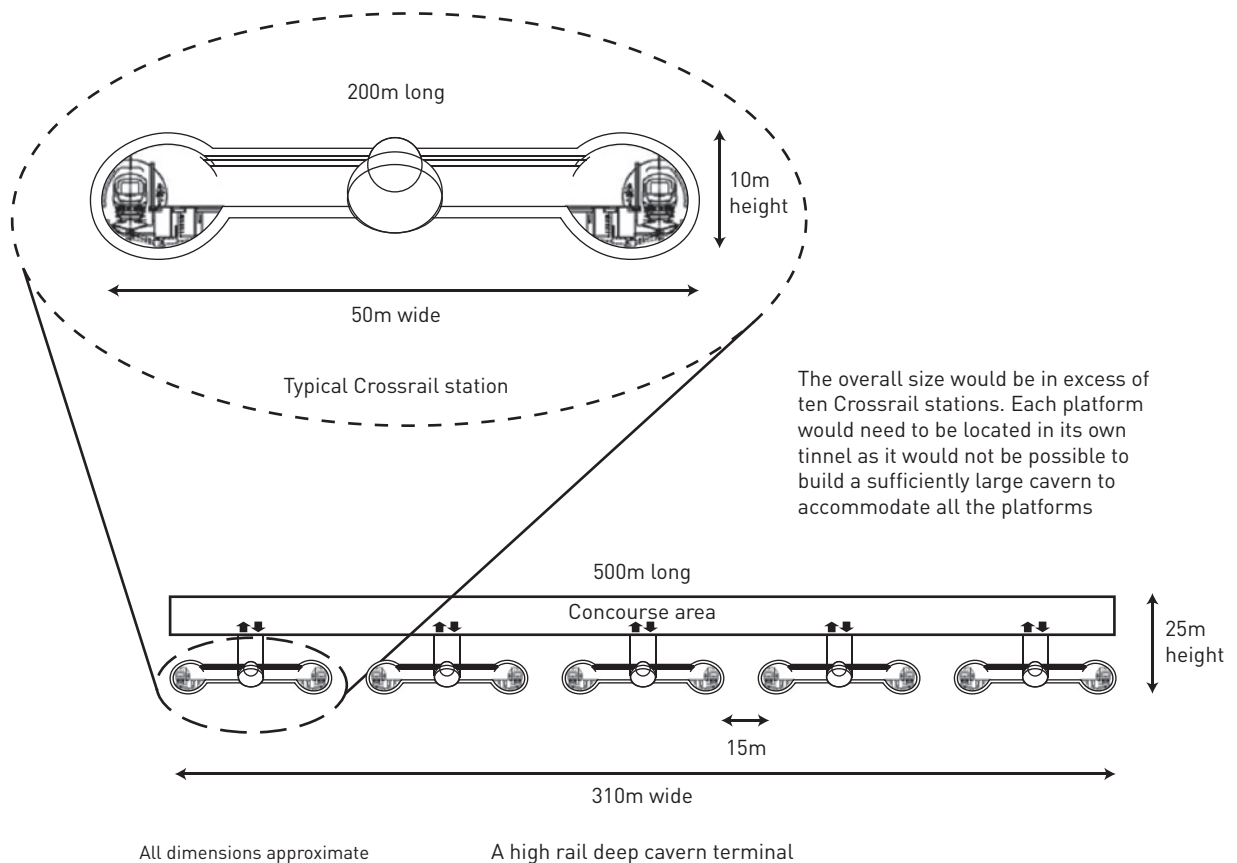


Figure 3.2c London sifting process – Stage Two

- Deep tunnelled cavern (Paddington and King’s Cross Lands).** A sample cross section of a cavern is provided in Figure 3.2d. The ground conditions at King’s Cross Lands would not permit this method of size of structure to be built underground. At Paddington, whilst the ground conditions would permit this type of structure, ground settlement could be of the order of 150mm. Although grouting would reduce the risk of settlement, it would not be a viable solution over such a large area. This degree and type of settlement would be unacceptable underneath Brunel’s Paddington station, or a hospital. The significant risks associated with these deep cavern options, along with the possible cost of over £5bn, led us to conclude that, while we still had potential sites in central London without such risks, we should focus on those. Although we decided to do no further work on a cavern option at King’s Cross Lands, we carried forward for further investigation a cut and cover station option.

Figure 3.2d Size and scale of a deep cavern option



- St Pancras.** We reviewed two options. The first, a ten-platform station constructed immediately above the extended HS1 platform zone, was not pursued as it would present major construction challenges – including building new foundations beneath the existing deck – and would be hugely disruptive during construction since it would require complete closure of the station. The second, a ten-platform terminal station sited to the north-west of St Pancras at the same level as St Pancras International, on the site known as Somers Town, was not pursued. It would entail

significant disruption to the local community with housing demolitions and the loss of St Pancras Hospital, commercial property, and a number of listed buildings and monuments.

- Willesden Junction and Old Oak Common.** Further demand analysis continued to suggest that the journey time penalty for central London passengers using these stations as the only London terminal was likely to severely reduce the benefits of HS2. A Crossrail connection at Old Oak Common or Willesden Junction would allow some passengers a quicker journey time to the East or West of London, but the bulk of the demand for HS2 would come from the central, north and south of London which would be best served by a central London station.

Selecting the preferred and alternative options - Stage Three

3.2.9 From our short list of options, noted in Figure 3.2e, we identified our preferred option using the following criteria:

- Construction and Operational Impacts.
- The Four Sustainability Priorities.
- Costs.
- Economic analysis.

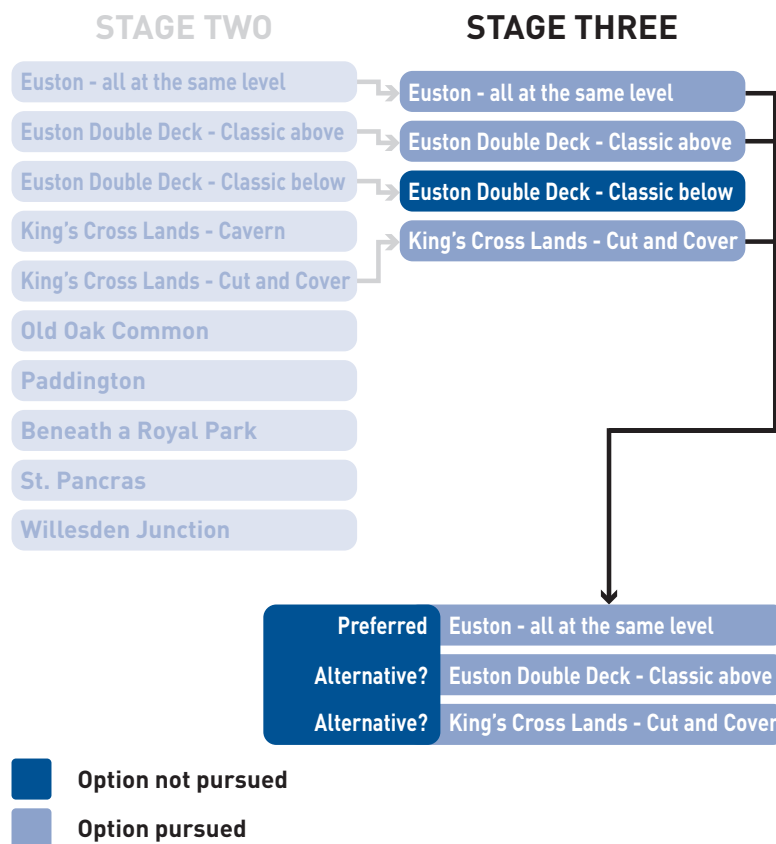


Figure 3.2e London sifting process – Stage Three

Preferred station – Euston – all platforms on one level

Design, Construction and Cost

3.2.10 Euston station – the existing London terminal for the WCML – currently comprises 18 platforms of varying length and width, with a concourse and retail area just south of the platforms. A parcels deck - which is now largely disused - covers the station. Immediately in front of the station is a square with additional retail facilities, some high rise office accommodation, a bus station and Euston Gardens. The station is at its busiest during the morning peak period, during which time all 18 platforms are required to operate the service.

3.2.11 With the introduction of the HS2 platforms and the replacement of longer distance services from the current WCML with local or medium-distance trains which have shorter turnaround times, slightly fewer platforms would be needed for the classic services. The preferred HS2 solution extends the current station footprint to the west to accommodate 10 HS2 platforms, with 14 classic platforms to the east. The overall footprint can be found in Figure 3.2f.

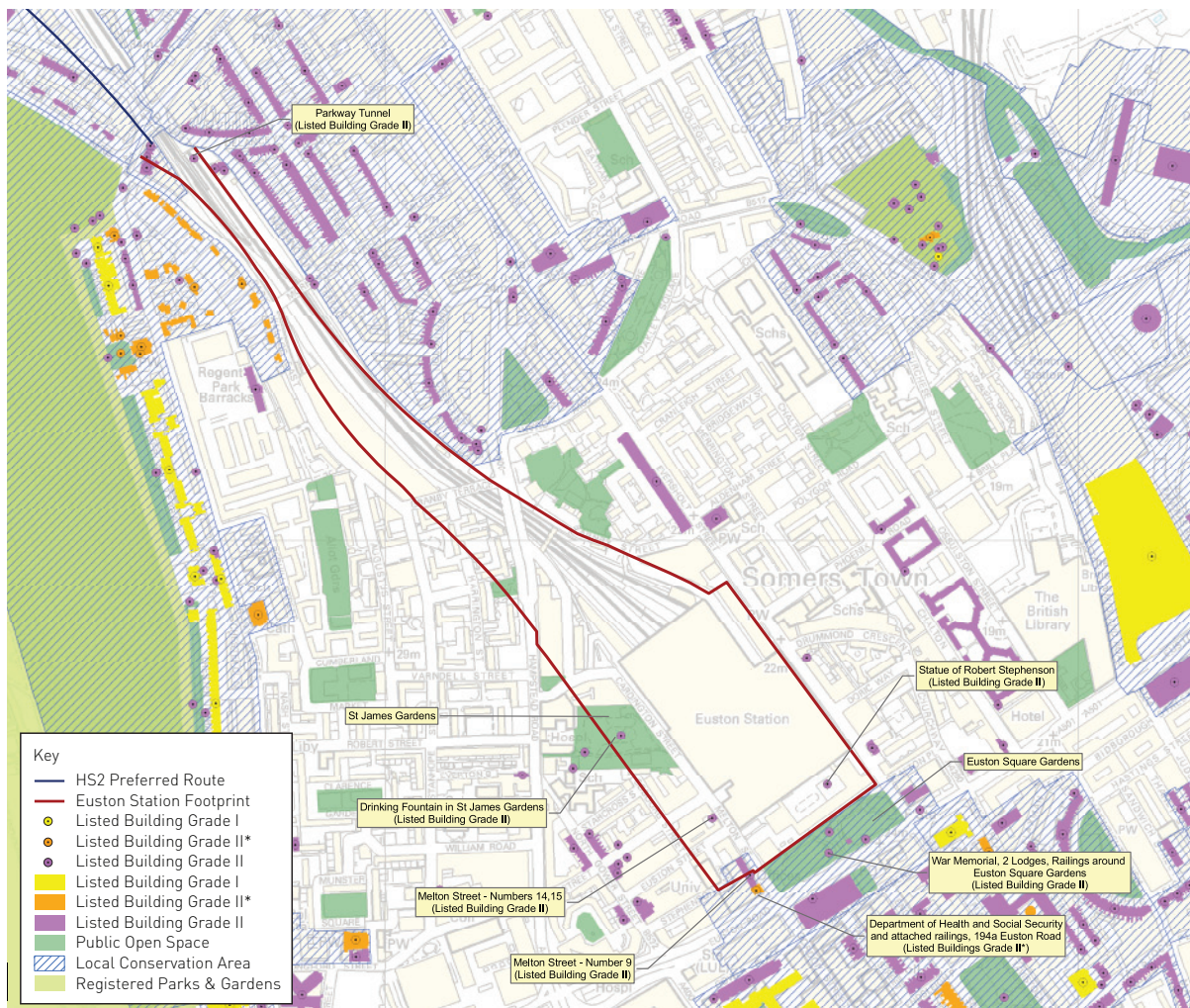


Figure 3.2f Proposed Euston station footprint

- 3.2.12** Figure 3.2g shows the platform layout. Two of the classic platforms adjacent to the HS2 platforms, and connected to both the classic and the HS2 approach tracks. This enables use by classic-compatible HS2 trains in the late evening and early morning to reach Wembley for stabling overnight.

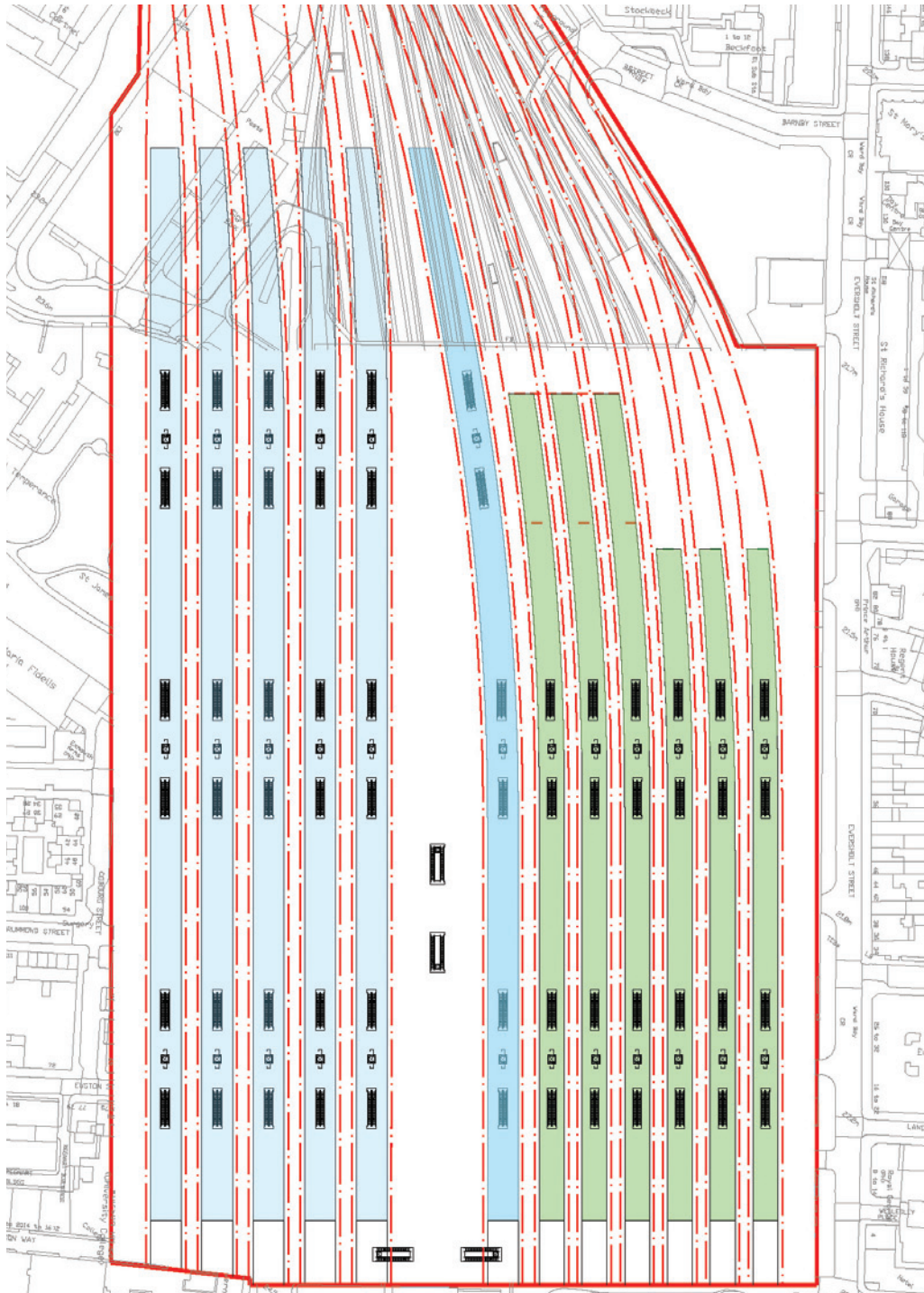


Figure 3.2g Proposed Euston station platform layout

3.2.13 The station footprint is also extended southwards to meet, but not affect, Euston Gardens. We envisage that the platforms would be built about two metres below current track level to obtain the necessary clearance under Hampstead Road Bridge immediately to the north of the station. The concourse would be extended over the platforms at street level for two thirds of their length. This would provide effective passenger access to the full length of the trains, with step-free access to the concourse from three sides. This increases access across the site for both pedestrians and - potentially - vehicles, which the current station cannot offer. Redevelopment opportunities have not been a deciding factor in our station choice. However it is worth noting that this location would offer development potential for commercial and retail facilities to be built above the station. Figure 3.2h is an artist's impression of the station that could be built; it may not necessarily have a glass roof if there is redevelopment above.



Figure 3.2h Artistic impression of Euston concourse

3.2.14 We have undertaken an initial examination of how works at Euston might be staged, in order to limit disruption to rail users and the local communities. The programme of work would need to be developed in detail with stakeholders including the London Borough of Camden, TfL, Train Operating Companies and Network Rail. For example, it would be potentially possible to construct the west side of the high speed platforms in Stage 1 in a form capable of temporary use by classic services to help reduce disruption during later stages. We have estimated the cost of Euston based

on an outline sequence of four principal stages which could last between 6 and 7 years in total. Throughout these stages we have assessed the complementary construction of the classic and high speed work on concourses, access to the Underground and approach tracks:

- **Stage 1: Months 1-18.** Buildings along the west side of the station cleared and the new high speed station structure in that area constructed including any provision to permit development above it.
- **Stage 2: Months 6-30.** Reconstruct the eastern half of the classic station.
- **Stage 3: Months 30-54.** Reconstruct the western half of the classic station.
- **Stage 4: Months 54-78.** Construct the remainder of the high speed station.

3.2.15 We estimate the cost of constructing the station and the rebuilding of the tube ticket hall would be approximately £1bn. This includes all contractor costs but excludes location-specific construction risks, ancillary items, environmental mitigation, land purchase, TOC compensation, project costs and any routewide or programme level risks which are included in the overall costs.

Passenger benefits and dispersal

3.2.16 Euston has good links with most London destinations via the Underground, with the Victoria line and both branches of the Northern line currently integrated within the station complex, and the Metropolitan, Hammersmith & City and Circle lines at nearby Euston Square station, with the potential for a new connection from the eastern end of Euston Square station platforms to the south west corner of the Euston station site. A short Advanced People Mover could connect Euston to St Pancras along a route to the north of the British Library. This would provide immediate access to First Capital Connect (Thameslink and Great Northern services), East Midlands Trains, South Eastern (domestic high speed services), Eurostar and East Coast core services. These connections would require further work and have not been included in our costs.

3.2.17 Around half the passengers arriving or departing from Euston currently go on to use the London Underground. Even with TfL's investment programme for the Underground, parts of the tube network are likely to be heavily loaded by the time HS2 opens. We forecast that the impact of HS2 would be to add as much as 50,000 long distance and 15,000 - 20,000 short distance passengers per day to and from Euston (i.e. 25,000 in each direction). Assuming that half of these passengers go on to use the Underground, that could mean around 32,000 additional passengers at Euston and Euston Square Underground station per day. With an outer London interchange station, the number of additional passengers on the Underground reduces to 17,000 per day. There are several potential ways to relieve some of the crowding problems on the Underground. An HS2 interchange with Crossrail in West London would be one such option, as discussed in section 3.3.

3.2.18 Suggesting improvements to the Underground network itself was not part of this study but we note a number of potential ways that could help with crowding around Euston which we have discussed with TfL. For the purposes of this study, we have not included their costs or benefits. Further work would be required to understand the impacts of these proposals alongside a new HS2 scheme.

Schemes to help dispersal at Euston – Transport for London proposals

The following schemes were all included in the consultation on the Mayor’s Transport Strategy, published in October 2009, and many of them meet wider objectives.

- **Northern Line Upgrade 2.** This proposal involves a service recast on the Northern line and expansion of its train fleet in order to permit up to 28tph to operate from Euston southbound via each branch (Charing Cross and Bank) in the morning peak – a capacity increase of 17% over post-upgrade levels. This proposal is funded with completion scheduled for 2018.
- **Removal of London Overground services from Euston.** We have assumed that these services would be able to return to Euston after construction of the new station, using the dual-voltage capability of the rolling stock to run into any of the classic platforms at Euston, having removed the third-rail DC equipment during the rebuilding of the station. To help relieve pressure at Euston there would be a number of options including diverting these services elsewhere; curtailing the services at Queen’s Park, or extending the Bakerloo line to Watford Junction. All these would have different impacts that would need to be considered.
- **Diversion of suburban London Midland services onto Crossrail.** The transfer of eight stopping services into London which are currently operated by London Midland from Milton Keynes, Tring, Berkhamsted and similar (on the slow lines) into Crossrail from the West, rather than terminating at Euston. We did a high level analysis of the difference this proposal would make to the crowding issues at Euston. Removal of 16 train movements per hour from Euston (8 arrivals and departures) would equate to an estimated 13,000 number of passengers when fully loaded in the morning peak hour and half loaded in the opposite direction. It could also reduce the number of classic platforms required from 14 to 12.
- **Chelsea-Hackney Line.** This is a safeguarded long-standing proposal to create a new Underground line from southwest to northeast London via Victoria, Tottenham Court Road and King’s Cross St Pancras. Its relevance to Euston is that it could offer considerable relief to the Victoria line. A Chelsea-Hackney Line may offer crowding relief arising from background growth in trips in London.

Sustainability considerations

- 3.2.19** Any development at Euston should help to realise the potential aims of the Central Camden and West Euston Renewal areas. As outlined in the London Borough of Camden’s Unitary Development Plan, their objectives are to intensify job creation in the area and increase and improve housing. The London Borough of Camden has produced a more detailed masterplan (Supplementary Planning Document) for Euston where they have identified the station as being a fundamental catalyst for regeneration.

- 3.2.20** Figure 3.2f, earlier in this section, maps the key sustainability features in the area. The proposed footprint has an impact on around 220 flats, in 5 blocks, within Regent's Park Estate and its associated amenity space and community facilities, approximately 30 other residential units, and more than 20 commercial and other buildings. We recognise the community impacts that such significant demolitions could create. The phasing of the construction works could allow new housing to be built nearby, although significant local authority and community consultation would be required before any decisions could be made.
- 3.2.21** St James' Gardens, on Cardington Street, provide enclosed green space for the local community and would largely be taken up by the footprint. The Gardens also contain several listed structures but it is likely that these could be preserved or moved. The overall heritage impacts of the proposed Euston station are significant; in addition to St James' Gardens, several Grade II buildings and structures would need to be demolished or relocated. The Grade II* listed 194a Euston Road would be retained, but, as it is very close to the new station site, would require very careful protection.
- 3.2.22** The design of the station would facilitate pedestrian access across the site at Euston, helping east – west movements between the communities of Regents Park Estate and Somers Town, that are currently limited by the existing station. Housing, employment spaces, different types of open space and thoroughfares could be built on top of the station. Plans to relocate the Euston Arch at the front of Euston Gardens by the hunting lodges would be compatible with this proposal.
- 3.2.23** The strategic view corridor stretching across the site from Primrose Hill to St Paul's Cathedral would be unaffected by the proposed design. The demolition of the office blocks to the front of the existing Euston station to accommodate the expanded station would offer the opportunity to improve the strategic view.

Is there a viable alternative - double-deck at Euston?

- 3.2.24** A new ten platform terminal station for HS2 at or just below the surface constructed below a new classic terminal is the double deck option. The layout would extend through the existing office blocks at the front of the station and several blocks of flats to fit in the required platform lengths. The station approach would require alterations to existing highways which cross over the WCML. The station and throat would create an impermeable barrier, in excess of a kilometre long, with Hampstead Road as the only bridge. We estimated that this option would be about 15-20% more expensive than the preferred Euston scheme.
- 3.2.25** Extensive civil works would be required which would be very difficult to carry out in a safe manner above a live railway line. Construction would therefore involve significantly more disruption than the preferred solution, taking out more platforms at any one time and lasting for a year longer. Passenger dispersal opportunities and passenger benefits would be the same as for the preferred Euston option, although a split level station would not be as easy for passengers to navigate.

- 3.2.26** We would not expect the roof height to conflict with the strategic view corridor to St Paul’s Cathedral from Primrose Hill. However, the station could reach a height approximately 44 metres above ground level, leaving little room for further development above, to replace buildings demolished at the front and west of the existing station.
- 3.2.27** The main difference from the preferred layout is the extent to which the double deck solutions would create substantial visual and noise effects for residents to the East and West from the station throat and approach tracks. Whilst the overall land-take would be less and therefore the number of houses demolished would be less, the impact on the flats adjacent to a five storey high railway would be significant. The height of the station would also create a significant barrier to east-west connections. The direct impacts on the Grade II listed buildings would be less. However, given the height of the station throat the noise and visual impacts would be significantly greater on the Camden and Regents Park Conservation Areas, and the Grade II and II* buildings within.
- 3.2.28** Given the aggregate impact of these factors, we do not recommend that this option be pursued but present it here for completeness. We also tested and ruled out an option to house HS2 services on top of classic services at Euston, with the main difference being that the station throat in this scenario would be substantially more difficult to build and to maintain. The HS2 lines would need to move from above to below the classic lines over a short distance in order to minimise property and highways impact. This would be a complex construction and provide no additional benefit.

Is there a viable alternative – King’s Cross lands?

- 3.2.29** In construction terms, the King’s Cross Lands site presents several difficulties. The location would not easily accommodate a station box – bounded as it is by Thameslink tunnels, the HS1 and North London lines to the north, the East Coast Main Line to the east, Midland Main Line to the west, with Regent’s Canal at the southern edge and the Camden sewer crossing the site. The Thameslink tunnels at the northern edge of the site also bisect the proposed throat, forcing the alignment deeper below the ground and precluding a station on the surface. The Regent’s Canal would require either to be permanently diverted, or careful construction beneath the canal would be needed to create a permanent aqueduct over the finished station. The sewer would also require diversion.
- 3.2.30** King’s Cross Lands has long presented a major opportunity to create sustainable communities in a deprived area of London for both Camden and Islington on land previously used for construction of HS1. The current masterplan is designed to help create employment and provide new housing and amenity space. Plans are currently underway for a significant heritage-led regeneration project. We estimate that approximately 90% would be affected by a new HS2 station with 12 Grade II Listed structures impacted directly. A cut and cover station would significantly disrupt these aspirations. It would affect a substantial proportion of the initial phase of that development and blight future planned development phases. Other commercial development could be achieved over the station following construction but the uncertainty over the use of the site would blight the area for many years. A substantial proportion of the retained heritage, that would otherwise be saved by the current plans, would also be lost as a result. This would therefore be a very unattractive option. We do not recommend that it be pursued but present it here for completeness.

Why not have two smaller stations?

3.2.31 We have considered whether building two smaller stations could reduce the overall costs and impacts and therefore be better than our preferred station option. This high level assessment demonstrates that the costs would actually be higher in most cases and if there was any additional demand benefits these would not outweigh them. We considered a number of options.

- **A central through station with the line going on to serve a second central London terminal.** The second station would still require a ten platform station to allow all trains to terminate there. Therefore this option would significantly increase the overall costs. The demand case for this variant would be sensitive to station locations. Although there is likely to be an improvement in accessibility by using two stations this would be outweighed by a significant time penalty for through passengers at the first station, and by the cost of building two central London stations.
- **A through station with the line going on to a second location where the trains could turn round and be cleaned.** This option could reduce the time a train stood in the central station, possibly reducing the number of platforms required. However, a train has to be physically checked to ensure no passengers remain on board before it can depart to the turnback sidings. Similarly a train entering service takes much longer than an intermediate station dwell, due to the need for passengers to find seat reservations and load luggage. The tunnel linking the station and the turnback sidings would need to be very deep to pass underneath the existing tunnels, including Crossrail and so the station would need to be located below ground due to the practicality of trying to connect from a surface station to the required tunnel depth. The length and therefore the cost of the tunnel required to reach the turnback sidings would be significant and extra trains would be required due to the additional travel time to and from the turnback sidings. There are also no obvious areas of land large enough for turnback sidings in central London.
- **Two stations independently served by the main line of route.** This would require two 6 platform stations and so we reviewed a number of options to understand whether this would reduce the costs and impacts. There would be insufficient room to accommodate 6 platforms at Euston without the need to rebuild the entire station and throat. Disruption would be broadly similar when constructing 6 platforms on the site as with construction of 10 platforms. Similarly, some extension to the West would also be necessary. If the entire station would need to be rebuilt it would seem sensible to rebuild it to accommodate all the HS2 trains and provide 10 platforms. As regards King's Cross Lands, although 6 platforms would require a smaller footprint than 10, there would still be no available land large enough for such a station. The station would still require demolition of the brand new development above it to facilitate construction. A station at Stratford would be unattractive to anyone accessing central London, with interchange and connection penalties likely to be significant. The central London terminal would therefore have to be larger than the six platforms to accommodate a greater proportion of the demand.

Summary and key recommendations

- 3.2.32** We concluded that 10 platforms would be needed for a London terminal station, and that these should be provided at a single location. Our analysis showed that the terminal station should be in central London.
- 3.2.33** We found that accommodating all the classic and HS2 platforms at the same level at Euston was a credible and viable preferred option. We looked in detail at two alternatives and found that we were unable to recommend either.
- 3.2.34** We therefore recommend that the single level Euston option is taken forward and we suggest the next stage of design should include:
- Further dialogue with Camden Council to ensure that appropriate re-housing measures and master-planning for the area are considered early in the design phase, particularly for those residents potentially affected by the current proposed station footprint.
 - More analysis on how disruption to existing services might be kept to a minimum during construction.
 - Additional work to understand opportunities which would help with dispersal of passengers from Euston.