Leeds and Sheffield City Region Partners

High Speed Rail to the Leeds and Sheffield City Regions

Technical Report- Options Assessment and Wider Economic Benefits

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Ove Arup & Partners Ltd
Admiral House, Rose Wharf, 78 East Street, Leeds LS9 8EE
Tel +44 (0)113 2428498 Fax +44 (0)113 2428573
www.arup.com

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		Name	Iain Mobbs, Ellie Cooper (Volterra)	Tom Bridges	Nigel Foster
		Signature			
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			Prepared by	Checked by	Approved by
		Name			
		Signature			
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1 Introduction – The Case for Improved Inter-urban Rail Links

1.1 Background

Since the publication of the Eddington Report that principally advocated improvements to the existing rail network, the level of support for High Speed Rail has increased significantly. The success of the first UK High Speed Rail Link (HS1) operating between London St Pancras and the Channel Tunnel, together with various continental examples, has highlighted the number of potential benefits it can bring. High Speed Rail (HSR) enables higher operating speeds (typically 300kph), helping to cut the journey time between London and Paris, Brussels and other parts of continental Europe. This has strengthened the competiveness of High Speed Rail versus other modes. HSR has also helped to deliver other benefits, and is expected to act as a catalyst for delivering major regeneration schemes including Ashford, Stratford and the Thames Gateway.

HSR offers the potential to transform rail connectivity from the Leeds and Sheffield city regions to other major population and employment centres. Although HSR offers the potential to deliver a range of substantial benefits, comparisons with HS1 have highlighted a number of risks including the magnitude of costs, complex implementation and lengthy timescales.

Arup has therefore been commissioned by SYPTE and Metro to examine the potential to improve inter-urban rail links. In response to the likely timescales to deliver HSR, the scope of the study includes examining potential improvements to the existing inter-urban routes, as well as new HSR. In addition to the improving existing inter-urban links, the scope of the study also includes potential enhancements to the rail network within the city region, thus strengthening connectivity to the main hubs in the city region.

1.2 The Economic Arguments

Fast, frequent, reliable rail services that link the Leeds and Sheffield city regions with other major conurbations including Manchester, London and the Midlands are vital to stimulate economic prosperity. Attractive rail services are also important to link the Leeds and Sheffield city regions. The following summarises the economic arguments for improving inter-urban rail links:

- **The size and significance of the region's £82 billion economy** – the economic size of the Leeds and Sheffield City Regions is similar to Scotland and Norway. The city regions are the location for 1.9 million jobs; Leeds is the largest employment location in the north and has the largest concentration of financial services jobs of any city in England outside London; Sheffield has been one of the fastest growing UK regional cities in terms of jobs in the past five years;
- **The region's rapid population and housing growth** – The city of Leeds provides work for over 400,000 employees, the highest level of employees in any district in the north and the third largest in England. Leeds has the highest level of employees in legal, financial and business services out of all districts in England outside London. With almost 250,000 employees, Sheffield is also a significant employment centre, ranking within the top ten centres in the country. Over the last five years there has been a 6% growth in jobs in Sheffield, a higher rate than Manchester, Birmingham or Leeds. The region's population has grown by 220,000 over the past decade;
- **The economic importance of transport connections from the region to London and Heathrow** – the routes between Yorkshire and London include some of the largest and fastest growing rail markets in the UK and play a key role in the region's attractiveness for investment in key economic sectors. The region is at a major competitive disadvantage from having no flights, and poor surface connections to

Heathrow. Links to the global financial centre of London and the international gateway of Heathrow are vital to maintaining and growing the financial, legal and business services sectors in the Leeds City Region, and to expanding these sectors in the Sheffield City Region. Together these City Regions make an important contribution to the overall UK economy in these sectors.

- Whilst there has been **rapid economic growth** in the Leeds and Sheffield city regions, **significant problems of deprivation remain**, and parts of the city regions are particularly vulnerable to widespread job losses in the recession. Although the regions' main cities are doing well, they could do better with improved transport connections.
- **Future capacity constraints on existing north-south rail routes and the strategic highway network;** there is evidence of capacity constraints affecting most north-south rail corridors, and these constraints are expected to be exacerbated over the next 10-20 years as demand increases. In addition, there are further capacity constraints likely to affect the strategic highway network and locations close to airports.
- **Poor rail links between main centres in the region, and with key centres in adjacent regions** – poor rail links currently limit the ability of businesses to access markets and for people to access jobs in adjacent city regions within and outside of the Yorkshire and Humber region. This limits the potential for economic agglomeration.

1.3 The Travel Market

1.3.1 Introduction

The analysis above highlights the size of the economy in the Leeds and Sheffield city regions, and the role rail plays in providing attractive connectivity both to the Leeds and Sheffield city regions for commuting purposes, and for longer distance trips, primarily to London and Manchester, but to a lesser extent, Birmingham and Manchester Airport. A review of selected rail flows is useful to understand the most important journey patterns in the city region. This is shown in Table 1.1.

1.3.2 Strategic Rail Journeys

London is the most important strategic destination shown in Table 1.1, with almost 4.5m journeys per annum between the capital and selected stations in the Leeds and Sheffield city regions. The importance of flows between Leeds and London is clearly demonstrated, accounting for over one-third of total trips (over 1.55m journeys per annum). York and Sheffield also generate over 0.75m journeys per annum to London, whilst there are around 380,000-460,000 from Wakefield and Doncaster respectively. The number of trips from other stations in the city regions is relatively small.

In terms of passenger growth, the London to Leeds flow was one of the fastest growing rail markets in the UK, with a 50% increase in journeys since 1999/2000. This compares favourably with a 37% increase for the London to Manchester flow over the same period, although the ticket data may not fully include the impact of the recent service improvements.

There are around 2m journeys per annum between Manchester and selected stations in the Leeds and Sheffield city regions. Again, the principal flows originate from Leeds and Sheffield stations, although there are also a significant number of journeys from Huddersfield. Both the north TransPennine route via Huddersfield and the southern route via the Hope Valley have recently experienced strong passenger growth to Manchester. The combination of new rolling stock, a revised clock-face timetable and additional capacity has delivered a 25% growth on some flows via Huddersfield between 2004/05 and 2006/07. The demand growth on the south route has been smaller (around 15% over the same period), with new higher capacity rolling stock contributing to this.

There are around 480,000 annual journeys to Manchester Airport and Birmingham. Similar to the trends for London and Manchester, the majority of these journeys originate from

Sheffield, Leeds and York. Anecdotal evidence has indicated the Leeds to Birmingham flow has experienced significant growth during the last few years.

1.3.3 Local Rail Journeys to Leeds and Sheffield

Table 1.1 also includes trips from stations in the city regions to Leeds and Sheffield. There are about four times more rail journeys to Leeds from selected stations in the city region, compared with Sheffield. The busiest flows include York, Wakefield and Sheffield to Leeds. The Sheffield to Leeds flow generates almost 0.5m journeys per annum, increasing by 140% since 1999/2000. This growth in trips is consistent with the step change in service frequency introduced by Cross Country (regular hourly service) and Northern (semi-fast services via Barnsley) since 2000.

Table 1.1: Number of Annual Rail Trips ('000's)

	London	Manchester	Birmingham	Manchester Airport	Sheffield	Leeds
Barnsley	15	10	4	2	155	139
Doncaster	462	57	22	18	180	219
Rotherham	10	10	3	2	109	32
Sheffield	751	429	153	112		481
Bradford	49	110	12	8	27	541
Halifax	26	77	3	3	6	334
Huddersfield	57	399	13	71	44	691
Leeds	1,558	681	167	137	480	
Wakefield	379	9	26	1	67	448
York	883	193	68	107	173	1112
Selby	38	11	1	2	3	231
Harrogate	101	23	7	9	9	329
Skipton	39	5	2	1	4	201
Northallerton	66	8	2	4	3	38
Total	4,434	2,022	1,260	483	1,260	4,796

Source: MOIRA data 2007/08. Data illustrates total two-way journeys between each pair of stations, for example, there are 15,000 journeys per annum between Barnsley and London. Travelcards within West and South Yorkshire are not included in this dataset

1.3.4 Surface Access Trips to Heathrow Airport

The number of surface access journeys to Heathrow Airport from the Yorkshire and Humber Region is presented in Table 1.2. There are 407,000 annual trips from the Leeds and Sheffield city regions to Heathrow. Not surprisingly, the CAA data indicates these journeys are solely international trips. There are no domestic trips from Heathrow originating from these city regions. Around 40% of the total journeys shown in Table 1.2 originate from South Yorkshire, with a further 33% from West Yorkshire. Other Districts in Derbyshire and North Yorkshire account for the remaining 27%.

Table 1.2: Number of Annual Trips to Heathrow Airport from LCR and SCR

District	CAA Total	Adjusted Total
Derbyshire *	148	41
North Yorkshire *	115	71
South Yorkshire	161	161
West Yorkshire	134	134
Total	558	407

Source: 2007/08 CAA data Note: Selected Districts in Derbyshire and North Yorkshire form part of the Leeds and Sheffield city regions, and the totals have been adjusted on a pro-rata basis using population totals. Totals include car and bus as well as rail.

1.4 Overview of Existing Rail Links

1.4.1 Introduction

The rail ticket data presented in Table 1.1 highlighted that there are a significant journeys to London and Manchester, and to a lesser extent Birmingham and Manchester Airport from stations within the city regions. There are also strong local flows, both between Leeds and Sheffield, and also journeys to these stations from the adjacent journey to work areas. This section reviews the quality of the existing rail links.

1.4.2 London via the East Coast Main Line

Leeds benefits from the 2tph service to London which now operates all day via the East Coast Main Line (ECML), with the fastest journey time to London around 2 hours 5 minutes. Some services are slower, given the requirement to serve intermediate stations south of Doncaster. York also benefits from 2tph to London, with some northbound trains taking less than 2 hours.

The longer distance services to Leeds and York interact with commuter services south of Peterborough towards London, and freight. The current mix of passenger and freight services causes capacity constraints, given the differences in operating speeds (60/75mph for freight and up to 125mph for passenger services). These conflicts are exacerbated by the deployment of a non standard timetable pattern for passenger services, the predominantly twin track layout north of Grantham to York, and specific capacity bottlenecks approaching London (Hitchin Junction, Welwyn viaduct and Alexandra Palace to Finsbury Park). As a result, the route is currently operating close to capacity.

Furthermore, some trains (Grand Central from Sunderland, Hull Trains) only operate as five car formations, thus significantly reducing the seated capacities compared with the National Express East Coast services.

1.4.3 London via the Midland Main Line

In contrast, services via the Midland Main Line to London are less attractive compared with the East Coast route. The East Midlands Trains (EMT) franchise features a new timetable with fewer stops (trains now generally call at Chesterfield, Derby and Leicester now), and journey times from Sheffield to London have been reduced by around 10-15 minutes to 2 hours 7 minutes. Service frequency is just hourly from Sheffield to London.

There are also significant capacity constraints affecting the Midland Main Line. Similar to the East Coast route, there are significant commuting flows originating from stations closer to London, and these issues will be further exacerbated by the delivery of substantial new housing resulting from economic and plan-led growth (including the Sustainable Communities Plan housing growth areas located in the South Midlands).

However, EMT has submitted proposals to the Office of Rail Regulation to extend the hourly Derby to London service to Sheffield. This would deliver 2tph between Sheffield and London. If approved, this service change could be implemented from December 2009.

1.4.4 Assessing the Performance of Links with London

Table 1.3 compares the performance of rail services from the Leeds and Sheffield city regions to London, with other major cities served by the West Coast Main Line (WCML). The examples shown have similar catchments. The results in Table 1.3 highlight the slower speeds operated, particularly from Leeds and Sheffield compared with stations on the WCML. With the exception of York, average speeds from the major stations in the Leeds and Sheffield city regions are significantly slower than Manchester, Preston and Liverpool.

Of the sample stations shown in Table 1.3, Sheffield and Leeds have the slowest average speed for journeys to London. This is largely due to the number of intermediate stops en-route to London. In contrast, with some trains operating non-stop between York and London, leading to an average speed of 94mph. Leeds benefits from 2tph to London, Manchester enjoys both a higher frequency and faster average speeds.

Table 1.3: Rail Services to London - Comparison of Key Performance Indicators

	Frequencies (trains per hour)	Typical Journey Time (mins)	Speed (mph)	Service Quality
Leeds	2	2 hr 15 minutes	87	Services operated by refurbished Mk3 or Mk4 units
York	2	2 hrs	94	
Sheffield	1 (2 during the peaks)	2 hrs 7 minutes	79	New Meridian trains operate services
Manchester	3	2 hrs 7 minutes	94	New Pendolino trains operate services to London
Liverpool	1 (2 during the peaks)	2 hrs 8 minutes	91	
Preston	1	2hrs 8 minutes	98	

Source: National Rail timetable

1.4.5 Connections to Heathrow

There are no direct rail links to Heathrow Airport from the Leeds and Sheffield city regions, with passengers forced to travel via central London. Overall journey times to Heathrow are slower, given the requirement to interchange and / or the slow connecting journeys. Furthermore, direct flights between Leeds Bradford International Airport and Heathrow are no longer available, reducing the journey opportunities to travel between the two destinations. The number of daily flights was relatively low, and therefore mainly used for passengers with onwards connections. The removal of these flights has led to rail playing an increasingly important in providing this connectivity.

1.4.6 Connections Between Leeds and Sheffield

Despite the combined size of the economies of the Leeds and Sheffield City Regions (1.9 million jobs), slow rail links between them limit the generation of synergies and agglomeration benefits. The fastest rail journey times between Leeds are Sheffield are 42 minutes, for a journey of only 33 miles (average speed 47 miles per hour), and the frequency of these fastest trains is only hourly. Whilst there are additional semi-fast trains via Barnsley, journey times are even slower (typically 55 minutes). This makes it difficult for people from one City Region to access jobs in the other. With the Leeds to Sheffield via Wakefield Westgate service forming an integral part of a longer distance journey, overcrowding is also a constraint affecting the attractiveness of services.

There are a number of constraints that reduce line speeds, particularly via Barnsley, and the requirement to serve intermediate stations. The timetabling of longer distance trains via Wakefield Westgate is constrained by the interaction with local stopping services, particularly the relatively poor performance of some diesel units.

1.4.7 TransPennine Connections to Manchester

Slow and overcrowded TransPennine rail links between Yorkshire and the Humber and Manchester are also a major issue. Leeds and Sheffield are only 40 miles away from Manchester, but slow rail journey times (55 minutes from Leeds, and 48 minutes from Sheffield) mean that the combined economic potential of the three City Regions is not being realised fully. Crowding is also a constraint on both routes – whilst there are 4tph between Leeds and Manchester, the high passenger flows, particularly in the peak periods force passengers to stand. On the south route via the Hope Valley, fewer trains are overcrowded. However, train frequencies are lower (2 fast services per hour between Sheffield and Manchester), but changes to the East Midlands services have reduced capacities. Both links are extremely important, given their direct connections to Manchester Airport.

There are a number of engineering constraints that reduces overall line speeds between the City Regions including the requirement to serve intermediate stations such as Dewsbury, Stalybridge and Garforth. The timetabling of longer distance trains is constrained by the interaction with local stopping trains between Manchester and York. Although a small number of services operate during the peak periods as 6-car formations, there are significant overcrowding problems affecting other trains. This overcrowding is forecast to worsen as economies both sides of the Pennines grow.

1.4.8 Connections to the Midlands

Rail links with cities in the East Midlands are very slow. For instance most of the fastest direct rail journeys from Leeds to Nottingham are 1hour 55 minutes for a 70 mile journey, an average speed of 36 miles per hour. Although this service introduced in December 2008 offers useful direct journeys, timings are too slow to offer significant competition with the parallel M1. Whilst journey times from Leeds and Sheffield to the West Midlands are faster than timings to Nottingham, connectivity is affected by the frequent overcrowding.

1.4.9 Other Local Rail Links to Leeds and Sheffield

Many of the local trains to Leeds and Sheffield are heavily loaded during the peak periods, and the resulting overcrowding reduces their attractiveness. Whilst the Airedale and Wharfedale Lines to Leeds offer an attractive, fast links, on many other routes serving both Leeds and Sheffield, the service quality is relatively poor. Some additional rolling stock has been secured to address overcrowding, but the relatively old diesel units offer slower journey times compared with the electrified routes. Service quality is also inferior.

1.4.10 Overview of Rail Links

The quality of both longer distance and local rail links from Leeds and Sheffield is mixed, and generally compares unfavourably with other routes. Whilst Leeds and York benefit from higher frequencies to London compared with some WCML stations, average speeds are significantly slower from Leeds. Furthermore, whilst the average speed from Sheffield to London is comparable to Leeds, the current hourly frequency is a further barrier to growth. Other longer distance links are also relatively slow, including Leeds to Sheffield, and the TransPennine connections to Manchester. Links to the Midlands and connections to Leeds and Sheffield are also relatively poor on many routes, with the poor quality diesel rolling stock contributing to relatively slow journey times offering poor service quality.

It is therefore possible to conclude the economies of Leeds and Sheffield city regions are being constrained by the relatively poor connectivity to London.

1.5 Drivers of Change – Demand Growth

There has been significant demand growth affecting both Leeds and Sheffield. For example, the number of passengers to / from Leeds has increased by 60% between 2002/03 and 2007/08, whilst Sheffield has achieved 38% growth over the same period. This demand growth has contributed to the existing overcrowding problems. An understanding of the likely change in demand patterns is essential to help plan future service requirements.

Network Rail has recently produced a range of growth forecasts as part of the Network Rail Scenarios and Long Distance Forecasts workstream. Four forecasting scenarios have been defined:

- local awareness (scenario 1);
- insularity (scenario 2);
- continued profligacy (scenario 3); and
- global responsibility (scenario 4).

Further details of the assumptions used to develop prepare these scenarios is outlined in the Network Rail report[1]. Growth forecasts have been prepared for a number of routes between 2007 and 2036, including the ECML, MML, TransPennine and Cross Country corridors. The forecasts take account of the planned housing and employment growth highlighted earlier in Chapter 1, plus other demand drivers. Table 1.4 presents these growth forecasts for longer distance flows.

The results indicate between 35-70% of growth will occur to 2036, equating to a 1-2% increase per annum for the routes to London. The growth rates for TransPennine are broadly similar to the London routes, but the forecast rates for Cross Country are about 20% higher.

The results emphasise the requirement for improved rail services to accommodate future growth to London from the Leeds and Sheffield city regions, but also better connections to the Midlands and the North West. These improvements will be particularly necessary during the peak periods, when overcrowding already occurs on many services. As well as strengthening existing services, the forecast demand growth could also necessitate the introduction of wholly new services from other destinations that are not directly served.

Table 1.4: Forecast Growth Rates 2007-2036

Corridor	Scenario			
	1	2	3	4
ECML	34%	41%	78%	71%
MML	36%	45%	77%	71%
TransPennine	36%	38%	69%	79%
Cross Country	48%	43%	78%	95%

Source: Network Rail Network RUS

1.6 Drivers of Change – Supply

Capacity relief for existing routes is the principal driver of change making the case for improved inter-urban rail connections. If additional capacity is required, the construction of new high speed lines could offer the most effective solution to meet this objective. Equally, there may still be scope to secure smaller scale incremental enhancements for existing

[1] Network Rail "Network Route Utilisation Strategy", Scenarios and Long Distance Growth

routes, delivered through timetable changes or infrastructure schemes that would enable the number of services to be increased, measures to reduce overall journey times or train lengthening that would deliver increased capacities. The potential benefits and costs associated with incremental enhancements to the existing network, or the construction of a wholly new high speed rail alignment to deliver these benefits are examined in Chapters 2 and 3 respectively.

1.7 Chapter Conclusions

Chapter 1 has highlighted the importance of the Leeds and Sheffield city regions to the wider economy, and illustrated the significant planned housing and employment growth. This illustrates the importance of good transport connectivity to fast, attractive links, both for commuting purposes, and for business and leisure journeys.

Analysis of existing ticket data highlighted the importance of rail journeys to several strategic destinations from the Leeds and Sheffield city regions, particularly London and Manchester. Furthermore, the comparison of network performance has highlighted the significantly slower average speeds from Leeds and Sheffield to London compared with stations on the WCML. This is a particular constraint for Sheffield, since it only has an hourly frequency at present to London.

The growth forecasts prepared by Network Rail highlight the significant increase in demand set to occur during the next 30 years, emphasising the importance of interventions to improve rail services. In Chapter 2, the potential options to improve links to the Leeds and Sheffield city regions are explored.

2 Options to Enhance Existing Routes

2.1 Introduction

There are a number of opportunities to enhance existing routes, and these could potentially be delivered in a shorter timescale at lower cost compared with the delivery of wholly new infrastructure. However, the opportunities to upgrade existing routes need to be carefully balanced to assess the benefits, costs and risks associated with this type of strategy. The delivery costs to upgrade the WCML were significant, and the necessary engineering possessions meant parts of the route were closed for extensive periods. Chapter 2 examines the potential options to enhance the principal inter-urban routes from the Leeds and Sheffield city regions, comprising the East Coast Main Line, the Midland Main Line, TransPennine routes to Manchester and the links to the Midlands.

2.2 East Coast Main Line

The discussion in Chapter 1 highlighted the ECML is already close to capacity, given the pattern of passenger services, interactions with freight and the availability / capability of the existing infrastructure.

2.2.1 Committed Infrastructure Enhancements

Network Rail's Strategic Business Plan for the current Control Period (CP4, to be delivered by 2014) includes around £560m of investment to deliver incremental capacity enhancements. This investment will help to make better use of existing capacity, and reduce journey times. The package of improvements includes:

- 4th running line at York Holgate Junction;
- re-modelling Shaftholme Junction to minimise conflicts between passenger and freight services;
- upgrading the GN/GE joint line (between Doncaster and Peterborough via Lincoln) to create a freight diversionary route;
- Peterborough station area capacity enhancements;
- Grade separated junction at Hitchin; and
- Alexandra Palace to Finsbury Park capacity improvements.

The delivery of this package of capacity improvements will help to minimise potential conflicts between passenger and freight services at critical locations. In conjunction with timetable changes (described below), the schemes will form the catalyst to enable a higher number of passenger and freight services to operate. The greater separation of trains at key locations will also help to deliver a more reliable and punctual service. This infrastructure schemes could help to reduce some of the performance and pathing allowances now included in the timetable. The number of additional services using the ECML, together with an overarching aspiration to improve train performance, has contributed to the extended journey times. For example, journey times between York and London have been extended by around 5 minutes compared with typical timings from the mid 1990s.

2.2.2 Revised Passenger Timetable

There are proposals to restructure the existing passenger timetable in the short term, and this is intended to complement the Network Rail infrastructure proposals. The ECML is the only long distance route without a regular interval timetable, and the irregular stopping pattern means the available capacity cannot be optimised. Fewer trains are able to operate as a result, and this restricts the opportunities to support the forecast growth.

In response to these constraints, Network Rail has developed a regular interval timetable as part of the ECML Route Utilisation Strategy. In conjunction with the infrastructure measures

described above, the revised passenger timetable would create sufficient capacity for 6 passenger services per hour, plus an hourly freight service between London and Doncaster during the off-peak. The delivery of the GN/GE freight improvements would be critical to release the necessary line capacity.

Higher train frequencies would enable the number of intermediate stops between London and stations in the Leeds and Sheffield city regions to be reduced. If other services were introduced, existing trains via York and Leeds could be revised to operate with fewer intermediate stations. The amended timetable would also help to reduce journey times, with the removal of each station stop typically saving around 10 minutes.

2.2.3 New Rolling Stock

The DfT recently announced the Agility Trains consortium as the preferred bidder for the Intercity Express Programme (IEP). The new rolling stock to be developed by this consortium will replace the current mix of High Speed Trains and Class 91 / Mark 4 stock using the ECML. This rolling stock replacement offers a number of benefits:

- seating capacities per train will be increased;
- trains will be lighter, thus offering better acceleration to achieve faster journey times; and
- energy consumption will be reduced.

It is expected the new rolling stock will be deployed from 2014. Initial outputs published by the Department for Transport suggest the new rolling stock could reduce journey times between London and Edinburgh by around 10 minutes.

2.2.4 Potential Further Enhancements

Similar to the existing units, the new Agility Trains rolling stock could operate up to speeds of 140mph. However, other infrastructure improvements will be required to support these faster operating speeds, comprising better signalling, changes to the track layout and measures to improve the resilience of the overhead electrification.

In addition to these requirements, a menu of other infrastructure schemes could also be delivered to avoid various speed restrictions or other capacity bottlenecks affecting the route. This menu of improvements could include:

- speed restrictions near Grantham;
- solutions to avoiding the flat crossing at Newark; and
- reducing the interaction with freight near Doncaster.

These enhancements could be delivered in the medium to long term (beyond 2015), but the implementation of any improvements would be subject to a value for money evaluation.

2.3 Midland Main Line

2.3.1 Timetable Changes

As noted in Chapter 1, there is just an hourly service between Sheffield and London for most of the day. It is understood EMT has submitted a proposal to the Office of Rail Regulation to extend the existing Derby to London north to Sheffield, creating a secondly hourly service. The outcome of this application has still to be determined, but if approved, the timetable changes could be delivered in December 2009.

The capacity constraints affecting the southern end of the MML are likely to severely restrict further opportunities to enhance frequencies between Sheffield and London services, particularly given the scale of plan-led housing growth to be delivered at the southern end of the route.

2.3.2 Infrastructure Improvements

Despite the timetable changes introduced as part of the EMT franchise, and the deployment of Meridian rolling stock to improve train performance, the London to Sheffield route is affected by a relatively low average speed as demonstrated in Chapter 1. Journey times are in excess of 2 hours.

The main contributory factor for the low average speed are topographic factors that restrict line speeds to a maximum of 110mph. This compares unfavourably with the ECML, which permits speeds of up to 125mph. Furthermore there are significant parts of the route where line speeds are much lower, for example, 60 or 90mph near Market Harborough and Wellingborough. Some of the tunnels also have speed restrictions due to inadequate clearances.

A package of infrastructure improvements could be implemented to reduce overall journey times by around 10 minutes. In contrast with the ECML, the status of these improvements are less well developed, (the level of engineering development for these schemes is significantly lower). Furthermore, these schemes are not included within Network Rail's Strategic Business Plan, and therefore do not have committed funding.

2.3.3 Electrification

The deployment of Meridian trains to operate the Sheffield to London services has helped to improve service performance. These units have better acceleration characteristics compared with the High Speed Train fleet, and this has helped to reduce overall journey times. However, the introduction of high specification electric units could further address this issue. Modern electric units offer better acceleration characteristics than diesel trains, and this is beneficial when accelerating back to line speed.

The level of political support for electrification has increased significantly since the publication of the Rail White Paper in July 2007. Growing concern about climate change, coupled with the cost and security of energy is adding to these environmental pressures. The Government has started to recognise the potential for a rolling programme of electrification. Network Rail has recently published the results from initial assessments to examine the benefits and costs associated with electrification[2]. The study suggested the electrification of the MML from Bedford to Sheffield, plus a spur to Nottingham had a strong case with financial benefits generated from reduced operating costs and incremental revenue outweighing the capital costs. Route electrification could further reduce the journey times described above.

2.4 North TransPennine Route via Huddersfield

2.4.1 Manchester Hub

There is scope to deliver a package of incremental improvements for the Trans-Pennine Route via Huddersfield. Network Rail, in conjunction with the Northern Way, is developing plans for the Manchester Hub. The delivery of this project could generate significant economic benefits, both for longer distance and local passengers. The Hub proposals are still being developed, but the proposals could deliver a step change in capacity for the central Manchester area, helping to improve connectivity between key destinations.

Furthermore, a package of other improvements could also be delivered to help reduce journey times to both Leeds and Sheffield from Manchester to about 40 minutes. This would save around 10-15 minutes compared with the current journey times. Examples could include measures to increase line speeds in various locations, including the Huddersfield area, Guide Bridge, and via the Hope Valley. Feasibility studies are currently underway, but there is no committed funding to deliver theseinfrastructure measures.

[2] Network Rail Network RUS, Electrification

2.4.2 Other Infrastructure Enhancements

The additional capacity to be delivered as part of the ECML at Holgate Junction would benefit TransPennine services. The new capacity will help to reduce journey times between Leeds and York by removing some of the pathing time and performance allowance.

2.5 South TransPennine Route via the Hope Valley

Although the rail journey between Sheffield and Manchester is comparable to the timings between Leeds and Manchester via Huddersfield, fast trains operate significantly less frequently compared with the northern route. There are plans to amend the timetable to operate three fast services per hour departing at clockface intervals via the Hope Valley. Several infrastructure schemes are proposed to boost capacity, including schemes at Dore, and measures to increase capacity for freight. The South TransPennine route will also benefit from the Manchester Hub proposals as described above, with potential journey times between Sheffield and Manchester reduced to around 40 minutes. The implementation of these measures will strengthen connectivity between the city regions.

2.6 Links to the Midlands

There are two main issues to address. The average speed of journeys between Leeds and Birmingham is around 60mph, significantly faster than the TransPennine links. However, there are significant overcrowding problems affecting these trains, given the nature of the longer distance services. Whilst the busiest trains have been lengthened, crowding problems remain on other services, thus reducing service quality, particularly for business passengers. The recently published Yorkshire and Humber RUS has suggested the existing Cross Country service via Doncaster could be re-routed via Leeds. This change will be subject to DfT approval, although it could address some of the overcrowding issues.

In contrast, the average speed of the direct trains to Nottingham is just 36mph, significantly slower than the TransPennine links. Regular direct services were only introduced in December 2008, but the timings are too slow to compete effectively with the parallel M1 corridor. Service quality is also relatively poor for business passengers.

These gaps have been highlighted in a number of RUS documents, although it is currently uncertain how they will be addressed. Various engineering measures could be implemented to cut journey times, subject to meeting value for money criteria. The potential for additional services to Birmingham is being examined as part of the RUS process.

2.7 Affordability, Funding and Timescales

Various proposals have been developed to enhance existing inter-urban routes, with a short term implementation timescale. There are a number of potential opportunities for enhancing existing strategic links. However, this type of enhancement does require careful consideration, given the potential implementation risks and scope for cost escalation.

The Network Rail Strategic Business Plan has identified a number of measures during the next Control Period (CP4, for delivery by 2014). Some of the funding to enhance the ECML is already committed as part of CP4, with around £560m allocated. The new Agility trains rolling stock will also be delivered within this period.

The initial results of the Midland Main Line electrification produced by Network Rail have highlighted the positive financial case for delivering these improvements. The MML scheme is likely to be delivered in the first tranche of electrification schemes, during the next 5-10 years.

Some improvements to the TransPennine routes will also be delivered within the next Control Period, and the ongoing Manchester Hub studies for Network Rail will explore the scope of reducing journey times to Manchester from Leeds and Sheffield to around 40 minutes.

2.8 Chapter Conclusions

Chapter 2 examines the potential to enhance the existing inter-urban rail links. Links to London, the Midlands and TransPennine routes to Manchester from the Leeds and Sheffield city regions contribute to the economic success. The analysis presented in Chapter 2 has highlighted a number of potential solutions to improve the quality of these linkages, helping to address some of the weaknesses covering journey times and frequencies identified in Chapter 1. Some of these potential solutions already have committed funding sources during the next Control Period, and these will be delivered during the next five years. Other potential solutions have a slightly longer timescale for implementation. The capital costs for delivering these improvements is significantly lower than the indicative costs for HSR as shown in Chapter 4, whilst the timescales for implementation are also considerably shorter. The shorter lead time to develop and implement projects and the lower scheme costs means that there are considerable benefits associated with this type of project as the basis of short to medium term recommendations to enhance inter-urban rail.

3 High Speed Rail Lines

3.1 Understanding the Benefits

Evidence from continental examples demonstrates that HSR offers the potential to deliver a number of major benefits, including:

- deliver capacity relief to the ECML, which requires capacity enhancements by 2015. This would provide widespread benefits to the Yorkshire and Humber Region, and other locations, including the North East, East Midlands, and East of England. A new rail connection could also avoid the potential disruption and costs that may be associated with enhancing existing lines. A 2001 study commissioned by the Strategic Rail Authority concluded a new high speed line may be more effective and offer better value for money than comprehensive enhancements;
- transform the Yorkshire and Humber regional economy by bringing business within an easy days travel time to London with the delivery of transformational journey times. Significantly higher operating speeds (typically up to 186mph, 300kph) would be responsible for achieving these transformational journey times;
- build on the successes of the main economic centres – e.g. the largest concentration of financial and business service sector jobs outside London is located in Leeds, and helping to expand the number of high value jobs would help close the 15% productivity gap with the UK average;
- connect more people than the alternatives – Leeds and Sheffield city regions have over 1.9m jobs and 4.4m residents in comparison to 1.4m jobs and 3.2m residents in the Manchester city region;
- there is potential to transform connectivity from the city regions to the key international gateway of Heathrow, particularly as the region now has no direct flights to Heathrow; and
- depending on the service proposals and route alignment, it may be possible to improve connections between the Leeds and Sheffield city regions.

Some further examples of best practice from continental HSR and HS1 is included in appendix C.

A number of HSR proposals have come forward and these have been examined in detail in this section below to identify what benefits they offer the Yorkshire region. Various potential route options have been identified by several promoters, and these are summarised in Chapter 3. The possible implications for the Leeds and Sheffield city regions are also assessed, in terms of direct journey opportunities to major destinations, likely journey times, and timescales / phasing to serve the city regions.

Chapter 3 concludes by considering two other key issues. The likely scale of the capital costs required to deliver HSR has already been highlighted as a potential issue. For each potential route option, we have collated the estimated capital costs prepared by the scheme promoter. We have reviewed the out-turn costs from HS1 and other continental examples to provide a separate, independent benchmark of the promoter's costs, and to fill in any gaps.

The number of stations serving the city regions is a fundamental decision, given the complex trade-offs between accessibility to the high speed network and the detrimental impact on journey times if additional stops are added. The second issue reviewed is an examination of the trade-offs between city centre and out-of-centre parkway stations to provide these stops. We have examined the principal features of the continental networks, and reviewed the characteristics of the Leeds and Sheffield city regions to assess the applicability of these features.

3.2 Strategic Rail Authority

3.2.1 Project History – Atkins Study 2001 -2003

In 2001 Atkins was commissioned by the Strategic Rail Authority to assess the potential for High Speed Rail from London to the north. The final document was published in 2003. An addendum to the report was subsequently produced. Several key assumptions needed updating, and the publication of the Green Book altered the economic outputs. These revisions significantly changed the recommendations of the study. A further update to the study was produced in 2008, this time focussing on the route options offering the greatest benefit to cost ratio.

The study examined 16 route options, all originating in London. Some of these tested various additional options such as links from CTRL and Heathrow, as well as spurs away from the north-south routes, for example TransPennine links. These options are described in Table 3.1, and shown graphically in Figure 3.1.

Figure 3.1: Summary of Route Options Examined by SRA Study

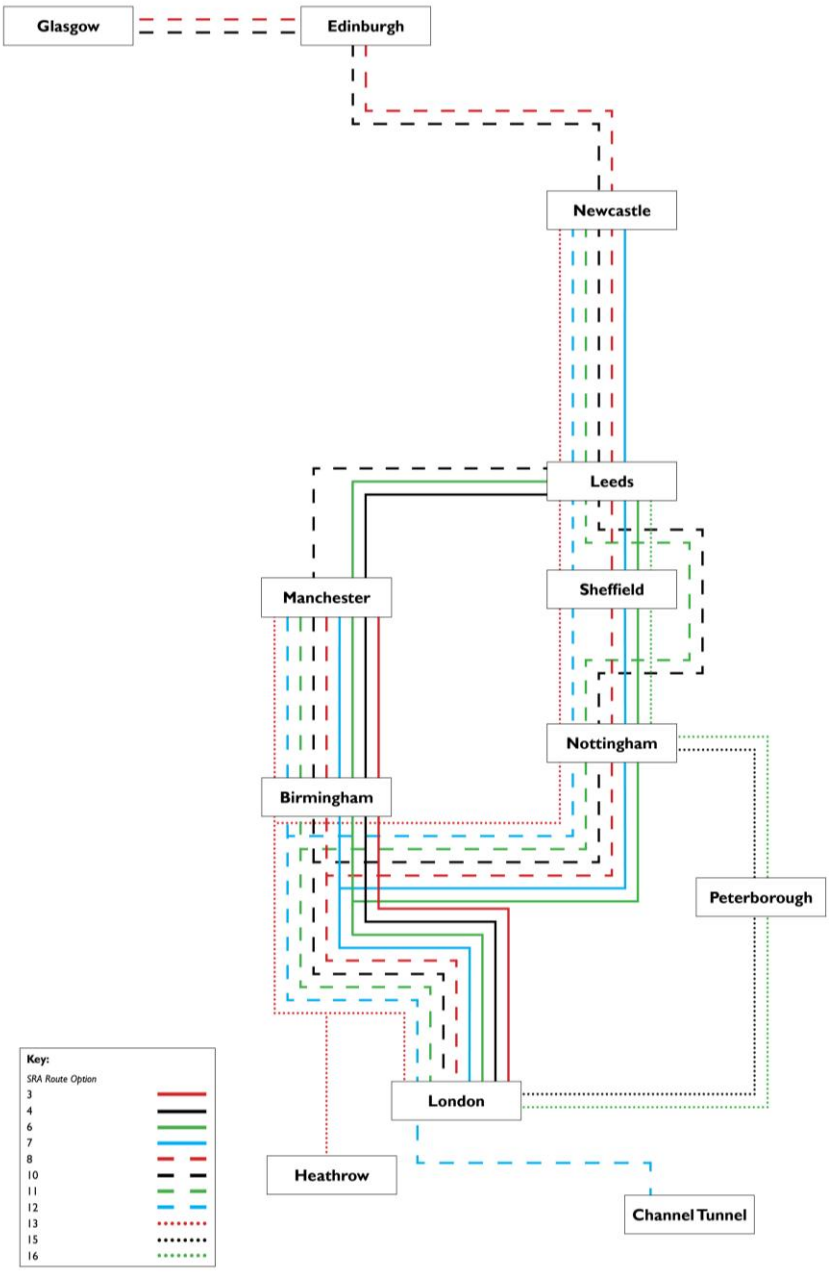


Table 3.1: Overview of Route Options Examined in SRA Study

Option	Route Summary	Route Description	Commentary	Costs (£bn, risk adjusted)	BCR (without capacity release)	BCR (with capacity release)	Recommended (based on 2001-2003 study)?	Considered in 2008 Update
1	London to West Midlands	HSL from London to West Midlands, with spurs to join classic infrastructure at Birmingham International and Trent Valley	Establishes viability of initial London-West Midlands route section, in terms of journey time or capacity benefits	9.9	1.29	1.41	Yes	Yes
2	London to Leeds	As Option 1, plus new HSL spur to serve East Midlands and Leeds, with a link to classic infrastructure to serve Sheffield and North East England. Connection at junction in Midlands to allow cross -country services.	1 vs. 2: establishes incremental value of serving Midlands-Leeds.	18.5	1.11	1.24	No	No
3	London to Manchester	As Option 1, with continuation north. HSL splits in Staffs to serve Manchester and Liverpool. Connections via classic WCML at Warrington to serve north west and Scotland.	1 vs. 3: incremental value of serving Trent Valley - Manchester. 2 vs. 3: compares serving Leeds or Manchester as a priority	13.2	1.27	1.38	Yes	No
4	London to Leeds via Manchester	As Option 3, with additional TransPennine link to serve Leeds and a connection to classic to serve Newcastle.	3 vs. 4: establishes incremental value of TransPennine link	20.6	1.05	1.12	No	No
6	London to Manchester and Leeds	Combination of Options 2 and 3, London to West Midlands then splitting into two lines to serve Manchester and Newcastle. Spurs allow cross -country services. Connections to Scotland on classic network on both lines.	4 vs. 6: compares accessing Leeds via Manchester or East Midlands	21.6	1.26	1.36	Yes	No
7	London to Manchester and Newcastle	As Option 6, with HSL extension to Tyne and Wear	6 vs. 7: establishes incremental value of serving Leeds -Newcastle (compare with test 4 vs. 5)	24.5	1.06	1.15	No	No
8	London to Manchester and Scotland	As Option 7, with HSL extension to Scotland, serving Edinburgh and Glasgow.	7 vs. 8: establishes incremental value of serving Newcastle –Scotland	32.7	1.34	1.44	Yes	Yes – Full Network

Table 3.1 (cont): Overview of Route Options Examined in SRA Study

Option	Route Summary	Route Description	Commentary	Costs (£billion, risk adjusted)	BCR (without capacity release)	BCR (with capacity release)	Recommended (based on 2001-2003 study)?	Considered in 2008 Update
10	London to Scotland via Manchester, plus TransPennine Link	As Option 8, with TransPennine link between Manchester and Leeds, replacing spur in Midlands.	8 vs. 10: establishes incremental value of TransPennine link	39.8	1.16	1.25	No	No
11	Segregated network: London to Manchester and TransPennine link	Segregated option. As Option 9, but without branches to Liverpool, WCML, Sheffield or Scotland	10 vs. 11: compares non-segregation and segregation	26.5	1.12	1.20	No	No
12	London/CTRL to Manchester and Newcastle	As Option 7, with a link to CTRL	7 vs. 12: establishes incremental value of accessing CTRL	25.5	N/A	N/A	N/A	No
13	London/Heathrow to Manchester and Newcastle	As Option 12, but replacing CTRL link with link to Heathrow	7 vs. 13: establishes incremental value of accessing Heathrow	25.4	N/A	N/A	N/A	No
14	London to Manchester freight route	As Option 3, with parallel freight route London/Manchester-WCML	3 vs. 14: establishes incremental value of providing dedicated freight capacity	13.2	N/A	N/A	N/A	No
15	London to Nottingham via Peterborough	HSL from London to Peterborough and Nottingham, with link to ECML north of Peterborough	Establishes viability of initial London-East Midlands route section, in terms or journey time or capacity benefits.	8.1	0.59	0.67	No	No
16	London to Leeds via Peterborough	As Option 15, with HSL extension to Leeds, with links to classic infrastructure to serve Sheffield, the North East and Scotland	15 vs. 16: establishes incremental value of Nottingham -Leeds section 3 vs. 16: compares easterly route to Leeds with westerly route to Manchester.	12.0	1.23	1.23	Yes on the proviso that the full ECML upgrade is not carried out	Yes – East Coast Route

Source: SRA Study

The following conclusions can be drawn from the economic assessment of the options presented above:

- a comparison of Options 1 and 15 to the Midlands shows a distinct advantage in favour of a westerly route to the West Midlands, with connection to the Trent Valley for the North West / Scotland. In comparison, Options 3 and 16 show closer results, although the capacity benefits achieved by Option 16 are very small;
- as Option 16 performs significantly better than Option 2, this suggests that the core route via the West Midlands lead to slightly longer journey times for passengers to the East Midlands and Yorkshire, which is reflected in the benefit cost ratios;
- Options 2 and 3 indicate an extension to the North West would deliver greater economic benefits than a route to Yorkshire, assuming both routes diverge from an initial alignment to the West Midlands;
- Option 4 indicates a TransPennine link between Manchester and Leeds would represent relatively poor value for money, since the BCR is significantly weaker when compared with Option 3. The TransPennine link between Leeds and Manchester fails to generate sufficient revenue and economic benefits to cover the capital costs. Furthermore the Atkins report does not explore a TransPennine link from Sheffield to Manchester, as an alternative route. The capital costs assumed for the TransPennine link are examined in section 3.7;
- a comparison of Options 6 and 7 indicates that an extension of HSR from Leeds to Newcastle would not generate sufficient benefits to cover the increased costs of the extension;
- Options 8 and 10 which serve Scotland clearly generate significant additional benefits from providing this new capacity north of Newcastle. However, the inclusion of the TransPennine link in Option 10 reiterates the earlier conclusion that this connection does not add significant value;
- the provision of links to either HS1 or Heathrow Airport strengthens the business case for HSL by opening up new passenger markets, and both options may reduce the need for a segregated alignment into a central London termini; and
- a parallel freight route is unlikely to generate sufficient revenues or benefits to cover the incremental capital costs of construction.
- in cost-benefit analysis terms, the study highlighted Options 1, 3, 6 and 8 produced the strongest benefit cost ratios, although there is also a case for Option 16 if the full ECML upgrade is not carried out.

In addition, the SRA study found the accessibility benefits of HSL are generally maximised from the longer distance options which provide the opportunities to achieve the largest benefits from frequency, journey time reductions, crowding relief and widening the potential catchment to HSR passengers. Furthermore, options with a single corridor tended to perform more strongly than options that serve both east and west coast alignments, since there are risks the latter could be affected by capacity constraints in future years.

3.2.2 2004 Addendum

The economic assessment results shown in Table 3.1 were updated by Atkins in 2004 as a result of the following:

- revisions to the Treasury's 'Green Book' guidance for project appraisal;
- re-scoping of the East Coast Main Line Upgrade project; and
- requirement to consider the implications of Road User Charging (RUC).

As a result of these changes, the Benefit-Cost Ratios (BCR's) typically increased by 45%-50% as a result of the Green Book changes. The scope of the ECML Upgrade was also reduced, and this helped to increase the BCR for the eastern route options by around 35%. RUC had a relatively minor impact on the cost benefit ratios.

These changes meant the BCR for the easterly alignments increased to around 3:1 for some options, contradicting the earlier findings which suggested the western options could generate a stronger business case.

3.2.3 2008 Update

To inform the ongoing debate, Atkins refreshed and expanded its original work for the SRA in 2008 by re-examining some of the preferred options. The update takes into account committed and likely upgrades planned on the network over the next 20 years as set out in the 2007 Rail White Paper and High Level Output Specification.

Much of the base year trip data was updated, and the rail demand forecasts for 2026 were refreshed using industry standard techniques. Three main options were reviewed:

- a West Coast alignment from London to the West Midlands, diverting most of the current long-distance services onto the new alignment south of Rugby. The pattern of HSR services was updated to reflect current long distance WCML services;
- an alternative East Coast alignment from London to West Yorkshire, diverting most long-distance services to Leeds, Newcastle and Edinburgh from the classic ECML. Services to Sheffield and Nottingham were also assumed. Some changes were made to the previous assumptions on stopping patterns and journey times;
- a Full Network option serving both the east and west sides of the country and extended to Glasgow and Edinburgh. Service patterns were updated to reflect existing ECML and WCML service levels. However, a maximum of 12tph operating on the core section into London was assumed.

The review showed that both the West and East Coast options result in financially viable load factors on HSR and existing services, whilst also providing major capacity relief.

- at a cost of around £9bn, the West Coast option generates a benefit-cost ratio (BCR) of around 1.7 - a slight reduction from the 2003 benefits assessment (which gave a BCR of 2.0), reflecting the improved service on the WCML route now assumed in the base scenario, together with the ongoing improvements planned over the next 10 years;
- the East Coast option would generate economic benefits of around £29bn, compared with costs of around £12bn (a BCR of about 2.5). This compared to the 2003 ratio of around 2.0, and reflects the relatively modest enhancements planned on the ECML and Midland Main Line (MML) routes.
- the Full Network option generates the highest economic benefits of the three, at around £63bn. With costs in the order of £31bn, a BCR of around 2.0 is achieved, unchanged overall since the 2003 assessment. However, this option is likely to require additional capacity on the southern core section of route relatively quickly, reiterating the earlier conclusion that a single HSR trunk connection to London is unlikely to be sufficient to solve capacity problems on all North - South rail routes.

3.2.4 Summary of SRA Study / Atkins Updates

The Atkins SRA study was updated to account for changes to the appraisal process. This action significantly altered the results of the study. The conclusions of the 2008 update broadly agree with those of the 2003 report, indicating that there is a need for High Speed Rail on both the east and west coast routes. It is clear that a strong business case is evident for an east coast route, particularly when planned enhancements to the rail network are taken into account over the next 10 to 20 years.

3.2.5 Implications for the Leeds and Sheffield City Regions

The updated SRA study suggests there is a strong business case for a route via the East Coast. The East Coast proposal could be developed independently from an alignment serving the West Midlands, and the resulting journey times to London would be faster. With estimated journey times of 85 minutes to Leeds and 80 minutes to Sheffield from London, this proposal offers the potential to transform connectivity. Furthermore, links to parts of the East Midlands could also be significantly strengthened.

The proposals envisage Sheffield would be served by a spur to the main line to / from London, and this may restrict the potential for better links to Leeds. The SRA study highlights the business case for HSR links to Manchester are limited, with the costs significantly outweighing the benefits. Furthermore, the case for extending the high speed network beyond Yorkshire to the North East is also weak, unless the network is continued to Scotland.

The introduction of HSR would enable capacity on the existing routes to be released, especially the ECML, and to a lesser extent, the MML. A number of existing trains via the ECML and MML would be revised, and this would provide the catalyst to restructure the timetable. The spare capacity could enable services to other destinations to be operated.

3.3 Greengauge 21 Analysis

3.3.1 "A New Proposition"

In June 2007 Greengauge 21, a campaign group, published a report: "High Speed Two, A Greengauge 21 Proposition". The report evaluates the potential options for high speed rail in the UK. The report examines the indicative capital costs and the likely benefits of creating a new high speed rail link between London St Pancras and the North West via Heathrow and Birmingham. The report also explores how HS2 fits in with the future development of the high speed network, which could be expanded to include a North Eastern corridor towards Sheffield, Leeds and the North East.

3.3.2 "Next Steps"

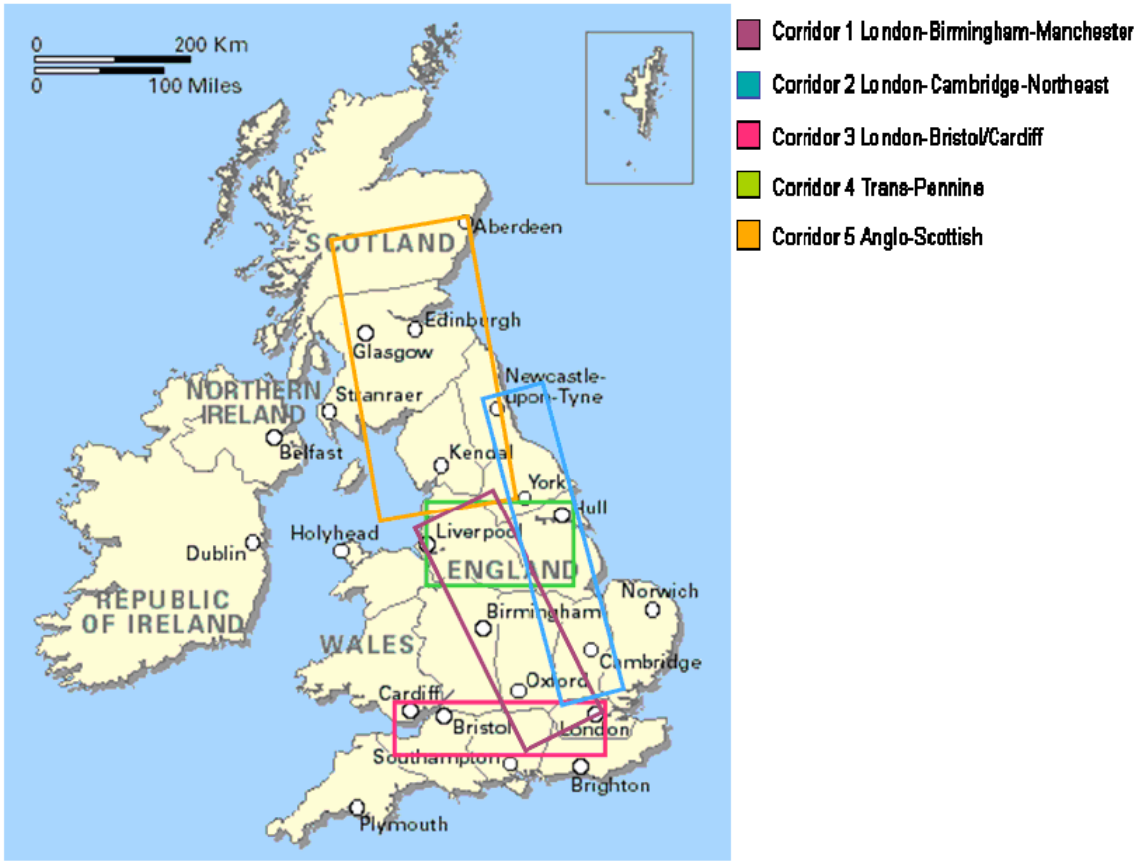
In November 2007 Greengauge 21 released a second document "The Next Steps" that focussed on delivering a strategic HSR network, termed HS3. The report analyses five potential corridors for HSR, which includes the original HS2 corridor outlined in the June report "A New Proposition". The five corridors shown in Figure 3.2 were selected on the basis of existing capacity shortfalls.

The 'Next Steps' report widens the discussion of potential HSR corridors beyond the London-Birmingham-Manchester route. The report also highlights the need for a strategic network assessment to examine the need and potential for high speed rail in the five corridors identified above. Furthermore, it explores the linkages between the corridors and issues of sequencing, technical standards and construction, plus project finance.

Some of the major conclusions of the report include:

- strong support for the London-Heathrow-Birmingham-Manchester corridor, which is clearly favoured versus other corridors;
- a strong case for investment in Corridor 2 (London-North East). Assuming there are no major upgrades to the ECML, a HSR serving the east coast could generate a benefit cost ratio of 2.67:1;
- the distribution of benefits is not confined to the ECML, since the line could also serve Cambridge, Nottingham and Sheffield. Capacity benefits relief could be achieved for the MML and the West Anglia Main Line; and
- Corridor 2 could also include part of the Cambridge and Stansted Airport growth corridor.

Figure 3.2: Greengauge 21 Network



Source: Greengauge 21 "Next Steps" November 2007

3.3.3 Implications for the Leeds and Sheffield City Regions

Greengauge 21 has identified a number of potential HSR corridors that could serve the Leeds and Sheffield city regions. Journey times to London would be reduced. However, the strategic description of the routes means it is difficult to confirm whether other destinations in the East Midlands could be served by high speed rail. The corridor via Cambridge to the North East could transform connectivity to this growth corridor, and introduce new journey opportunities to the M11 corridor and Stratford.

It is important to note that if a high speed alignment via the West Coast and the TransPennine corridors was constructed, the resulting journey times from the Leeds and Sheffield city regions to London would be virtually unchanged compared with the existing timings.

3.4 2M Group

3.4.1 Network Development

Figure 3.3: 2M Route Development Proposals

The 2M group is an alliance of local authorities concerned about the environmental impact of the Heathrow expansion proposals. 2M consider that the Government is overstating the benefits of aviation and fail to measure the full environmental costs. 2M propose that instead of a third runway, the Government develop a high speed rail network linking London with Heathrow, Birmingham, Liverpool and Scotland to the North. The line would extend north from London and serve Leicester, Nottingham, Sheffield, Leeds, Newcastle, Edinburgh and Glasgow. There would also be spurs to Birmingham (from Leicester), Manchester and Liverpool (from Sheffield).Figure 3.3 illustrates the proposed route alignment. The rail link will also join up with HS1 to open up routes to major city destinations in mainland Europe.

3.4.2 Principal Benefits

A high speed rail link from many parts of the UK to major destinations in mainland Europe could potentially significantly reduce domestic and European air travel, and this could reduce the requirement for a third runway at Heathrow. Other emerging conclusions include:

- the proposals would generate significant agglomeration by connecting the East and West Midlands into the London and South East Mega City Region. The three main cities in the East Midlands (Derby, Leicester, and Nottingham) would benefit from better connectivity with the Sheffield and Leeds city regions;
- the revised service patterns would release capacity on the existing ECML.

3.4.3 Implications for the Leeds and Sheffield City Regions

Similar to the SRA proposals, the alignment being promoted by 2M offers potential to transform journey times from the Leeds and Sheffield city regions, and release capacity using the existing north-south routes. The network proposed would be more comprehensive than the east coast route proposed in the SRA study, so direct journey opportunities could be available from **both** Leeds and Sheffield city regions, including Leicester, Birmingham, Manchester and Liverpool. The link from Sheffield to Manchester and Liverpool is the only high speed connection serving the south Pennines. Passengers from Leeds could also travel directly to Manchester and Liverpool. Limited business case work has been completed, so the viability of links to the West Midlands and the North West from Yorkshire is uncertain. With two east-west alignments across the Pennines proposed, this is a particular issue, given the relatively poor business case for the high speed TransPennine links highlighted in the SRA study.

3.5 Northern Way North-South Connections Report (2007)

3.5.1 Background

This report describes the evidence base for high speed rail, which is to enhance connectivity between London and the South East and the North. This report includes independent work which explores the substantial scale of agglomeration benefits that high speed rail could potentially generate.

The study uses the Department for Transort's 'pure agglomeration' methodology to assess the potential wider economic benefits (WEBs) of high speed rail. Existing journey times were compared against potential timings that would be achieved by high speed rail. By making simple but reasonable assumptions about the magnitude of journey time savings that could be achieved by HSR, the 'effective density' part of the calculation examines how well locations are connected to the rest of the economy. This in turn allows the potential agglomeration benefits to be calculated. The report uses conservative estimates such as assuming no employment growth. It assumes that the operational year of all high speed options is the same, to enable direct comparison between the results. The indicative results were:

- high speed lines via the west and east coast routes would generate annual productivity gains across the UK of £80m and £130m respectively. The full network (including a transpennine route) would generate around £270m per annum, or around £10bn Present Value over 60 years;
- North-South high-speed line(s) will contribute significantly to the UK economy, both to the Northern regions as well as to London and the South East;
- the agglomeration effects offered by adding the trans-Pennine corridor are significant for the more northerly regions, adding 50% to the North East and the North West, but are more modest for Yorkshire and the Humber. A trans-Pennine link will bring substantial additional benefits if it joins two north south links;
- a TransPennine high-speed connector as an integral part of a national network of conventional high-speed rail lines will facilitate not only a new economic geography of faster city to city links across the North but also nationally through faster linkages between the North East and Yorkshire and the West Midlands, and between the North West and East of England growth areas.

3.5.2 Implications for the Leeds and Sheffield City Regions

The Northern Way study highlights that the potential benefits from the West and East coast routes are both significant, with the East coast route producing higher benefits due to its longer route through the North East and Scotland. It also highlights the potential agglomeration benefits that could be generated by a HSR connection across the Pennines. The inclusion of these benefits could form an important component of the overarching business case, given the relatively weak financial and economic performance of the high speed TransPennine rail links appraised as part of the earlier SRA study.

The study concludes that a northern high speed network containing West, East and Transpennine routes could result in £10bn of productivity gains. The study also highlights that the benefits accrue almost all across the UK. The only regions not affected are Wales and the South West. All other regions would benefit from significant productivity gains.

3.6 High Speed Two Ltd

3.6.1 Objectives

High Speed Two (HS2) Ltd was set up by the Government to examine the case for new high speed services between London and Scotland. It has a remit to study the benefits and costs that could be generated by new lines, and in response to existing capacity constraints, the London to West Midlands is the first corridor to be examined. HS2 has identified a number of key issues to be considered:

- **passenger capacity:** this is the principal consideration, given the capacity constraints affecting the existing routes;
- **land use and development objectives:** ensuring the proposed corridors are aligned to the plan-led growth proposals;
- **freight:** routes should be developed as fast passenger routes;
- **modal shift from car:** transformational change in rail journey times will help to attract car drivers, particularly given the characteristics of the London to West Midlands corridor;
- **modal shift from air:** limited impact for journeys within the corridor, but some through journeys to the continent could be abstracted;
- **technical standards:** loading gauge, type of rolling stock, line capacity – particularly to cater for future growth;
- **connections to Heathrow:** scope for interchange from other rail corridors and HSR; and
- **city centre or parkway stations:** includes an analysis of the benefits and costs.

3.6.2 Scope of Work

Work began early in 2009 on the development a second UK High Speed Rail line, following the incorporation of High Speed Two Ltd (HS2) in January. By the end of the year a report will be submitted by HS2 to the Government with a preferred route, including options, and a business case, including environmental, social and economic assessments.

The first phase of work to identify a long list of geographical options for station in the West Midlands and London and options for a Heathrow interchange has been completed and an initial review of these options has been carried out. At this stage only options that have very obvious and significant operational difficulties and/or have other major showstoppers have been sifted out so leaving a significant number of options still in play. The next stage of assessment will involve further analysis of the strategic fit, costs, environmental considerations, wider impacts and high level consideration of demand/benefits of the options. This assessment should be completed by the end of June and will identify a shortlist of options for more detailed analysis.

3.6.3 Implications for the Leeds and Sheffield City Regions

HS2 has invited evidence from individual stakeholders to help demonstrate the case for high speed rail, and a number of stakeholder workshops have been convened. The initial study recommendations are due to be published by the end of 2009, and these outputs will offer important indication of the emerging shape of the network.

3.7 Overview of the High Speed Rail Options

3.7.1 Journey Time Savings

Various options for high speed rail have been developed, and the delivery of these schemes could generate a number of potential benefits for the Leeds and Sheffield City Regions.

The alignment between Leeds and London via the WCML and TransPennine corridor are not particularly direct, and therefore unlikely to offer any journey time savings to London compared with the existing routes. Furthermore, the alignment towards the West Midlands, before diverging onto a route towards Sheffield, Leeds and the North East is also unlikely to offer any savings.

Table 3.2 summarises the potential journey times to key destinations that could be achieved via the M1 (London – Leicester – Sheffield – Leeds) or London to Leeds via Peterborough and Nottingham.

The main savings to highlight include:

- journey time savings to London from Leeds are about 20-30 minutes. The journey time for the HSR alignment via Nottingham achieves a similar saving compared with the enhanced ECML route, despite the higher operating speeds. The additional stop assumed for the HSR service, and the extended distance are the contributory factors;
- the journey time savings to Sheffield from London are larger compared with Leeds. This outcome is consistent with the slower average speeds shown in Chapter 1;
- HSR would transform journey times to Leicester (2M proposal) and Nottingham (SRA, Option 16), particularly from Leeds. This reflects the lack of regular services to Leicester and the very slow journeys to Nottingham.
- **Table 3.2: Journey Time Savings**

Origin	Destination	Services via Leicester and Sheffield (2M proposal)	Services via Peterborough and Nottingham (SRA, Option 16)
From Leeds	Birmingham	28	No direct journeys
	Heathrow	No direct journeys	No direct journeys
	Leicester	73	No direct journeys
	London	29	21
	Nottingham	No direct journeys	68
	Manchester	No direct journeys	No direct journeys
	Sheffield	15	15
From Sheffield	Birmingham	12	No direct journeys
	Heathrow	No direct journeys	No direct journeys
	Leicester	23	No direct journeys
	London	47	39
	Nottingham	No direct journeys	31
	Manchester	No direct journeys	No direct journeys

Source: Estimated by Arup

3.7.2 Other Conclusions

The main conclusions are:

- many of the alignments presented in Chapter 3 offer the potential to transform journey times between the Leeds and Sheffield city regions, London and other major employment centres;
- the potential new alignments would deliver capacity benefits for selected inter-urban routes, especially the ECML and MML routes;
- the business case for HSR alignments via a East Coast route is stronger than alternative ideas, for example, a Y shaped network with a connection to the East Midlands / Yorkshire diverging from a West Midlands alignment, or a link via the WCML and TransPennine corridor;
- using the results from the SRA study, the financial and economic business case for the TransPennine links appears relatively weak, and the inclusion of agglomeration benefits would be needed. whilst the 2M proposals recommends two TransPennine links to Manchester, the financial and economic viability of these links have yet to be reported. However, the Northern Way report indicates the wider agglomeration benefits would form an integral component of the business case;

There is limited information presented in the business case submissions, examining the robustness of the capital costs, the choices between city centre and parkway stations and the key features of continental systems to use best practice examples are incorporated.

4 Understanding Best Practice, Scheme Costs and Station Locations

4.1 Engineering Characteristics of Existing HSR Alignments

The engineering characteristics of various high speed rail alignments have been reviewed, it will be important to ensure the proposals developed for the Leeds and Sheffield city region are developed with regard to the main emerging findings from this assessment. The following sections highlight the main findings.

4.1.1 France

The first high speed rail services were established in France in the 1980s, with capacity constraints affecting some inter-urban corridors comprising the main contributory factor, including Paris to Lyon. One of the main advantages of France's high speed network is the capability to operate on both "classic" and high speed alignments. This makes connections to city centres more straightforward, with TGVs (*Train à Grande Vitesse)* generally using the same termini and approaches as the classic services.

TGVs use a mixture of high speed lines and classic lines. An example of the interaction is the Paris to Bordeaux route. Services use a short section of the classic lines on departure from Paris, before joining the high speed line outside of the city. The TGV network serves a small number of intermediate parkway stations en-route, before diverting back onto the classic lines between Tours and Bordeaux. Plans are in place to extend the high speed alignment south of Tours, incrementally adding to the existing network. The TGV Est route towards Strasbourg has also applied a similar approach.

The parkway stations TGVs to stop and minimise the journey time penalty incurred by serving intermediate stations.

4.1.2 Other European Networks

There are HSR networks developing in a number of other European countries, including Spain, Portugal, Germany and Italy. The characteristics of these networks are broadly similar to the French model. The trains use a mixture of dedicated high speed alignments, before diverting onto the classic lines close to the cities. These examples have opted to make use of existing city centre stations, or construct a dedicated terminus adjacent to the central areas specifically designed for the high speed services.

4.1.3 Japan

The first Japanese high speed route opened in 1964 between Tokyo and Osaka, with services reaching speeds of up to 185mph. In contrast with the European examples, the high speed Japanese services run on dedicated tracks, thus preventing any interaction with trains on the classic lines. A mix of non-stop and limited stop services operates on some corridors, in response to the different levels of demand using each corridor. This separation from other services means very high levels of punctuality are generally achieved, in spite of the high service frequencies.

4.1.4 US

Proposals being examined in the US are very similar to the French and other continental schemes, with classic lines used on the approach to city centres, and dedicated high speed alignments elsewhere.

4.1.5 UK

The first high speed rail line in the UK was opened in November 2007. High Speed 1 comprises about 70 miles of track from London St Pancras to the Channel Tunnel via Kent. Several stations were constructed, St Pancras International, Stratford International, Ebbsfleet and Ashford. At present, there is no interaction between the classic and high speed lines, with HS1 comprising a wholly separate alignment, with the section between

Ebbsfleet and central London predominantly constructed in tunnel. Eurostar trains to Paris and Brussels are the only current operator of HS1, although the new high speed trains from Kent are due to commence shortly. Service reliability via HS1 has been very high.

4.1.6 Station Location – City Centre versus Parkways

The location of the station is a critical factor affecting the development of the HSR network. The station must be linked to complementary transport networks that enable the estimated number of passengers to board / alight. A city centre station would provide good access to the adjacent bus and suburban rail networks, but the scope for serving many UK examples are already constrained by restricted platform availability, limited scope to increase passenger throughput and slow line speeds on the approaches to these stations. The slow speeds restrict the opportunities for through services. Alternatively, entirely new underground stations could be constructed in the city centres, although significant costs would be incurred. Based on the continental examples, city centre stations are generally used at the start / finish of the journey, when the typical journey time penalties are less critical.

Parkway stations are extensively used on the continent to provide intermediate journey opportunities. This type of approach helps to minimise the time penalties incurred with additional stops. The parkways are generally located in locations remote from the urban centres, although they are conveniently located close to the strategic highway network to serve a wide catchment. However, the location of some stations has been criticised for being too remote from the adjacent areas. A summary of the key performance indicators is shown in Table 4.1 below.

Table 4.1 Key Performance Indicators: City Centre Versus Parkway Stations

Performance Indicator	City Centre	Parkway
Proximity to major employment areas	Termini are centrally located, and therefore offer convenient access to major employment trip generators by public transport or on foot, especially high value employment	Poor connectivity to major employment areas, except by car
Public transport connectivity	City centres already have strong public transport connectivity, and HSR would complement this	Limited public transport access and likely to require significant upgrading
Highway access	Slow, congested access to the city centre. Lengthy timescales to reach the strategic highway network.	Convenient access to the strategic highway network, although extra traffic on the approach to the station could exacerbate existing congestion problems
Station Infrastructure	Already in place but limited room for expansion	New build station could be designed for the purpose of HSR.
Passenger Circulation	Station may already be approaching capacity, and insufficient space to accommodate extra passengers generated by HSR	New station could be built designed to HSR needs and large capacity
Journey Time Impact	Extra city centre stop will have a significant impact on overall journey times due to the reduced operating speeds	Inclusion of an additional stop has a smaller journey time impact compared with city centre stations
Connecting Travel Opportunities	Convenient access to bus and suburban rail networks	Requirement for onward connections to the city centre reduces the advantages of high speed rail
Car Parking	Facilities already operate close to capacity, and there is generally limited space for major expansion	Sufficient space adjacent to the station to construct a large car park

Source: Arup proposals

4.1.7 Implications for the Leeds and Sheffield City Regions

There are a number of important lessons for the Leeds and Sheffield City Regions emerging from the case studies presented above. The Japanese high speed services and the UK portion of HS1 (until the start of the commuter services from Kent) operate using exclusive networks. In contrast, European systems generally share track with other operators on the approaches to city centres, and benefit from dedicated track elsewhere. The proposed spacing between stations also requires comment. To achieve the current journey times, the number of intermediate stops is reduced, to minimise the time spent decelerating, waiting for passengers to board / alight and accelerating.

There are a number of key conclusions to highlight:

- **operational issues:** characteristics of the European examples suggest short sections of classic lines approaching the city centre, with new high speed alignments is the recommended approach. However, the line capacity constraints affecting the major termini, both in London and to a lesser extent, Leeds / Sheffield means this model may need to be revised. Despite a major expansion in 2002, Leeds station is currently operating close to capacity, and there are growing tensions for platform capacity between local and longer distance trains. There are severe capacity constraints affecting Sheffield station from the north, and there is also an intense frequency approaching Sheffield from the south.
- **station spacing:** to deliver competitive journey times, particularly versus air, stations on other high speed corridors are typically spaced 100-200km apart. The higher population densities in the UK could mean a smaller spacing between stations. In response to the likely journey time penalties that would be incurred when high speed services stop, it is unlikely more than two stations would be located in the Leeds and Sheffield city regions;
- **city centre versus parkway stations:** the majority of intermediate HSR stations located on the French and other continental networks are parkways. There are a number of transport benefits resulting from a city centre location, in terms of the proximity to wider public transport networks and major employment sites, although the engineering complexity of identifying a suitable alignment and the high capital costs should be taken into account. The locations of a high speed station for the Leeds City Region may therefore require further work, given the importance of locating it close to the largest concentration of financial service sector jobs in the UK outside London. This decision for the Sheffield City Region may be less critical, given the more dispersed employment patterns.

4.2 Costs

4.2.1 Continental Schemes

We have reviewed the outturn capital costs from a number of continental projects to understand the cost range per kilometre. The section below explores the cost of continental HSR projects and establishes some comparator for the UK schemes.

Table 4.2 illustrates the typical costs per kilometre is around £20-25m if data outliers are excluded. These comparisons provide some important context, both for benchmarking HS1 costs, and the estimated costs identified by the scheme promoters.

Table 4.2: Comparison of Outturn Capital Costs – Continental Examples

Line	Route (km)	£m / km
Belgium: Antwerp – Dutch border	44	23
France: Perpignan - Figueres cross border high speed project	44	15
France: TGV Est Paris - Baudrecourt	300	9
France: TGV Mediterranee: Valence - Marseille and Nimes	250	16
Germany: Nuremburg – Munich	171	15
Italy: Rome – Naples	205	18
Italy: Florence – Bologna	79	47
Korea: Seoul – Busan	410	30
Netherlands: Amsterdam – Rotterdam – Belgium Border	100	26
Spain: Madrid – Zaragoza – Barcelona Frontier	805	9
Spain: Madrid – Segovia – Valladolid – Medina del Campo	211	13
Spain: Leon – Asturias – Variate de Pajares	50	33
Spain: Vitoria – Bilbao – San Sebastian	180	17
Taiwan: Taipei - Kaohsiung	345	31

Source: DfT New Line Capacity Study – London, July 2007

4.2.2 Costs for HS1

The total costs for High Speed 1 were £5.8bn, or an average of £53m/km. This average reflects the differences in costs between the sections in tunnel north of Ebbsfleet (typically £85m/km) and the rest of the alignment through Kent (around £26m/km). The out-turn capital costs per kilometre are significantly higher than the continental examples. Land costs may be a contributory factor, since the South East has some of the highest land values in Europe.

The cost per kilometre for HS1 is about double the estimated costs shown in Table 4.2 for continental schemes. There are a number of reasons for this including higher land costs, consultancy fees, terrain and the length of the planning process, and this will affect the overall business case.

4.2.3 Estimated Costs for HS2 – SRA Study

Chapter 3 described a number of HSR options, and the comparison of costs in presented in Table 4.3. The route length for each option has been estimated, and a cost per kilometre has been derived. Overall, the cost per kilometre is significantly higher than the continental examples shown in Table 4.2. It should be noted an allowance of 30% for optimism bias has been included. This assumption may be lower than the recommended Green Book value of 66%. Specific issues to highlight:

- there are numerous potential routes to connect Yorkshire by HSR. The options with the lowest cost per kilometre include alignments via the East Coast (Peterborough), or a spur towards Yorkshire / North East / Scotland that diverges in the Midlands. Indicative capital costs are around £35-40m/km;
- Options 2 and 6 cost about £45m/km. The smaller network size mean the higher costs per kilometre incurred in the South East have a greater impact on the overall total.

- Option 4 generates the highest cost per kilometre (£53m/km). The inclusion of a TransPennine link between Leeds and Manchester is the main contributory factor, in response to the tunnelling costs. In particular, the costs are about £100m/km between Leeds and Manchester. The relatively small network (compared with Option 10), means the TransPennine section accounts for a large percentage of the overall costs.

Table 4.3: Review of HSR Scheme Costs

Option	Route Summary	Costs (£bn, risk adjusted)	Costs (£bn, risk adjusted)	Route Length (km)	Cost/km (£m)
1	London to West Midlands	HSL from London to West Midlands, with spurs to join classic infrastructure at Birmingham International and Trent Valley	9.9	215	46
2	London to Leeds	As Option 1, plus new HSL spur to serve East Midlands and Leeds, with a link to classic infrastructure to serve Sheffield and North East England.	18.5	400	46.3
3	London to Manchester	As Option 1, with continuation north. HSL splits in Staffs to serve Manchester and Liverpool. Connections via classic WCML at Warrington to serve north west and Scotland.	13.2	320	41.3
4	London to Leeds via Manchester	As Option 3, with additional TransPennine link to serve Leeds and a connection to classic to serve Newcastle.	20.6	390	52.8
6	London to Manchester and Leeds	Combination of Options 2 and 3, London to West Midlands then splitting into two lines to serve Manchester and Newcastle. Spurs allow cross -country services. Connections to Scotland on classic network on both lines.	21.6	460	47.0
7	London to Manchester and Newcastle	As Option 6, with HSL extension to Tyne and Wear	24.5	640	38.3
8	London to Manchester and Scotland	As Option 7, with HSL extension to Scotland, serving Edinburgh and Glasgow.	32.7	930	35.2
10	London to Scotland via Manchester, plus TransPennine Link	As Option 8, with TransPennine link between Manchester and Leeds, replacing spur in Midlands.	39.8	1000	39.8
11	Segregated network: London to Manchester and TransPennine link	Segregated option. As Option 9, but without branches to Liverpool, WCML, Sheffield or Scotland	26.5	700	37.9
12	London/CTRL to Manchester and Newcastle	As Option 7, with a link to CTRL	25.5	650	39.2
13	London/Heathrow to Manchester and Newcastle	As Option 12, but replacing CTRL link with link to Heathrow	25.4	670	37.9
15	London to Nottingham via Peterborough	HSL from London to Peterborough and Nottingham, with link to ECML north of Peterborough	8.1	210	38.6
16	London to Leeds via Peterborough	As Option 15, with HSL extension to Leeds, with links to classic infrastructure to serve Sheffield, the North East and Scotland	12.0	320	37.5

Source: New Line Capacity Study – Cost Estimate July 2007

4.2.4 Estimated Costs for HS2 – Greengauge 21

In addition, the estimated costs presented in the Greengauge 21 suggests that the average cost per kilometre could be even higher. The estimated capital cost for the London to West Midlands scheme is around £11bn. This estimate includes an allowance of 66% for optimism bias, and uses the out-turn costs from individual HS1 contracts to produce these costs. This suggests the cost per kilometre is about £100m / km, even higher than the costs for the Ebbsfleet to St Pancras section.

4.2.5 Other Potential Benchmarking

Consultants are currently reviewing engineering alignments and preparing scheme costs on behalf of HS2. At this stage, 2M have yet to produce indicative capital costs to support their proposals.

4.2.6 Overview of the Capital Costs

There are significant differences between the capital costs per kilometre for continental schemes versus HS1 and examples being developed in the UK. The costs for UK schemes are broadly double compared with the out-turn costs for a typical continental example. The magnitude of the UK costs emphasises the importance of producing a robust value for money case, if HSR serves the Leeds and Sheffield city regions. The development of a high speed TransPennine corridor would incur even higher capital costs, given the significant proportion of the route that would need to be constructed in tunnel.

4.3 Chapter Conclusions

There are several important conclusions emerging from the operational review and the assessment of indicative capital costs:

- in response to the trade-offs between journey time penalties, accessibility to the high speed network and the construction costs for a new station, the maximum number of stations in the Leeds City Region is likely to be two;
- we have examined a number of the potential issues influencing the choice between city centre or parkway stations. Although some of the factors affecting this choice have been examined, further work is needed to understand the potential issues in more detail, for example, operational issues given platform capacity constraints, differences in capital costs, and connectivity to adjacent land uses;
- the scale of the indicative capital costs per kilometre relative to other schemes needs highlighting. The typical costs are around £40-50m/km, and this is significantly higher than continental schemes. The magnitude of these UK costs could affect the affordability of a high speed network.

5 Enhancing Local Rail Connectivity

5.1 Significance of Improved Local Rail Connectivity

Although the primary focus for this study is improving inter-urban rail links, the quality of local links to the main hubs forms a vital part of the overall rail network. High quality, fast, frequent rail links with sufficient capacity can help to encourage greater usage of the rail network. Numerous benefits could result including:

- improved local air quality;
- better safety; and
- reduction in productive time lost.

Greater usage of the network could include local journeys to the main urban centres including Leeds, Sheffield and York. These improvements can strengthen connectivity to local labour markets for commuting purposes, helping to encourage modal shift away from the private car. As well as greater usage of the connection from local stations to these hubs as part of a longer distance journey.

Delivering an improved local rail network could deliver economic benefits for the city regions. The benefits from improved rail connectivity are not just confined to commuting trips to work. An improved network of local services would also help to strengthen wider linkages across the city region, frequency and quality of local services will also lead to new interchange opportunities for longer-distance travel. These constraints potentially act as a barrier, reducing the likelihood that passengers would use the local rail network to access the major hubs. If these constraints were addressed, it could reduce the numbers choosing to drive to the major rail hubs.

5.2 What are the Issues to be Addressed?

5.2.1 Accommodating Growth

There has been substantial passenger growth using the rail network in South and West Yorkshire during the last 10 years. Rail overcrowding commonly occurs on peak services, particularly to / from Leeds and Sheffield, with some passengers forced to stand. In particular, selected routes into Leeds are particularly overcrowded, with severe overcrowding affecting services via Castleford. Efforts have been made to lengthen the busiest trains (for example, Harrogate Line services), and increase frequencies to accommodate this level of growth (Huddersfield Line).

The revised services, either in terms of extra carriages or the additional frequencies has caused restrictions on the availability of platforms, particularly at Leeds and Sheffield. The continuation of this trend could form a major constraint influencing the scope to support future growth.

5.2.2 Quality

Rolling stock quality is an issue for some local services. Low quality Class 14X and 15X units are deployed on numerous suburban routes in both the Leeds and Sheffield city regions. This type of rolling stock does not offer attractive travelling conditions for passengers, since trains are generally noisy and lack passenger information displays or air conditioning. The shortage of seating on the busiest routes leads to a negative perception of rail travel. These older diesel units are also relatively reliable when benchmarked against modern diesel units or electric trains.

5.2.3 Frequency

The service frequency on some corridors is relatively low, and this can act as a deterrent for passengers. There are numerous contributory factors, including low levels of demand or line capacity restrictions leading to tensions between longer distance and local trains. Improved

service frequencies are critical to strengthen the rail "offer" to these key hubs. Some stations in the Leeds and Sheffield city regions are served by just hourly trains. Such frequencies are too low to offer attractive connections with Leeds, Sheffield or York. Furthermore, there are small number of stations that do not have direct trains to Leeds or Sheffield, for example, intermediate stations between Wakefield Kirkgate and Pontefract Monkhill.

5.2.4 Speed

One of the main benefits offered by rail is the fast journey times from residential catchments to major employment centres, with competitive journey times versus other modes. However, the combination of relatively poor operational performance, and various infrastructure constraints mean average speeds on some corridors is relatively slow. This affects the competitiveness of rail versus other modes.

5.3 Identifying Best Practice – Case Study of Airedale and Wharfedale Lines

5.3.1 Understanding the Contributory Factors

The Airedale and Wharfedale Lines are generally acknowledged as excellent examples of local rail corridors serving corridors towards Skipton and Ilkley from Leeds and Bradford Forster Square. The Leeds North West electrification scheme was completed in 1994, and featured the following characteristics:

- modern Class 333 units, featuring passenger information and air conditioning;
- at least 2tph from both Skipton and Ilkley to Leeds and Bradford, with even higher frequencies available if passengers change at Shipley;
- infrastructure improvements to improve reliability and permit increased line speeds;
- procurement of a 4th vehicle to alleviate overcrowding;
- improved station facilities, car park extensions and bus feeder services to improve access to the rail network;

Rail achieves fast journey times to central Leeds and Bradford that compete strongly with other modes, particularly car. With the parallel roads heavily congested, survey work conducted by Metro suggests rail has achieved a 75% mode share for journeys that originate north of Shipley to central Leeds.

5.3.2 Comparison of the Key Performance Indicators

To demonstrate the differences in operational performance of the Airedale and Wharfedale Lines versus other routes in the Leeds and Sheffield city regions, a series of key performance indicators have been defined. A number of rail stations exclusively served by local trains have been presented, and the main indicators are shown in Table 5.1 below.

Overall, the Airedale and Wharfedale Line trains generally out-perform compared with other routes in the Leeds and Sheffield city regions, and the principal conclusions to highlight include:

- high seating capacity per train;
- faster average speeds;
- higher frequencies, compared with some other corridors, note the Airedale / Wharfedale trains offer additional journey opportunities by interchanging at Shipley.

These characteristics could be used to define the scope for future improvements to other rail corridors in the city regions.

Table 5.1: Summary of Key Performance Indicators

Corridor	Selected Station	Journey Opportunities	Peak frequency (tph)	Average Speed (mph)	Typical Capacity (seats per train, peak hour)
Airedale	Crossflatts	Leeds	3tph *	44	360
Wharfedale	Guiseley	Leeds	3tph *	56	360
Harrogate	Horsforth	Leeds	4tph	30	231
York / Selby	East Garforth	Leeds	3tph	31	248
Pontefract	Glasshoughton	Leeds	1tph	33	150
Barnsley	Normanton	Leeds	1tph	36	205
Huddersfield	Mirfield	Leeds	2tph	38	160
Caldervale	New Pudsey	Leeds	4tph	31	261
Doncaster	Mexborough	Sheffield	2tph	29	127
Barnsley	Elsecar	Sheffield	1tph	37	151
Swinton	Swinton	Sheffield	3tph	29	126

Source: Compiled by Arup using data from the National Rail website. Higher frequencies are available from Airedale / Wharfedale stations to Leeds by interchanging at Shipley

5.4 Local Rail Enhancements

5.4.1 Electrification

The publication of the Network Rail business case assessment examining the benefits and costs, together with increasing political support, has increased the awareness of electrification. In addition to the Airedale and Wharfedale Lines, the Leeds and Sheffield city regions also benefit from electric traction operating via the East Coast Main Line to London, Doncaster, Leeds, the North East and Scotland. An expanded electric network could offer the potential to transform local routes, generating a number of potential benefits including:

- **environmental benefits:** electric multiple units (EMUs) do not produce any emissions at point of use. Furthermore, carbon dioxide emissions for EMUs will be 20% lower than those of DMUs by 2010;
- **energy security:** in response to the rising fuel costs, the benefits of greater energy efficiency should be recognised, particularly given the recent fluctuations in diesel prices;
- **value for money:** lower rolling stock maintenance charges per kilometre, whilst lease costs, traction and variable track access costs are also lower;
- **rolling stock fleet requirements:** the number of spare vehicles could be reduced as reliability improves;
- **journey time savings:** EMUs are capable of faster acceleration and deceleration than conventional diesel rolling stock. The scale of the journey time savings will vary according to the nature of the route. Corridors with relatively short gaps between stations will generally achieve the largest savings, and help to achieve modal shift away from car.

In addition to the above benefits, journey ambience would also be improved, with the quieter, more comfortable rolling stock.

The ECML is also affected by the lack of diversionary routes, in the event of engineering work, but also service perturbation. For example, there are a very limited number of electrified diversionary routes. Selected in-fill schemes in the Leeds and Sheffield city regions could create several new 'diversionary' routes between Doncaster, Leeds and York. These schemes would help to improve wider network flexibility and resiliency.

5.4.2 Potential Network Expansion

The coverage of the electrified rail network in the Leeds and Sheffield city regions would need to be expanded incrementally, given the feasibility and business case work required before implementation. This phased approach is therefore required, with some short to medium term schemes, and other long-term aspirations. Building on the proposed strategic electrification of the Midland Main Line, three schemes have been proposed for in-fill:

- Sheffield to South Kirkby Junction (allows line capacity increases and would allow electric services to operate between Leeds and Sheffield via Rotherham. This would build on the national scheme to electrify the Midland Main Line between Bedford and Sheffield)
- Sheffield to Doncaster (allows Leeds-Doncaster-Sheffield electric services and creation of an East Coast Main Line diversionary route)
- Neville Hill Junction to Colton Junction and Selby (allows electrified local services on the York/Selby line and creation of a diversionary route for the East Coast Main Line)

The potential second phase includes the Trans-Pennine corridor via Huddersfield, with extensions beyond York / Selby. Other routes that could benefit from electric traction include the Harrogate, Barnsley and Caldervale Lines.

5.4.3 Other Potential Improvements

The lengthy timescales for electrifying some corridors mean alternative short to medium term interventions may be required. For example, taking the Caldervale Line as a case study, a package comprising better rolling stock, selected infrastructure improvements that would enable achieve faster journey times, and extra capacity would help to improve connectivity between Halifax / Bradford and Leeds. A similar approach would also benefit the Huddersfield Line, particularly given the interaction with the longer distance TransPennine services. Extra capacity is also urgently required for the Harrogate Line, although the introduction of electric traction could be linked to the development of the tram-train proposals. A package of improvements could also be delivered in the short term to enhance the Barnsley Line, in advance of future electrification.

6 Modelling Comparative Wider Economic Benefits

6.1 Wider Economic Benefits

Standard transport appraisal methods value the benefits of time savings, frequency improvements, and reductions in delays and accidents to users as a result of improvements to and investments in transport infrastructure. These are not evaluated here. Some discussion of previous evaluation of them and the resulting benefit-cost ratios (BCRs) can be found in section 3.2.

In addition to standard transport appraisal, guidance from the Department for Transport on Wider Economic Benefits (WEBs) is intended to quantify the potential economic impacts of transport improvements upon business productivity. WEBs are completely additional to standard transport user benefits. Including WEBs in the evaluation of a transport scheme can therefore completely alter the BCR of a project.

The inclusion of WEBs in transport appraisals is designed to assess the benefits which transport investment can bring in terms of increasing workers' productivity and the resulting increase in output. The two most significant WEBs are:

- **Move to More Productive Jobs (M2MPJ).** This relates directly to transport investment which results in additional capacity on an already constrained route, which will enable more workers to access city centre jobs where they will be more productive.
- **Pure Agglomeration.** The concept 'effective density' is a measure of the employment density of a place and other places around it, scaled by the distances between them. Effective density can increase either because employment increases or because distance between places decreases. There is a positive relationship between effective density and productivity. Therefore if a scheme results in increased effective density, this increases productivity in the place, leading to 'pure agglomeration' benefits.

The WEBs guidance emerged following a particular type of investment (Crossrail) that increased the accessibility to a single key business area (London) and as a result the approach is most appropriate for assessing the benefits of relieving (commuting) capacity constraints into productive city centres.

High speed rail links can and often do improve accessibility to key business areas and it is envisaged that the domestic services on HS1 will be used significantly for commuting into London, making the WEBs methodology very appropriate for assessing the benefits of that high speed line. The latest evaluation of HS1, undertaken by Volterra and Colin Buchanan, estimated WEBs of £3.8bn (60yr PV), of which approximately half were M2MPJ and half were pure agglomeration. Inclusion of WEBs in the analysis doubled the benefits of the scheme, as the standard transport benefits were also valued at £3.8bn.

Because of the nature of the methodology, it is important to consider the ranges of travel times being effected by HSR before applying this methodology and interpreting the results. It is generally accepted that journey times of under an hour begin to appeal as commuter routes, journey times up to 2-3 hours allow businesses to carry out face to face day meetings on a semi-regular basis and journey times of over 3 hours are associated with less frequent business travel, for which air travel begins to compete. In the context of the Leeds and Sheffield city regions, it is the central bracket which high speed rail will primarily impact upon – making it more practical to conduct day meetings between businesses in Yorkshire and London.

As a result, the primary element of WEBs which it is appropriate to measure is pure agglomeration. This estimates the increase in productivity for existing workers as a result of

a higher density of workers being closer together. This is the element which has been used most widely in studies to date to assess the potential benefits of high speed rail.

The 'pure agglomeration' element of the WEBs methodology estimates the productivity benefits of business centres becoming 'effectively' denser – that is to say that if there are 10 jobs in place A and 20 jobs in place B and they are 30 minutes apart, both places A and B become effectively denser by reducing the travel time between them as they have more ready access to the other place's labour market and business services.

The estimation of WEBs is an important part of the overall appraisal of the costs and benefits of a transport scheme.

Where a transport scheme is likely to impact on productivity (and welfare) through the impact of the scheme on agglomeration then the appraisal of the agglomeration impact of the scheme and the resulting welfare impact, must be appraised and reported.

WEBs are reported separately from other economic benefits but form an important part of the appraisal. For schemes such as high speed rail the wider economic benefits tend to outweigh the traditional transport benefits including journey time savings and accident benefits. For example, in the case of HS1, the WEBs were of the same magnitude as the transport user benefits, so the inclusion of them in the evaluation doubled the estimated benefits of the scheme.

This section of report provides a high level analysis of some of the potential wider economic benefits of introducing a high speed rail link to Yorkshire.

6.2 Modelling Assumptions

In order to estimate the WEBs of potential high speed rail and rail enhancement options for Leeds and Sheffield city regions, we use estimated journey time savings calculated using the assumptions set out in this document and standard DfT guidance on productivity, elasticities and discounting to evaluate the options. Where assumptions have to be made, we have been conservative. Where relevant we have carried out sensitivity tests to assess the likely range around our central results. We now discuss each of the important assumptions.

6.2.1 'Do Something' Options

Wider economic benefits have been calculated for four different options. These are:

Enhancements to the East Coast Main Line (as discussed in Section 2.2)

Enhancements to the Midland Main Line (as discussed in Section 2.3)

High Speed Rail – 2M Alignment (as discussed in Section 3.4)

High Speed Rail – SRA Option 16 Alignment (as discussed in Section 3.2)

The first two options are enhancements to existing routes and the latter two are options for high speed rail routes. Table 3.2 provides a useful summary of the travel time savings delivered by the two high speed routes.

6.2.2 'Do Nothing' scenario and timing

All four options have been evaluated against the same 'do nothing' base case, which represents the current situation.

In order that the benefits can be compared against one another without being confused by discounting factors, we have assumed that the improvements all occur at the same future point in time, ten years in the future and assessed them all against the existing situation.

The start year is effectively arbitrary for the purposes of assessing a hypothetical scheme, the only impact it has is upon the discounting of the results. It is therefore appropriate for carrying out comparisons, to have the same hypothetical start year for all options. Similarly,

the reason we assess all options against the same base is so that the results are not skewed by any assumptions made about which benefits occur first.

By evaluating them all against the same base, with the same start year, the resulting WEBs estimates can all be compared directly with one another to assess the relative merits of each scheme. They should not be added together as some of the benefits will overlap. However in the context of the two enhancement options, due to the routes of the ECML and MML, many of the benefits of improving both would be additional to one another.

6.2.3 Geographical Coverage and basis

The analysis is carried out at the Local Authority level, in line with DfT guidance. Arup estimated rail journey times from all local authority origins in the Leeds and Sheffield City regions (column one below) to each other and other relevant destinations (column two below), as set out in the table.

Table 6.1: Origins and Destinations used in Modelling

Origins	Destinations
Barnsley	Derby
Bradford	Nottingham
Calderdale (Halifax station)	South Kesteven (Grantham station)
Craven (Skipton station)	Lincoln
Harrogate	Leicester
Huddersfield	Northampton
Leeds	Peterborough
Selby	Birmingham
Wakefield	Coventry
York	Wolverhampton
Bassetlaw (Retford station)	Darlington
Doncaster	Durham
Chesterfield	Newcastle
Rotherham	Sunderland
Sheffield	Middlesbrough
	Edinburgh
	Glasgow
	London

Source: Volterra / Arup proposal

The journey times available to us enabled us to carry out relatively complete analysis for the two city regions, considering the journey time savings from all LCR and SCR districts to each other and destinations in London, Scotland, the North East and the Midlands. We also carry out the analysis to assess the benefits to London from the four options. The figures reported for London are only partial however as they value the benefits to London of improvements in travel times to Yorkshire but the travel times are kept constant to the other

destinations (Scotland, North East and Midlands). This results in a partial but informative set of results.

6.2.4 Employment

We utilised ABI employment data for 2007 and in order to be conservative, assumed no growth in employment.

In line with DfT guidance, we split this employment into Manufacturing, Construction, Consumer Services and Producer Services for the calculations.

6.2.5 Generalised travel time

We use the generalised rail travel times calculated by Arup, including access/egress. We then used highway distance between the local authorities to estimate highway travel times and scaled this by public transport and highway modal share in order to get appropriate overall generalised travel times for use in the analysis. Any highway times and weighting between highway and rail usage was assumed to remain constant in all scenarios and through time. Again, this was in order to be conservative.

We used Network Rail information to inform our assumption about rail modal share. The assumptions made for rail modal share are 5 per cent for short distance journeys, 10 per cent for medium distance and 30 per cent for long distance. Short distance is defined as less than one hour, medium is less than 250 minutes and long is anything above this. We tested various sensitivities and found the impacts on the results to be immaterial for any sensible modal share assumptions around these values.

6.2.6 Distance decay factors and elasticities

DfT issued a consultation paper 3.5.14 'The Wider Impacts Sub-Objective' in April 2009. This discusses the use of new elasticities and distance decay factors (alpha) resulting from new analysis carried out by Dr Dan Graham. On the advice of DfT we have used these new figures even though they are not officially part of guidance yet. We have also carried out the analysis using the old assumptions as a sensitivity, the results of this are presented later.

In previous guidance, the distance decay factor (alpha) was simply equal to 1 in all cases. The new guidance has four different alphas, by sector, which are detailed below. The value of alpha influences the rate at which distance decays. The larger the value of alpha, the less important density elsewhere is to a given place. For example an alpha value of 1 would mean that the benefit of Leeds being closer to London is higher than with an alpha of 1.5.

Table 6.2: Distance decay parameter (alpha)

Sector	Decay parameter (alpha)
Manufacturing	1.097
Construction	1.562
Consumer services	1.818
Producer services	1.746

Source: Volterra forecast

Agglomeration elasticities tell us the degree to which productivity increases in relation to increased effective density. In previous guidance, the agglomeration elasticities varied by nine sectors and for all local authorities. The DfT provided us with the top level new agglomeration elasticities by sector. These are detailed below.

Table 6.3: Agglomeration Elasticities

Sector	Agglomeration Elasticity
Manufacturing	0.021
Construction	0.034
Consumer services	0.024
Producer services	0.083

Source: Volterra forecast

Because we did not have access to the local authority level elasticities, we scaled these by the ratios from the previous guidance, in order to allow for the productivity benefits to vary geographically, as they have done previously. We also carry out a sensitivity which simply uses the same elasticities for all local authorities.

TAG Unit 3.5.14 (for consultation) also recommends two sensitivities in section 4.4 that specifically relate to inter-city schemes. Both relate to the value of the decay parameter (alpha). The first is to set alpha equal to the average of the alpha for consumer and producer services for all sectors. The second is to set alpha equal to the highest of the four sectors considered. We present the results of these sensitivities later.

6.2.7 Output

As a proxy for output at the local authority level we use workplace average earnings from 2008 from ASHE. In order to estimate these by sector, we use the ASHE regional tables which present earnings by region and sector. We apply the ratio of sector to average earnings at the regional level to each local authority to give a local estimate of output in the four required sectors. This will be a conservative estimate as actual output will be higher than earnings.

6.2.8 Evaluation period, discounting and productivity

We present all WEBs as annual productivity gains and as a 60 year Net Present Value, as required by DfT. All figures are presented in 2002 prices.

We use the discounting factors recommended by DfT, namely 3.5 per cent for the first thirty years and 3 per cent thereafter. We assume the Green Book long run productivity growth rate of 2 per cent.

6.2.9 Move to More Productive Jobs

Based on a 2-hour commuter peak period, Arup estimate that additional capacity of 500 seats could be offered on the Cross Country Leeds-Wakefield-Sheffield route. This capacity increase would only occur if a HSR route is developed because there is not enough capacity on the lines between Sheffield and Leeds to increase service frequencies unless a new alignment is developed. If a HSR option is developed, a new Sheffield-Barnsley-Leeds service would be introduced in addition to a new HS service which would operate at 2tph.

The routes between Leeds and Sheffield are currently at full capacity. We estimate a M2MPJ benefit based on the assumption that all additional new capacity would be taken by new commuters, equally originated from Wakefield and Sheffield. This calculation is supposed to be illustrative and should not be taken as a forecast of additional commuter trips associated with HSR to Yorkshire.

6.3 Wider Economic Benefit Estimates: Pure Agglomeration

In this section we present the results of our analysis to estimate the pure agglomeration benefits of the options discussed previously. This analysis has been carried out based on the assumptions detailed in the previous section and in line with the latest guidance. We

present the results for the central assumptions and also for a number of sensitivity tests, which have also been explained in the previous section.

The results are presented for the Leeds City region (LCR), Sheffield City Region (SCR) and London. Barnsley is part of both city regions. For the purpose of avoiding double counting or confusion, Barnsley is included in the SCR but not the LCR in the following tables.

As detailed previously, the figures reported for London are only partial as they value the benefits to London of improvements in travel times to Yorkshire but the travel times are kept constant to the other destinations (Scotland, North East and Midlands). In reality, the high speed routes would also reduce journey times between London and these other destinations and so benefits would both accrue to Scotland, the North East and Midlands which are not recorded here and the total benefits to London would be higher.

6.3.1 Central assumption results

The table below summarises the estimated annual productivity benefits and the Net Present Value (NPV) over a typical 60 year appraisal period, discounted to 2002 prices, to the two city regions and London (as defined above) from the four options using our central assumptions.

Table 6.4: Productivity Gains from Increased Agglomeration

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	8.4	0.9	23.4	11.2
SCR	1.4	4.5	8.9	11.2
London	9.7	4.8	27.7	24.5
Total	19.5	10.3	60.1	46.8
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	710	380	2,200	1,710
LCR & SCR	360	200	1,180	810

Source: Volterra forecast

In summary, we find that enhancements could lead to annual productivity benefits to the two city regions of between £5m-10m coupled with a further £5m-£10m of benefits accruing to London. The high speed options would increase this to £22m-£32m.

The table above shows that the high speed lines yield benefits which are significantly higher than the enhancement options. On the whole, the LCR benefits more than the SCR but both would benefit from significant annual productivity gains as a result of all options. Of the high speed options, the 2M route results in the highest overall benefits but the Option 16 route results in a more even division of benefits between the two city regions.

As discussed previously, this result is reasonably accurate for the two city regions which are of primary interest here, but the overall benefits from the Option 16 route are likely to be higher than this because the magnitude of the results presented are partially due to the geography over which we have carried out the evaluation – the route of Option 16 would suggest it may result in larger benefits to the East Midlands, for example, which is only partially considered here.

Between 35-50 per cent of the estimated benefits to the LCR accrue to Leeds itself and between 7 and over 70 per cent of the SCR benefits accrue to Sheffield, depending on the

scenario. This is shown in the table below. Enhancements to the ECML have the lowest absolute impact on Sheffield and similarly enhancements to the MML have the lowest impact on Leeds.

Table 6.5: Percentage of city region benefits accruing to the main cities

	ECML	MML	HSR 2M	HSR Op16
Leeds	36%	45%	36%	47%
Sheffield	7%	72%	57%	59%

Source: Volterra forecast

The previous work which is most comparable to the analysis we have carried out is the Northern Way North-South Connections study (discussed in section 3.5) which estimated that an entire northern network (West, East and trans-Pennine routes) would result in productivity benefits to the north of £10bn (60yr NPV). Of this, just under half, or £4.8bn, was due to the eastern route. And of this, around 18 per cent was attributed to Yorkshire. This is equivalent to annual productivity gains in Yorkshire of £24.2m or a 60yr NPV of £0.9bn. This is very comparable to our estimates of the benefits to the Leeds and Sheffield city regions, giving us confidence that the methods used are reasonably consistent.

6.3.2 Sensitivity One: Using previous DfT guidance

As discussed earlier, the methodology used in this analysis is the latest available from DfT, detailed in their April 2009 consultation document. Prior to this, analysis was carried out using a fixed alpha of 1 and local authority level elasticities.

Table 6.6: Productivity Gains, Sensitivity One (previous DfT guidance)

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	10.7	1.4	30.8	15.1
SCR	1.9	6.0	12.3	14.0
London	12.6	7.6	35.9	33.7
Total	25.3	15.0	79.0	62.8
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	925	549	2,890	2,297
LCR & SCR	461	271	1,576	1,064

Source: Volterra forecast

Using the previous guidance results in estimates which are around a third higher than our central estimates.

6.3.3 Sensitivity Two: Same elasticities for all Local Authorities

As discussed earlier, we were provided with the top level sectoral elasticities and we scaled them by the ratios from the previous local authority level data to get local area level sectoral elasticities. This sensitivity presents the results from using the same elasticities across all local authorities.

Table 6.7: Productivity Gains, Sensitivity Two (same elasticities across LAs)

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	7.0	0.8	19.7	10.2
SCR	1.6	5.4	10.3	13.2
London	8.2	4.1	23.6	20.8
Total	16.8	10.3	53.5	44.3
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	610	380	1,960	1,620
LCR & SCR	310	230	1,100	860

Source: Volterra forecast

Using the same elasticities for all local authorities results in estimates which are more heavily weighted towards the Sheffield City Region. The benefits to the SCR rise by around 15 per cent whereas those to the LCR and London fall by around 7-17 per cent. This is because the previous Dr Dan Graham analysis (used in the central estimates) found that Leeds and London benefited significantly more from agglomeration effects than Sheffield.

6.3.4 Sensitivity Three: DfT sensitivity Average Alpha

As discussed earlier, TAG Unit 3.5.14 (for consultation) also recommends two sensitivities in section 4.4 that specifically relate to inter-city schemes. Both relate to the value of the decay parameter (alpha). The first is to set alpha equal to the average of the alpha for consumer and producer services for all sectors. The table below presents the results of this sensitivity.

Table 6.8: Productivity Gains, Sensitivity Three (average alpha)

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	8.3	0.9	23.2	11.0
SCR	1.4	4.5	8.9	11.0
London	9.6	4.8	27.5	24.4
Total	19.3	10.2	59.6	46.4
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	710	370	2,180	1,700
LCR & SCR	360	200	1,170	810

Source: Volterra forecast

This sensitivity has very little impact on the results, reducing them by approximately 1 per cent.

6.3.5 Sensitivity Four: DfT sensitivity Highest Alpha

The second sensitivity recommended in section 4.4 of TAG Unit 3.5.14 is to set alpha equal to the highest of the four sectors considered. The table below presents the results of this sensitivity.

Table 6.9: Productivity Gains, Sensitivity Four (highest alpha)

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	8.2	0.9	22.8	10.8
SCR	1.4	4.5	8.8	11.0
London	9.5	4.8	27.3	24.1
Total	19.1	10.1	58.9	45.9
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	700	370	2,150	1,680
LCR & SCR	350	200	1,160	800

Source: Volterra forecast

This sensitivity also has very low on the results, reducing them by approximately 2 per cent.

6.3.6 Summary of results

The table below summarises the range of results arrived at by the sensitivity analyses detailed in the previous sections.

Table 6.10: Productivity Gains, Central estimate (and range from sensitivities)

	Annual Productivity Gains (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
LCR	8.4 (7 - 10.7)	0.9 (0.8 - 1.4)	23.4 (19.7 - 30.8)	11.2 (10.2 - 15.1)
SCR	1.4 (1.4 - 1.9)	4.5 (4.5 - 6)	8.9 (8.8 - 12.3)	11.1 (11 - 14)
London	9.7 (8.2 - 12.6)	4.8 (4.1 - 7.6)	27.7 (23.6 - 35.9)	24.5 (20.8 - 33.7)
Total	19.5 (16.8 - 25.3)	10.3 (10.1 - 15)	60.1 (53.5 - 79)	46.8 (44.3 - 62.8)
	60yr NPV (£m, 2002 prices)			
	ECML	MML	HSR 2M	HSR Op16
Total	710 (610 - 925)	380 (370 - 549)	2200 (1960 - 2890)	1710 (1620 - 2297)
LCR & SCR	360 (310 - 461)	200 (200 - 271)	1180 (1100 - 1576)	810 (800 - 1064)

Source: Volterra forecast

The sensitivities which have the largest impact on the results are using the previous DfT guidance (30 per cent upward impact) and using the same elastcities for all local authorities (15 per cent downward impact except for Sheffield which has a 15 per cent upward impact).

The fact that our original central estimates are indeed central within this range gives us confidence that the most appropriate assumptions have been made.

6.4 Wider Economic Benefit Estimates: Move to More Productive Jobs

In addition to the pure agglomeration benefits described and estimated above, there may be some commuter benefits, which can be valued in terms of people moving to more productive jobs (this was defined earlier in section 6.1). Capacity increases on the existing Sheffield-Wakefield-Leeds line would occur if a new alignment is development (ie a high speed rail). If a HSR option is developed, Arup estimate that there would be around 500 seats of additional capacity in the commuter period on this line and 990 seats on an entirely new HSR line from Leeds to Sheffield.

If the 500 seats on the existing line were used entirely used by new commuters moving to more productive jobs, this would result in 'move to more productive jobs' benefits of around £20m (60yr NPV). We assume that the commuters come evenly from Sheffield and Wakefield although this assumption in reality makes no material difference to the analysis.

In addition, if the 990 seats on the entirely new HSR line were used entirely used by new commuters moving to more productive jobs, this would result in additional 'move to more productive jobs' benefits of around £40m (60yr NPV).

These numbers are relatively small in comparison to the pure agglomeration benefits but important nonetheless.

6.5 Further 'transformational' benefits

Whilst the WEBs methodology goes some way to quantifying the benefits of high speed rail, it does not explicitly capture the potential transformational impacts which high speed rail could have upon the future development of the country's economic geography. These sorts of benefits are difficult to quantify and methods for doing so are not yet contained in guidance. In the following sections we discuss the relevant examples of High Speed One in the UK and European examples.

6.5.1 The Example of High Speed One

A recent evaluation by Volterra and Colin Buchanan of the impacts of High Speed One tried to quantify these to some extent. The table below summarises these.

Table 6.11: High Speed One Economic and Regeneration impacts

	£bn
Transport benefits	3.8
Wider Economic benefits	3.8
Regeneration benefits	10.0
Total benefits (PV over 60yrs)	17.6

Source: Volterra forecast

The transport benefits were primarily time savings and the wider economic benefits (WEBs) were split almost evenly between move-to-more-productive-jobs and pure agglomeration benefits. As with all transport evaluations, it should be noted that WEBs are completely additional to standard transport user benefits, hence the addition of the benefits in the table above. It should also be noted that the domestic services are expected to be used significantly for commuting purposes, making the incentives, drivers and benefits of the scheme quite different in some ways from other proposed HSR lines.

However, HS1 is also credited with significant regeneration impacts. It has enabled the delivery of three major development schemes in Ebbsfleet, Stratford and Kings' Cross. Those schemes will significantly impact on three regeneration areas with plans for over

15,000 homes and 70,000 jobs resulting in quantifiable residential spending and output, summarised in the table below.

Table 6.12: Redevelopment across the HS1 Stations

	King's Cross	Stratford	Ebbsfleet	Eastern Quarry
Permanent jobs	22,100	34,000	24,000	7,200
GDP per annum	£1.3bn	£1.8bn	£1bn	£275m
Homes	2,000	Up to 5,500	2,100	6,250
Household spending per annum	£50m	£140m	£49m	£144m
Temporary jobs during construction (FTE)	2,500	4,000	3,500	

Source: Volterra forecast

The construction of HS1 provided the justification for rolling back the green belt and previous strategic gap policies in Ebbsfleet Valley where previous planning history was one of strict development restraint. Without HS1 it is very unlikely that development of this quantum would have been permitted at Ebbsfleet.

Similarly, in Newham (home to Stratford), the planned jobs created at the development will be three times the growth seen in the area in the last 15 years. These comparisons show the extent of the growth enabled by these developments.

It is difficult to quantify the extent to which any of this growth is additional. The DfT's approach is to assume that this growth would have otherwise occurred elsewhere and therefore a benefit cannot be claimed. However, if it is the case that a constraint exists which may have prevented this growth from occurring then it must be the case that some value should be attributed to delivery of this growth.

Such a constraint might be, for instance, the lack of easily available and attractive locations that would encourage businesses to expand or start up when they might otherwise not have done so. They could also attract investment that might otherwise have taken locations outside of the UK. This is particularly true in locations with easy access to other countries which is (by definition) true of the study area.

If just five per cent of the impacts are viewed to be completely additional then this would generate over £200m of additional GDP per annum. This results in a PV over 60 years of £10bn. It does not seem unreasonable that at least five per cent of this growth could be completely additional and HS1 was fundamental in the availability of these particular sites for development.

Other regeneration benefits quantified by the assessment included:

- The value of the housing stock in the study area may increase by around £1.3bn, representing a capitalised value of HS1 benefits to current residents
- Earnings per annum across the study area may increase by between £62m and £360m due to the commuting facilitated by HS1

6.5.2 European Qualitative Examples

If the delivery of high speed rail is accompanied by planning policies to support sustainable economic development, European examples suggest that it can have very positive impacts.

For example, the French cities of Lille and Lyon suggest (qualitatively) that HSR can have very beneficial impacts upon the economic development of a city. High Speed Rail on its own will not deliver transformational change but these examples and others suggest that

alongside strategic plans for other investment and planning policies which support growth it can have very beneficial effects.

These examples underline the importance of aligning economic development strategies with transport strategies. Lille for example was supported by planning policies which enabled significant development to occur (a conference centre for example) near the high speed station and various other regeneration strategies.

The importance of joined up planning and strategic fore-thinking is highlighted by examples where HSR has not had the envisaged beneficial impacts. For example Tours did not benefit significantly, commentators suggest this might be because the economy which was there before did not fit well with HSR (it was mainly tourism). Many smaller places which are stopped at infrequently appear to have been limited in success too (Le Creusot for example).

This implies a need to balance transport provision with good local services so that surrounding smaller towns do not lose out. There is some evidence that success in some cities (benefiting from HSR) could result in economic losses in neighbouring centres (eg Lyon v Dijon). This could be mitigated by good regional transport links.

In addition, accentuating existing trends is nearly always easier than completely redefining a place. Building upon the already strong assets of Leeds as the centre of the Yorkshire economy, supported by a growing economy at Sheffield, and improving the links both northbound with the North East, Scotland and southbound with the East Midlands and London should offer a very positive potential for future economic growth.

We now discuss some European examples in a little more detail.

Lyon

Due to physical constraints around the existing station, a major new station to accommodate TGV services was built adjacent to an emerging commercial district. Since the start of these services, further development around the commercial area has followed:

- Businesses relocated to the commercial district, and office accommodation became more valuable
- The scale of business and commercial relocation has created its own momentum in attracting further such activities
- The urban public transport system has been developed to enable access to the area (and the TGV station) from surrounding areas
- Hotels have been built in an area formerly lacking them; suggesting that the TGV service has also expanded tourist travel to what was already an important tourist destination. The author suggests that this may also indicate that visitors value hotels close to their place of arrival.

Lille

Historically, Lille had been heavily reliant on industry, being at the heart of a key industrial region. The city benefitted from incorporating the plans for high speed rail into a wider long term vision to transform the city as a whole. In 2004, Lille gained the position of European City of Culture.

- A New through station strictly for TGV services (Lille Europe) was built on a former barracks site near to the original station. Most of the rest of this site was used for a major commercial centre with offices, hotels and a large modern retail centre. The remainder was made into a public park, replacing former open space used to build the new approach lines to Lille Europe. The whole area is adjacent to the old city centre and has formed an extension of it

- Further programmes have led to substantial new building of offices, public housing and a very large conference and events hall in areas adjacent to Lille Europe. This forms part of a continuing strategy of development for the area. Further expansion is now in hand (at the time of writing) to take in redevelopment of a closed railway goods yard and other disused land beyond the conference hall
- Reorganisation of the local universities has included locating some faculties in former cotton mills in older areas, thus creating local employment and businesses in these areas. These older areas have also benefited from regeneration programmes. In turn some of the traditional university buildings have been taken over by larger businesses, often for regional head offices
- Complementary programmes of regeneration have been undertaken in other parts of the conurbation, notably in the former cotton towns of Roubaix and Tourcoing. These have seen disused public and industrial buildings modernised for reuse as offices, leisure and community centres, and specialist education. Notable is the Euroteleport complex at Roubaix, adjacent to a modern retail centre designed to enhance the traditional city centre. In parallel, housing areas in these towns have seen programmes of improvement and new building

Le Mans and Tours

In the cases of Le Mans and Tours the main change after opening the TGV-Atlantique was for people who had travelled up to Paris Monday and returned Friday to switch from weekly to daily commuting. The overall number of residents who worked in Paris did not change significantly. Developing the TGV system was not specifically aimed at increasing commuting yet this effect occured.

Development of the TGV did little to regenerate areas around Tours station (brought within an hour of Paris) or to unite the city development strategy as a whole. As result Tours did not see significant gain.

Dijon

Smaller cities can lose out, in relative terms. Dijon was a significant intermediate city on the former main line to Lyon. It still benefitted from a small number of TGVs from Paris but, initially, opening the TGV line led to substantial loss of fast rail services for Dijon, although it does now benefit from increased regional services. The regional councils were critical of SNFC's focus on TGV development at the expense of other fast services.

Grenoble

With the planned arrival of TGV services, the city authorities developed a new business area close to the station. They also upgraded the city centre retail area and the environment of adjacent areas (partly in connection with a new tramway system).

Zaragoza

The city lies half way along the Madrid-Barcelona high-speed (AVE) line. With the approval and design of the Madrid-Barcelona AVE line, the city strategy was focused on developing the area round the AVE station as a major location, both in its own right but also well integrated into the city strategy. The principal focus was a new Fair site, used for the World Fair in 2008. Complementing this, the development also includes hotels, conference and leisure facilities and a large, high-quality residential area, much of it in a parkland setting. There are direct transport links (rail and bus) with the central area and other parts of the city.

Cologne

In 1988 the Cologne city authorities decided that, with the planning of the Brussels–Cologne– Frankfurt high-speed corridors, the station should be rebuilt as part of a major redevelopment of the whole area around the Cologne Fairground. This redevelopment

includes offices, hotels, retail and leisure centres, and housing, as wall as redevelopment of the main Fair site venues. Commentators believe that combined with access by high-speed trains from much of Western Europe, this puts Cologne in a stronger position to host international events. The new station also acts as a key node on regional rail services and local transit. Furthermore, because the station is less than one kilometre from the centre of the city, and linked by bridges, it is able to complement the more traditional activities based there.

6.5.3 European Quantitative Examples

The previous section detailed some useful qualitative examples from Europe. Very little quantification has been carried out in this area although the following projects were evaluated ex-post:

- TGV Sud-Est (Paris-Lyon) – Bonnafous (1987)
- AVE (Madrid-Seville) – de Rus and Inglada (1997)
- Japanese Shinkansen – Banister and Berechman (2000)

The ex-post evaluations show increases in commercial activity, and hence land values around some, but by no means all, high speed rail stations. For example between 1983 and 1990, there was a 43% increase in office space around Lyon Part-Dieu station; whilst in Japan land values in commercial areas rose by 67% with a Shinkansen station (Nakamura and Ueda, 1989). However, it is recognised that these measures may reflect displacement of activity from elsewhere and should not be interpreted as being indicative of net growth.

6.6 Chapter Conclusions

This section has detailed our analysis to estimate the wider economic benefits of HSR rail and enhancement options for Leeds and Sheffield city regions. Using the DfT's guidance on 'pure agglomeration' benefits, which have been used in all other studies looking into the benefits of high speed rail, we estimate that enhancements could lead to annual productivity benefits to the two city regions of between £5m-10m coupled with a further £5m-£10m of benefits accruing to London. The high speed options would increase this to £22m-£32m, or £45bn-£60bn including the benefits which accrue to London.

This equates to between £1.7bn and £2.2bn of productivity benefits over a 60year horizon which is very significant in the context of the economies of the city regions.

We also carried out sensitivity analysis both in line with DfT guidance and some sensitivities of our own which we thought were appropriate. The fact that our original central estimates are indeed central within the range of outcomes of the sensitivities gives us confidence that the most appropriate assumptions have been made.

In addition to the pure agglomeration, we have also considered the potential for 'move to more productive jobs'. These benefits could be as much as £60m (60yr NPV) if all additional capacity is used by new commuters.

Whilst these attempts at quantification are useful, they do not explicitly capture the potential transformational impacts which high speed rail could have upon the future development of the country's economic geography. These sorts of benefits are difficult to quantify and methods for doing so are not yet contained in guidance. A recent study for HS1 estimated that regeneration benefits could be as much as £10bn, more than 2.5 times the estimated WEBs for HS1. Qualitative examples from Europe also support the contention that if the delivery of high speed rail is accompanied by planning policies to support sustainable economic development, then it can have very positive impacts.

7 Conclusions and Recommendations

7.1 The Need for Improved Rail Links

The economy in the Yorkshire and Humber Region is worth over £80bn per annum, strong housing and employment growth is forecast for the Leeds and Sheffield city regions. Convenient, fast, attractive transport links are essential to connect both residential areas with the major employment locations for commuting purposes, and city regions for business travel. Rail ticket data indicates London is the principal long distance trip destination from the city regions, with around 1.56m journeys per annum from Leeds, and 0.75m and 0.883m per annum from Sheffield and York respectively. In contrast, the size of the travel markets to Manchester is generally, with the main flows originating from Leeds and Sheffield. Leeds generates a higher number of local rail journeys compared with Sheffield. There are significant flows from Sheffield, York and Huddersfield to Leeds. In contrast, the total travel market to Heathrow is smaller, with about 410,000 surface trips per annum from the LCR and SCR, note, this includes journeys by car and bus as well as rail.

Whilst Leeds and York benefit from 2tph to London, the quality of links from Sheffield is relatively poor. Although the average speeds from York are comparable to trains from the principal WCML stations, the speeds from Leeds are significantly slower, given the requirement to call at intermediate stations. Furthermore, there is just an hourly service from Sheffield, and the slower average speed offers a weak comparison compared with the West Coast route. Links between Leeds and Sheffield, the TransPennine connections to Manchester, and the links from the city regions to Nottingham are constrained by relatively slow speeds.

Local rail connections to the major stations also provide essential links to the major stations, both for local commuting journeys, but also part of the longer distance journeys. Our analysis highlighted the strong patronage growth that has been achieved, albeit against a backdrop of relatively slow services, low frequencies and rolling stock with insufficient capacity.

Network Rail has recently developed demand forecasts, presented in terms of four scenarios. By 2036, long distance demand could increase by 35% to 70% on the TransPennine, East Coast and Midland Main Lines. Furthermore, demand growth using the Cross Country routes could increase from 50% to 95%.

Using the DfT's guidance on 'pure agglomeration' benefits, which have been used in all other studies looking into the benefits of high speed rail we estimate that enhancements could lead to annual productivity benefits to the two city regions of between £5m-10m coupled with a further £5m-£10m of benefits accruing to London. The high speed options would increase this to £22m-£32m, or £45bn-£60bn including the benefits which accrue to London. This equates to between £1.7bn and £2.2bn of productivity benefits over a 60year horizon which is very significant in the context of the economies of the city regions.

In addition to the pure agglomeration, we have also considered the potential for 'move to more productive jobs'. These benefits could be as much as £60m (60yr NPV) if all additional capacity is used by new commuters.

The above analysis demonstrates a clear requirement to address these constraints affecting both the inter-urban and local networks, and the importance of supporting forecast growth. There are two main types of solution that could be delivered to improve the inter-urban networks:

- enhancing the existing inter-urban routes, including links to London
- constructing wholly new high speed rail alignments.

Furthermore, improvements are also needed for the local network to improve connectivity to the main hubs in the city region.

The recommendations are presented in terms of measures that could be delivered in the short to medium term (up to 10 years) and the longer term (beyond 10 years).

7.2 Recommended Short to Medium Term Strategy

We have identified various incremental improvements that would benefit the ECML, MML, TransPennine corridors to Manchester, plus links to the Midlands. A package of potential improvements has been identified that could be delivered during the next 10 years. For example, the revised timetable, procurement of new rolling stock, and delivery of selected infrastructure schemes could reduce journey times from Leeds or York to London by around 15-20 minutes. It is therefore recommended city region stakeholders continue to engage with DfT and Network Rail to ensure these improvements are delivered, mainly in the short term. In terms of funding requirements, a preferred bidder has been announced to deliver the new rolling stock, there is £560m allocated in Network Rail's Strategic Business Plan to deliver the infrastructure schemes, whilst the timetable changes are expected to be implemented by December 2010, as part of a franchise agreement. However, the recent announcements affecting National Express East Coast could affect the implementation of these changes.

A package of incremental improvements could also be delivered for the Midland Main Line. The recent Network Rail electrification study suggested the MML would generate a positive financial business case, so it is recommended stakeholders continue to lobby both DfT and Network Rail to ensure this important project is delivered. As well as the positive financial business case, the MML scheme could also act as a catalyst for other electrification schemes in the Leeds and Sheffield city regions. There is scope to deliver other schemes to improve line speeds, with this package of measures potentially cutting journey times by around 10 minutes. However, no funding package has been agreed to deliver these improvements.

There is an urgent requirement to increase capacities and reduce journey times on the north TransPennine corridor via Huddersfield. These issues could be addressed as part of the next franchise agreement. It is recommended stakeholders in the Leeds city region continue to lobby DfT for extra seats on the Huddersfield route, and some incremental journey time improvements. These measures could be delivered through the new franchise agreement. The Manchester Hub proposal offers scope to further reduce journey times for the TransPennine routes. The East Midlands Trains franchise has recently been let, so the scope for implementing short term improvements between Sheffield and Manchester via the Hope Valley route is more limited.

A package of improvements to strengthen links to the Midlands is needed, comprising extra capacity to the West Midlands, and faster journeys combined with improved service quality for the link to the East Midlands. It is recommended stakeholders lobby to secure further capacity enhancements for the Cross Country links, and examine the potential infrastructure solutions to improve line speeds.

The schemes described above to existing inter-urban routes offers the potential to reduce current journey times by around 10-20 minutes. The delivery of these improvements would generate important economic benefits, although the scale of journey time reductions and resulting level of economic benefits is likely to smaller than the longer term proposals outlined. However, the more modest scale of benefits is consistent with the scale of capital costs.

7.3 Recommended Medium to Long Term Strategy

HSR will fundamentally alter the economic and spatial geography, and generate a number of major benefits, including the generation of significant economic benefits, transformational

journey times to London from parts of the Leeds and Sheffield city regions, and capacity relief for the East Coast and Midland routes to London. There are several HSR options identified for the Leeds and Sheffield city regions, including ideas generated on behalf of the SRA, Greengauge 21, 2M, the Northern Way. Furthermore the Government recently established HS2 Ltd to examine the potential route options.

Inevitably, the improved connectivity will act as a catalyst for economic development and regeneration. For example depending on the alignment selected, journey times could be reduced by [xx] minutes to London, with a frequency of 1-2 trains per hour between London and the Leeds and Sheffield city regions. The new alignment could also transform journey times to the principal cities in the East Midlands, particularly from the Leeds City Region, since there are no direct regular journeys. As demonstrated in Chapter 6, the likely scale of journey time reductions and generation of wider economic benefits is significantly larger than the estimated benefits that could accrue from upgrading existing lines.

However, these transformational benefits need to be balanced against the significant risks including affordability, value for money and uncertainty linked to phasing. The reliance on HSR to improve inter-urban rail links represents a longer term, and potentially a higher risk strategy. The analysis presented in Chapter 5 highlights the significant capital costs per kilometre associated with delivering HSR alignments, particularly for complex routes incorporating city centre termini or tunnelled sections. Most notably, the estimated capital costs per route kilometre are at least double compared with the out-turn costs from a range of continental schemes. As a result, the magnitude of these capital costs could affect the affordability of HSR proposals.

Further work is needed to explore the trade-offs between a city centre or a parkway station to serve the city region. There are a number of complex decisions influencing this decision, and more detailed analysis is required. However, the typical journey time penalties incurred from intermediate stops suggest a maximum of two stops should be recommended for the city region.

Overall, HSR represents a longer term strategy for implementation. Whilst the transformational rail service presents significant opportunities to improve connectivity and stimulate economic benefits, the timescales and uncertainties mean such proposals represent a longer term solution.

7.4 Next Steps

The Leeds and Sheffield city regions have a critical role to lobby for the proposed improvements highlighted in the short to medium, and longer term plans. In spite of the funding outlined in Network Rail's Strategic Business Plan, stakeholders have a key role to play lobbying Network Rail and the DfT to ensure the timetable changes, new rolling stock and infrastructure improvements proposed for the ECML are delivered within the expected timescales. The electrification of the Midland Main Line also forms an important strategic priority. Whilst this scheme offers a positive financial case, as well as a range of other strategic benefits, securing the required capital funding will be challenging, particularly given the current challenging current fiscal environment. Stakeholders in the city regions should continue to lobby for the delivery of this vital project.

There is still further work to develop and refine options to improve connectivity between the Leeds and Sheffield city regions to London (via the Midland Main Line), Manchester & the North West, and the Midlands. Further work is needed to identify and appraise infrastructure schemes to help reduce journey times, and these studies need to be completed in partnership with Network Rail. The Northern and TransPennine Express franchises are due for renewal in the next 2-3 years (the timescales are dependent on the outcome of performance targets), so stakeholders have the opportunity to lobby DfT to influence the inputs to the next franchise agreements.

There are a number of strong economic and transport arguments to deliver high speed rail for the city region, given its likely transformational impacts. The scale of benefits that could be generated will be influenced by the choice of alignment and the number of intermediate stops. An alignment via the M1 corridor from London to the Leeds and Sheffield city regions appears to offer the strongest case, stakeholders will need to engage with HS2 to ensure this evidence base is fully taken into account when developing the wider proposals.

Appendix A

Wider High Speed Rail Issues for Consideration

Appendix B

Calculation of Modelling Inputs

Appendix C

Examples of Best Practice

C1 Examples of Best Practices

C1.1 Overview

These examples highlight the need to align city/regional economic development objectives with investment in infrastructure. High Speed Rail on its own will not deliver transformational change but these examples suggest that alongside strategic plans for other investment and planning policies which support growth it can have very beneficial effects.

The importance of joined up planning and strategic fore-thinking is highlighted by examples where HSR has not had the envisaged beneficial impacts. For example Tours did not benefit significantly, commentators suggest this might be because the economy which was there before did not fit well with HSR (it was mainly tourism). Many smaller places which are stopped at infrequently appear to have been limited in success too (Le Creusot for example).

This implies a need to balance transport provision with good local services so that surrounding smaller towns do not lose out. There is some evidence that success in some cities (benefiting from HSR) could result in economic losses in neighbouring centres (eg Lyon v Dijon). This could be mitigated by good regional transport links.

C1.2 Continental Examples

C1.2.1 Lyon

Due to physical constraints around the existing station, a major new station to accommodate TGV services was built adjacent to an emerging commercial district. Since the start of these services, further development around the commercial area has followed:

- Businesses relocated to the commercial district, and office accommodation became more valuable;
- The scale of business and commercial relocation has created its own momentum in attracting further such activities;
- The urban public transport system has been developed to enable access to the area (and the TGV station) from surrounding areas; and
- Hotels have been built in an area formerly lacking them; suggesting that the TGV service has also expanded tourist travel to what was already an important tourist destination. The author suggests that this may also indicate that visitors value hotels close to their place of arrival.

C1.2.2 Lille

Historically, Lille had been heavily reliant on industry, being at the heart of a key industrial region. The city benefitted from incorporating the plans for high speed rail into a wider long term vision to transform the city as a whole. In 2004, Lille gained the position of European City of Culture.

- A New through station strictly for TGV services (Lille Europe) was built on a former barracks site near to the original station. Most of the rest of this site was used for a major commercial centre with offices, hotels and a large modern retail centre. The remainder was made into a public park, replacing former open space used to build the new approach lines to Lille Europe. The whole area is adjacent to the old city centre and has formed an extension of it
- Further programmes have led to substantial new building of offices, public housing and a very large conference and events hall in areas adjacent to Lille Europe. This forms part of a continuing strategy of development for the area. Further expansion is now in hand (at the time of writing) to take in redevelopment of a closed railway goods yard and other disused land beyond the conference hall

- Reorganisation of the local universities has included locating some faculties in former cotton mills in older areas, thus creating local employment and businesses in these areas. These older areas have also benefited from regeneration programmes. In turn some of the traditional university buildings have been taken over by larger businesses, often for regional head offices
- Complementary programmes of regeneration have been undertaken in other parts of the conurbation, notably in the former cotton towns of Roubaix and Tourcoing. These have seen disused public and industrial buildings modernised for reuse as offices, leisure and community centres, and specialist education. Notable is the Euroteleport complex at Roubaix, adjacent to a modern retail centre designed to enhance the traditional city centre. In parallel, housing areas in these towns have seen programmes of improvement and new building

C1.2.3 Le Mans and Tours

In the cases of Le Mans and Tours the main change after opening the TGV-Atlantique was for people who had travelled up to Paris Monday and returned Friday to switch from weekly to daily commuting. The overall number of residents who worked in Paris did not change significantly. Developing the TGV system was not specifically aimed at increasing commuting yet this effect occured.

Development of the TGV did little to regenerate areas around Tours station (brought within an hour of Paris) or to unite the city development strategy as a whole. As result Tours did not see significant gain.

C1.2.4 Dijon

Smaller cities can lose out, in relative terms. Dijon was a significant intermediate city on the former main line to Lyon. It still benefitted from a small number of TGVs from Paris but, initially, opening the TGV line led to substantial loss of fast rail services for Dijon, although it does now benefit from increased regional services. The regional councils were critical of SNFC's focus on TGV development at the expense of other fast services.

C1.2.5 Grenoble

With the planned arrival of TGV services, the city authorities developed a new business area close to the station. They also upgraded the city centre retail area and the environment of adjacent areas (partly in connection with a new tramway system).

C1.2.6 Zaragoza

The city lies half way along the Madrid-Barcelona high-speed (AVE) line. With the approval and design of the Madrid-Barcelona AVE line, the city strategy was focused on developing the area round the AVE station as a major location, both in its own right but also well integrated into the city strategy. The principal focus was a new Fair site, used for the World Fair in 2008. Complementing this, the development also includes hotels, conference and leisure facilities and a large, high-quality residential area, much of it in a parkland setting. There are direct transport links (rail and bus) with the central area and other parts of the city.

C1.2.7 Cologne

In 1988 the Cologne city authorities decided that, with the planning of the Brussels–Cologne– Frankfurt high-speed corridors, the station should be rebuilt as part of a major redevelopment of the whole area around the Cologne Fairground. This redevelopment includes offices, hotels, retail and leisure centres, and housing, as wall as redevelopment of the main Fair site venues. Commentators believe that combined with access by high-speed trains from much of Western Europe, this puts Cologne in a stronger position to host international events. The new station also acts as a key node on regional rail services and local transit. Furthermore, because the station is less than one kilometre from the centre of the city, and linked by bridges, it is able to complement the more traditional activities based there.

C1.2.8 Quantification

Very little quantification has been carried out in this area although the following projects were evaluated ex-post:

- TGV Sud-Est (Paris-Lyon) – Bonnafous (1987);
- AVE (Madrid-Seville) – de Rus and Inglada (1997); and
- Japanese Shinkansen – Banister and Berechman (2000).

The ex-post evaluations show increases in commercial activity, and hence land values around some, but by no means all, high speed rail stations. For example between 1983 and 1990, there was a 43% increase in office space around Lyon Part-Dieu station; whilst in Japan land values in commercial areas rose by 67% with a Shinkansen station (Nakamura and Ueda, 1989). However, it is recognised that these measures may reflect displacement of activity from elsewhere and should not be interpreted as being indicative of net growth.

C1.3 High Speed One

The table below summarises the economic impacts of High Speed One estimated in a recent evaluation by Volterra and Colin Buchanan.

Table C1: Economic impacts of HS1

	£bn
Transport benefits	3.8
Wider Economic benefits	3.8
Regeneration benefits	10.0
Total benefits (PV over 60yrs)	17.6

The transport benefits were primarily time savings and the wider economic benefits (WEBs) were split almost evenly between move-to-more-productive-jobs and pure agglomeration benefits. As with all transport evaluations, it should be noted that WEBs are completely additional to standard transport user benefits, hence the addition of the benefits in the table above. It should also be noted that the domestic services are expected to be used significantly for commuting purposes, making the incentives, drivers and benefits of the scheme quite different in some ways from other proposed HSR lines.

However, HS1 is also credited with significant regeneration impacts. It has enabled the delivery of three major development schemes in Ebbsfleet, Stratford and Kings' Cross. Those schemes will significantly impact on three regeneration areas with plans for over 15,000 homes and 70,000 jobs resulting in quantifiable residential spending and output, summarised in the table below.

Table C2: Regeneration impacts of HS1

	King's Cross	Stratford	Ebbsfleet	Eastern Quarry
Permanent jobs	22,100	34,000	24,000	7,200
GDP per annum	£1.3bn	£1.8bn	£1bn	£275m
Homes	2,000	Up to 5,500	2,100	6,250
Household spending per annum	£50m	£140m	£49m	£144m
Temporary jobs during construction (FTE)	2,500	4,000	3,500	

The construction of HS1 provided the justification for rolling back the green belt and previous strategic gap policies in Ebbsfleet Valley where previous planning history was one of strict development restraint. Without HS1 it is very unlikely that development of this quantum would have been permitted at Ebbsfleet.

Similarly, in Newham (home to Stratford), the planned jobs created at the development will be three times the growth seen in the area in the last 15 years. These comparisons show the extent of the growth enabled by these developments.

It is difficult to quantify the extent to which any of this growth is additional. The DfT's approach is to assume that this growth would have otherwise occurred elsewhere and therefore a benefit cannot be claimed. However, if it is the case that a constraint exists which may have prevented this growth from occurring then it must be the case that some value should be attributed to delivery of this growth.

Such a constraint might be, for instance, the lack of easily available and attractive locations that would encourage businesses to expand or start up when they might otherwise not have done so. They could also attract investment that might otherwise have taken locations outside of the UK. This is particularly true in locations with easy access to other countries which is (by definition) true of the study area.

If just five per cent of the impacts are viewed to be completely additional then this would generate over £200m of additional GDP per annum. This results in a PV over 60 years of £10bn. It does not seem unreasonable that at least five per cent of this growth could be completely additional and HS1 was fundamental in the availability of these particular sites for development.

Other regeneration benefits quantified by the assessment included:

- The value of the housing stock in the study area may increase by around £1.3bn, representing a capitalised value of HS1 benefits to current residents; and
- Earnings per annum across the study area may increase by between £62m and £360m due to the commuting facilitated by HS1.