East Midlands Councils

HS2 Direct Connections Study

Outline Business Case

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Executive Summary

Background

This report, commissioned by the East Midlands Councils and five transport authorities, provides an independent assessment of the potential to provide direct access to the proposed HS2 network from Nottingham, Leicester and Derby.

The East Midlands Councils are seeking to gain the maximum possible benefits from the construction of HS2. The study will be used by the Three Cities to help prepare their response to HS2 as part of the Consultation on the Phase 2 route.

Objectives

This study has undertaken three strands of analysis in relation to direct connections to the proposed HS2 network. It has examined the economic development case, the transport benefits and practical engineering solutions.

The work should be read alongside other published work that forms the evidence base for HS2.

Other analysis on maximising the economic benefits of the East Midlands HS2 station at Toton has also been undertaken concurrently by Volterra[1]. The Volterra study examines the broad range of economic benefits potentially generated by the proposed HS2 station at Toton. In contrast, this report is focussed on establishing the economic principle for establishing direct connections to HS2, the resulting transport implications and identifying a practical and cost effective engineering solution.

Maximising the economic potential of the proposed HS2 network is a goal of both Government and the East Midlands Councils.

In practical terms, this means utilising local intelligence to inform the case for specific connections and to ensure that economic benefits are distributed widely. Concurrently, in ensuring the right connectivity is in place there is a need to ensure the cost effectiveness of solutions.

The critical role of direct classic connections

The proposed HS2 network has the potential to provide a substantial positive stimulus to economic development and regeneration in the East Midlands.

The development of critical infrastructure such as the proposed HS2 network has the potential to boost regional competitiveness; in turn this supports economic growth and other important aspects of economic development including social inclusion, health and wellbeing. From the perspective of UK plc, this is important in achieving economic rebalancing of the national economy.

It is clear from the existing body of evidence on HS2 that the East Midlands has the potential to achieve some of the strongest gains of any region when examining regional economic impacts. This is a substantial opportunity but

[1] 'Maximising the Economic Benefits of the East Midlands HS2 Station at Toton' Draft Final Report, Volterra for Nottingham City Council and partners (November 2013).

as is acknowledged in the regional impacts work by KMPG achieving it will be subject to a number of constraints.

The analysis has therefore explored the nature of these constraints and the potential role of direct connections to the proposed HS2 network from key city centres in reducing these constraints.

Whilst the current proposals do not include direct connections to cities in the East Midlands, classic capability could be particularly important in connecting up key centres of economic activity in the East Midlands and realising the potential catalytic regeneration benefits of HS2.

The proposed new station at Toton offers the potential to stimulate substantial economic benefits and growth across the region[2]. The quality of connectivity to the major economic centres in the East Midlands of Nottingham, Derby and Leicester will be crucial in realising this economic potential.

A key part of the multi-agency policy in developing the region is the bringing together of the East Midlands' cities which are the locations of the majority of its economic activity. In this way, they will function more effectively as one economic unit with associated benefits in economic output and productivity.

The analysis indicates that there is a strong economic imperative to ensure that the full potential benefits of this opportunity are therefore realised. The economic analysis undertaken has established that in principle there is a case for direct connections to the proposed HS2 network from the key centres of economic activity in the East Midlands. The city centre areas of Nottingham, Leicester and Derby are the economic centres of activity whose growth together as one economic unit must be supported.

The findings of the transport modelling exercise have demonstrated high levels of additional demand through provision of direct classic connections.

The results of the transport analysis show the strongest demand flows on the following routes:

- Nottingham to Birmingham;
- Nottingham to Leeds;
- Leicester to Leeds;
- Derby to Leeds.

These routes are very important in the context of the further development of the key functional economic relationships that will enable the East Midlands economy to achieve sustainable economic growth.

[2] See 'High Speed Two (HS2) Limited – HS2 Regional Economic Impacts', KPMG for HS2 Limited (September 2013) and Maximising the Economic Benefits of the East Midlands HS2 Station at Toton' Draft Final Report, Volterra for Nottingham City Council and partners (November 2013).

In particular, the analysis shows a substantial reduction in the Nottingham to Birmingham journey time and an increase in the total number of Nottingham-Birmingham journeys from 1,300 to in excess of 5,000.

These direct connections are expected to fulfil a critical role in enabling the significant potential regional economic benefits identified of £1.1 billion to £2.2 billion per year in Derby-Nottingham to be fully realised. This is equivalent to between a 2.2% and 4.3% increase in total local economic output in 2037.

Practical engineering solutions

This study has also identified practical and cost effective engineering solutions that would enable the provision of direct classic connections.

The analysis suggests that provision of a set of classic compatible connections would be simple to implement. These connections would allow classic compatible trains to run on and off the HS2 network to stations at Derby, Leicester and Nottingham. Provision of the chord at Trowell would allow trains to run through from Nottingham and Birmingham without turnback, provision of a chord through Attenborough would allow potential connectivity to the significant enterprise zones within Nottingham and Birmingham.

The indicative construction cost for the East Midlands Hub Station connections and Trowell chord is estimated at approximately £278 million.

Recommendation

The importance of the direct classic connections to achieving the economic development potential of the proposed HS2 network in the East Midlands is expected to far outweigh the associated costs of the engineering requirements.

A strong recommendation is therefore made to explore the potential for provision of direct connections to the HS2 network from the East Midlands in more detail.

1 Introduction

1.1 Purpose of this report

Arup have been commissioned by the East Midlands Councils to prepare a report to provide an independent assessment of the potential to provide direct access to HS2 from Nottingham, Leicester and Derby. The East Midlands Councils are seeking to gain the maximum possible benefits from the construction of HS2. The study will be used by the Three Cities to help prepare their response to HS2 as part of the Consultation on the Phase 2 route.

This report undertakes three strands of analysis in relation to direct connections to HS2:

- The economic development case
- Transport modelling of the benefits
- Practical engineering solutions and indicative costs

The work should be read alongside other published work that forms the evidence base for HS2. Other analysis on maximising the economic benefits of the East Midlands HS2 station at Toton has also been undertaken concurrently by Volterra[3]. The Volterra study examines the broad range of economic benefits potentially generated by the proposed HS2 station at Toton. In contrast, this report is focussed on establishing the economic principle for establishing direct connections to HS2, the resulting transport implications and identifying a practical and cost effective engineering solution. The latter aspect has been a core part of the study, ensuring that the following key questions are addressed:

1. Can the HS2 proposed layout be modified to provide direct connectivity into the key East Midlands cities of Derby, Leicester and Nottingham?
2. Is there opportunity to provide classic rail connectivity in or around the proposed East Midlands Hub Station and at Killamarsh?

1.2 Structure

The remainder of this report is structured as follows:

Section 2 – sets out the **economic development case** for direct connection to HS2 from the East Midlands;

Sections 3 and 4 – reports on the results of the **transport modelling** to understand the implications in terms of demand levels and journey times and the results of the high level economic appraisal;

Sections 5-7 – outlines potential **engineering solutions** that have been explored along with indicative costs; and

Section 8- summarises the **main conclusions and recommendations** arising from the analysis.

[3] 'Maximising the Economic Benefits of the East Midlands HS2 Station at Toton' Draft Final Report, Volterra for Nottingham City Council and partners (November 2013).

2 The Economic Development Case

2.1 Overview

This section examines the economic development case for direct connection to the proposed HS2 network from the East Midlands; serving the key city centres of Nottingham, Leicester and Derby.

The proposed HS2 network has the potential to provide a substantial positive stimulus to economic development in the East Midlands. Achieving sustainable economic development in the East Midlands is important in raising the standard of living and economic prosperity of the area. The development of critical infrastructure such as the proposed HS2 network has the potential to boost regional competitiveness; in turn this supports economic growth and other important aspects of economic development including social inclusion, health and wellbeing. From the perspective of UK plc, this is important in achieving economic rebalancing of the national economy.

There is a strong economic imperative to ensure that the full potential benefits of this opportunity are therefore realised. The connection from the proposed HS2 network into major centres of economic activity is vital in this respect.

The purpose of the economic analysis undertaken in this study is to establish whether, in principle, there is an economic case for providing direct connections to the proposed HS2 network from the key centres of economic activity in the East Midlands. The objective is to provide a high level analysis of the indicative economic development benefits that could be generated. The assessment is not intended to provide a detailed analysis of all economic impacts but instead to determine whether the expected magnitude of these impacts is sufficient to warrant further investigation and review on behalf of HS2 Ltd.

In ensuring value for money, the estimated economic development benefits must be weighed against the additional costs of providing the direct connections. An analysis of potential engineering solutions and indicative costs has been undertaken by engineers and is outlined in subsequent sections. The economic analysis is undertaken with reference to this evidence.

2.2 The economic case for HS2

There is a substantive and evolving evidence base on the economic case for the proposed HS2 network.

For the purposes of this study, the most recent report published by HS2 Ltd on the economic case[4] and the separate analysis commissioned by HS2 Ltd on regional economic impacts[5] are the most relevant.

[4] 'The Economic Case for HS2', DfT for HS2 Limited (October 2013).
[5] 'High Speed Two (HS2) Limited – HS2 Regional Economic Impacts', KPMG for HS2 Limited (September 2013).

The most recent DfT report on the economic case is the first substantive update to its analysis since January 2012 and constitutes the current view on the strength of the economic case for the HS2 network. This new analysis has benefited from a comprehensive programme of work to further enhance the analytical tools deployed.

The report reaches three main conclusions:

- The standard cost-benefit analysis shows that the benefits of the HS2 network exceed the costs by a considerable margin and that under standard assumptions the economic cases for both phases of the project are robust and are resilient to a wide range of factors and events;
- Standard assumptions on the demand cap and the value of time (VoT) in the appraisal fail to capture large amounts of potential additional benefits from HS2. There is a significant chance that the return on investment in HS2 could be considerably higher than previous appraisals have suggested;
- **HS2 has the potential to deliver productivity gains that will alter geographic distribution of economic activity** in a way that cannot be modelled in DfT's economic appraisal.

It is the third of these conclusions that is particularly significant in the context of considering the case for direct connection to the proposed HS2 network from key city centres in the East Midlands.

The DfT analysis demonstrates that investment in HS2 offers strong returns that are resilient to a broad range of eventualities and risks around costs, demand growth and the performance of the economy. This analysis is in accordance with the DfT guidance on cost benefit analysis in order to provide a basis for comparison with alternative options and proposals. However, as explicitly recognised in the report, when drawing comparisons with other schemes it is important to recognise that this form of economic appraisal may not fully capture the full range of potential benefits from investment in a transformational scheme such as HS2.

HS2 will lead to greater opportunities for businesses and people in one area to connect with businesses and people in other areas. This applies to city regions benefitting directly from HS2 services and to areas which benefit from released capacity. Increased opportunities to connect with others make these areas more attractive places for businesses and people to locate. It is likely that people and businesses would take these new opportunities into account in their location decisions, and that this could ultimately lead to changes in future patterns of land use.

The potential for the impacts on the redistribution of economic activity spatially to be significant has been recognised by DfT and HS2 Limited and underpinned their commissioning of a specialist report on regional economic impacts[6].

The regional impact analysis, considers the impact that investment in HS2 would have on economic output by understanding how such investment would influence regional economic performance, both in terms of overall economic productivity and, crucially, the location of economic activity. The results suggest that HS2

[6] 'High Speed Two (HS2) Limited – HS2 Regional Economic Impacts', KPMG for HS2 Limited (September 2013).

could boost the UK economy by as much as £15bn per year and that the UK regions outside London will experience the largest positive gains in this respect.

The results indicate that the East Midlands in particular will experience some of the strongest benefits due to improved business productivity; significantly improving its competitive position. **The estimated benefit in Derby-Nottingham is in the range of £1.1 billion to £2.2 billion per year; equivalent to between a 2.2% and 4.3% increase in total local economic output in 2037.**

This regional economic impact analysis is early work but suggests that there may be additional benefits from HS2 that are not being captured in the economic appraisal. In recognition of this, DfT has recommended that further work is done to consider whether the standard approach to appraisal can be developed further to capture a fuller integrated understanding of these impacts on economic geography.

What is clear is that the East Midlands has the potential to achieve some of the strongest gains of any region when examining regional economic impacts. This is a substantial opportunity but as is acknowledged in the regional impacts work achieving it will be subject to a number of constraints. The following sections explore the nature of these constraints and the potential role of direct connections to the proposed HS2 network from key city centres in reducing these constraints.

2.3 HS2 and classic compatibility

There will be two different types of train in operation on the proposed HS2 network.

Classic compatible trains will be designed to be capable of using both high-speed track and the current rail network. This will allow direct services to run from London to cities north of Birmingham after completion of Phase One, and north of Leeds and Manchester after the completion of the full network. These services will gain a time saving for the part of the journey that is on high-speed track and then run at conventional speed on the classic track.

Figure 1 shows the current HS2 phase two proposal including proposed classic compatible services. This shows that classic compatible connections are planned for a number of cities. There are no planned direct connections to cities in the East Midlands however.

Whilst the current proposals do not include direct connections to cities in the East Midlands, classic capability could be particularly important in connecting up key centres of economic activity in the East Midlands and realising the potential catalytic regeneration benefits of HS2. **The proposed new station at Toton offers the potential to stimulate substantial economic benefits and growth across the region[7]. The quality of connectivity to the major economic centres in the East Midlands of Nottingham, Derby and Leicester will be crucial in realising this economic potential.**

[7] See 'High Speed Two (HS2) Limited – HS2 Regional Economic Impacts', KPMG for HS2 Limited (September 2013) and Maximising the Economic Benefits of the East Midlands HS2 Station at Toton' Draft Final Report, Volterra for Nottingham City Council and partners (November 2013).

The importance of ensuring that the towns and cities in the Midlands and the North that do not have an HS2 station, have the local connectivity so that they are still able to benefit from the new network is recognised in the HS2 Phase Two Consultation document. Further views on the connectivity offered to ensure that the benefits of HS2 are spread as widely as possible were therefore requested.

The findings of analysis presented in the remainder of this report support the case for including direct connections to the Nottingham, Derby and Leicester; based on the potential scale of wider regeneration whilst recognising the need for cost effectiveness.

Figure 2.1: Proposed HS2 network and connections



Source: HS2 Phase Two Route Consultation.

2.4 The role of classic compatible services in driving economic development in the East Midlands

2.4.1 Key drivers of economic development

Understanding the drivers of economic development in the East Midlands is crucial in understanding the potential enabling role of direct connections to the proposed HS2 network.

The Heseltine Review[8] emphasised the importance of infrastructure in unlocking economic growth and the strategic leadership role the Local Enterprise Partnerships and Local Authorities can play in facilitating sustainable growth. The D2N2 Strategy for Growth[9] reaffirmed the importance of providing "effective infrastructure" to maximise the economic benefits from major investment such as HS2.

In addition to the strategic governance and partnership established to drive growth and prosperity in the sub-region, there are a number of other key economic drivers, business needs and constraints which will need to be addressed in an integrated way if economic success is to be realised. The HS2 proposition would provide the economic stimulus to improve the competitiveness of the sub-region, promote more effective integration of business plan priorities leading to a better quality of life for all. These priorities are:

- Improved inter and intra-connectivity;
- High levels of employment and a growing work force (characteristics of successful economies);
- Driving force of technology and innovation;
- High value added industries e.g. advanced manufacturing;
- Diversified economy;
- Strong University sector with close collaboration with business; R & D;
- Ability to meet the high level skills demanded by business and the need to address basic skills to provide "skills and employment pathways";
- Sub-regional disparities in economic performance, wealth and deprivation;
- Imbalances in the housing market;
- Demographic change;
- Availability of land and premises; and
- The growing importance of international trade and investment.

The emerging Aligned Core Strategy sets out a number of strategic priorities in line with national planning guidance including:

- **Economic Prosperity for all** – which aims to support economic growth, creating the conditions for participation in the labour market and encouraging enterprise;

[8] 'No stone unturned: in pursuit of growth – Lord Heseltine Review' The Rt Hon the Lord Heseltine of Thenford CH, BIS (October 2012).
[9] 'Strategy for Growth 2013-2023', D2N2 LEP (2013).

- **High Quality Housing** – to manage increases in housing supply, in meeting housing needs and to provide access to affordable homes;
- **Environmentally responsible development** – to minimise climate change impacts from development;
- **Regeneration** – to ensure brownfield land regeneration opportunities are maximised and enhances opportunities for local communities;
- **Excellent transport systems** - reducing the need to travel including access to jobs, leisure and services; and
- **Timely and viable infrastructure** – to support housing and more sustainable economic growth.

The emerging Spatial Strategy aims to support economic growth and recognised the complex relationship between housing, well-being and the economy and echoes the principles articulated in the Heseltine Review.

Many of the key economic drivers identified are further enabled by transport connectivity across the East Midlands economy and to outside where key economic relationships exist.

The spatial economic geography of the East Midlands is also highly significant in determining appropriate measures that can enable it to achieve sustainable economic growth.

More than 800,000 people live in the three cities of Nottingham, Derby and Leicester[10]. Cities are major employment areas which have a wider role than acting as an administrative and governance centres – they are infrastructure 'hubs' and also centres of tradable services, a role which is increasing in importance in respect of exports and trade. Universities, major hospitals and other public services are located there and cultural and leisure activities are substantial and increasing in importance. Highly skilled workers for example tend to be more mobile and will remain in city locations as long as there is a good quality of life offer including housing, education, health, transport as well as sufficient financial rewards. Importantly, cities are the gateways for business visitors and tourists and inward investment.

Whilst the economy appears to be recovering, it remains fragile. Professional services will continue to hold strong potential for employment growth and the improvements in the infrastructure within and between cities and major towns will improve the competitive offer of the sub-region. It is clear that the global threat to the UK's position and to cities such as Nottingham, Derby and Leicester is real.

Any reduction in competitiveness from policy inaction or failure to grasp investment opportunities which improve the competitive position of the sub-region will have a greater impact than before.

The implementation of the proposed HS2 network has the potential to be an engine for growth in the East Midlands. The co-ordination of the multi-agency response and the alignment of priorities grasp strategic and local issues and opportunities will be essential however if the potential impacts from the HS2 investment are to be maximised and the future prosperity of the sub-region secured.

[10] Office for National Statistics data.

A key part of the multi-agency policy in developing the region is the bringing together of the East Midlands' cities which are the locations of the majority of its economic activity. In this way, they will function more effectively as one economic unit with associated benefits in economic output and productivity. The following sections explore the potential role of direct connections to the proposed HS2 network in supporting this objective.

2.5 Benefits of classic compatible services

A key tenet of the rationale for proposed HS2 East Midlands Hub station is the extent to which it could be readily accessible by public transport from Derby, Nottingham and Leicester and the much wider East Midlands region. In this way, the station at Toton can act as a hub through which to distribute the economic benefits of the proposed HS2 network across cities of the East Midlands.

Strong public transport connectivity from the proposed HS2 East Midlands Hub to the key economic centres of Nottingham, Derby and Leicester is therefore critically important. The current proposals do not include direct classic compatible connections to these centres. This means that passengers travelling on HS2 to/from these centres would need to interchange onto alternative public transport or use a private vehicle. Consequently, the journey time savings of the proposed HS2 network to these passengers will be eroded. In particular, this could have a significant impact on the perception of travellers. **The implication is that the substantial potential regional economic benefits in the East Midlands may not be fully realised without the provision of direct classic compatible connections.**

A transport modelling exercise (reported in Section 3) has been undertaken to establish the benefits that could be derived from direct classic compatible connections.

The likely demand uplift that could result from providing direct connections from the three cities to key UK city regions (Manchester, Liverpool, Leeds, Sheffield, York, Edinburgh, Durham, Birmingham and Newcastle) has been calculated in a bespoke demand model. This demand model uses the trips forecast in Network Rail's PLANET Long Distance (PLD) model as a base and estimates demand uplift based on the change in generalised journey time (GJT). The change in journey times has been calculated by using a standard average speed of 80mph for the classic rail network and 165mph for the high-speed network. The analysis has also made an allowance for interchange time.

The results of this analysis show that the provision of direct classic compatible connections produces the strongest demand flows on the following routes:

- Nottingham to Birmingham;
- Nottingham to Leeds;
- Leicester to Leeds;
- Derby to Leeds.

See Table in Section 2.7 for journey time splits

These routes are very important in the context of the further development of the key functional economic relationships that will enable the East Midlands economy to achieve sustainable economic growth.

The classic compatible connections would allow classic compatible trains to run on and off the HS2 network to stations at Derby, Leicester and Nottingham to Leeds and the north east of England. The journey time between Leicester and Leeds would be less than 60 minutes and between both Derby and Nottingham and Leeds of less than 50 minutes.

The provision of the chord at Trowell would allow trains to run through from Nottingham and Birmingham without turnback. The chord would allow direct connectivity between Nottingham and Birmingham with a journey time of around than 30 minutes. It would also significantly increase connectivity between Lincoln, Newark and Birmingham.

The scale of latent demand for these journeys is substantial and supportive of significant long-term economic benefits.

2.6 Maximising the economic potential of HS2

Maximising the economic potential of the proposed HS2 network is a goal of both government and the East Midlands Councils. In practical terms, this means utilising local intelligence in informing the case for specific connections to ensure that economic benefits are distributed widely. Concurrently, in ensuring the right connectivity is in place there is a need to ensure the cost effectiveness of solutions.

The transport modelling analysis has demonstrated the significant journey time benefits expected to be derived from the provision of direct classic connections to the proposed HS2 network from the East Midlands cities. These journey time saving and associated implications for traveller demand mean that the enhanced connectivity enabled by classic compatible services could be important in reducing the constraints on the achieving the full benefits of HS2.

Strong public transport connectivity at East Midlands Hub is central to the additional benefits case for it as a solution - generating additional benefits of £500 million over the next best performing option and additional fare revenues of around £190 million. This connectivity would allow a significant proportion of passengers to access the station making it the best of all the options for serving the East Midlands. As demonstrated by the transport modelling exercise, the provision of direct classic connections is fundamental to the level of this connectivity.

The provision of direct classic connections is central to regeneration and economic rebalancing across the East Midlands.

Prominent factors acting as constraints on the strength of economic development in the East Midlands are the area's skills base and accessibility to sufficient employment opportunities. Better connectivity between the East Midland's cities and to other major UK cities will enhance the area's ability to attract a greater number of high-skilled employment opportunities. In turn, a virtuous circle can then be supported; as these opportunities benefit local residents who can up-skill and highly skilled workers from outside, both contributing to an increase in productivity and output. For example, the reduction in journey times to other

cities such as Birmingham will have a significant impact on the locational decisions of both firms and workers. Over time this will mean a different pattern in the investment decisions of businesses and where workers choose to live.

In this way, **connectivity will work to maximise the impact and outcomes of interventions by local authorities and LEPs to tackle deprivation and skills issues across the East Midlands.**

These impact mechanisms are consistent with the findings of other analysis on maximising the economic benefits of the East Midlands HS2 station at Toton undertaken by Volterra[11]. In particular, in relation to the need to increase labour mobility and the close dependent relationship of districts surrounding Derby and Nottingham to the two cities in terms of their economic performance and future prosperity.

Without the classic connections there is a risk that the level of benefits identified in the regional economic benefits analysis undertaken by will not be fully realised. The regional economic benefits analysis demonstrates the substantial magnitude of the positive impact that increases in labour and business connectivity could have on the East Midlands economy. **Direct connections will fulfil a critical role in enabling the significant potential regional economic benefits identified of £1.1 billion to £2.2 billion per year in Derby-Nottingham**. This is equivalent to between a 2.2% and 4.3% increase in total local economic output in 2037 and would be a real missed opportunity for the long terms economic development of the East Midlands.

2.7 Summary

The proposed HS2 network has the potential to provide a substantial positive stimulus to economic development in the East Midlands.

The development of critical infrastructure such as the proposed HS2 network has the potential to boost regional competitiveness; in turn this supports economic growth and other important aspects of economic development including social inclusion, health and wellbeing. From the perspective of UK plc, this is important in achieving economic rebalancing of the national economy.

There is a strong economic imperative to ensure that the full potential benefits of this opportunity are therefore realised. The economic analysis undertaken has established that in principle there is a case for direct connections to the proposed HS2 network from the key centres of economic activity in the East Midlands. The city centre areas of Nottingham, Leicester and Derby are the economic centres of activity whose growth together as one economic unit must be supported.

Transport modelling of the provision of direct classic connections from the proposed HS2 network to these centres projects substantial increases in demand arising out of significant journey time benefits of classic services. The results demonstrate the scale of latent demand between cities across the midlands and north, in particular between Nottingham and Birmingham.

The results of regional economy impact analysis published by HS2 Limited indicate that the East Midlands in particular has the potential to experience some

[11] 'Maximising the Economic Benefits of the East Midlands HS2 Station at Toton' Draft Final Report, Volterra for Nottingham City Council and partners (November 2013).

of the strongest benefits due to improved business productivity; significantly improving its competitive position.

The findings of the transport modelling exercise have demonstrated high levels of additional demand through provision of direct classic connections.

The following table shows the suggested journey time split for the key journeys

	Travel Time (mins)
Nottingham -> Toton	12
Toton -> Birmingham	19
Leicester -> Toton	25
Toton -> Leeds	33
Derby -> Killamarsh	26
Killamarsh -> Leeds	18
Nottingham -> Toton	12
Toton -> Leeds	33

These connections are expected to fulfil a critical role in enabling the significant potential regional economic benefits identified of £1.1 billion to £2.2 billion per year in Derby-Nottingham to be fully realised. This is equivalent to between a 2.2% and 4.3% increase in total local economic output in 2037. These connections add to the overall business case for HS2 in maximising its economic benefit, particularly in terms of realising potential regional economic growth.

The following sections outline the findings of the transport modelling and engineering design of solutions that would enable classic connections to support the economic development benefits identified.

3 Transport Modelling of Direct Connections

3.1 Overview

Demand forecasts for trips from Derby, Nottingham and Leicester have been produced and compared with the current demand. This section outlines the methodology employed to perform the demand assessment and the key results.

3.2 Methodology

In addition to the three cities the key cities we have used within the assessment are Manchester, Liverpool, Leeds, Sheffield, York, Edinburgh, Durham, Birmingham and Newcastle. Some of these will be provided with direct access to the three cities, others will have enhanced connections via interchange at Leeds, Meadowhall or Birmingham.

The PLANET Long Distance (PLD) model has been developed as a tool to forecast the demand and benefits of HS2, respecting longer-distance (over 50 miles) domestic travel by road, rail, air and high speed rail. A detailed demand forecast has been produced for HS2 Ltd using the PLANET Long distance (PLD) model. The forecasts from the PLANET Long Distance model have been used in this study to inform the base demand position. The base year is 2010-11; these figures have been grown by 78% to estimate for the year 2033, as assumed by HS2 in their demand forecasts.

The proposed services patterns are:

- Nottingham – East Midlands Hub Station – Birmingham;
- Nottingham - East Midlands Hub Station – Sheffield Meadowhall – Leeds – York – North East;
- Leicester – East Midlands Hub Station – Sheffield Meadowhall – Leeds;
- Derby – Sheffield Meadowhall – Leeds;

A Generalised Journey Time (GJT) approach has been used to forecast the new demand. The change in GJTs as a result of providing a new direct connection from the city centres to key cities via the HS2 alignment has been examined.

The Base GJTs are based on existing rail services' journey times. The HS2 GJTs consist of the following elements: The journey time from the East Midlands city to the HS2 track calculated using current speeds for a standard train along conventional track. The journey time along HS2 track calculated using anticipated HS2 speeds and the journey times from leaving the HS2 track for the remainder of the journey using existing service journey times. Where appropriate interchange time has also been included. The journey times do not consider potential future line improvements, such as electrification and replacement of rolling stock.

Elasticities from the Passenger Demand Forecasting Handbook (PDFH) have been used to examine how this change in generalised journey time will affect demand. A standard elasticity recommended in PDFH of -0.9 has been applied. However it has been recognised that that the elasticities from PDFH may not fully represent the demand uplift that can be expected from transformational journey time

improvements, therefore for changes greater than 10% a higher elasticity of -1.5 was applied[12].

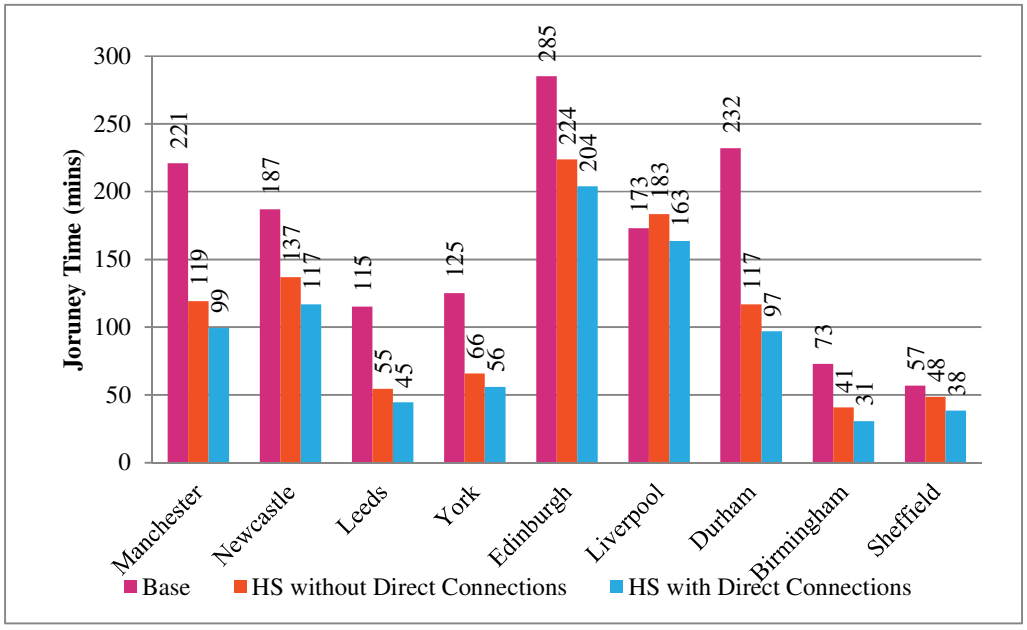
The uplift in demand was applied to the Base Demand data to produce the new demand estimates for each service option.

3.3 Results

3.3.1 Generalised Journey Times

Figures 2, 3 and 4 compare the current rail GJTs with the HS2 estimated GJTs for Nottingham, Leicester and Derby respectively.

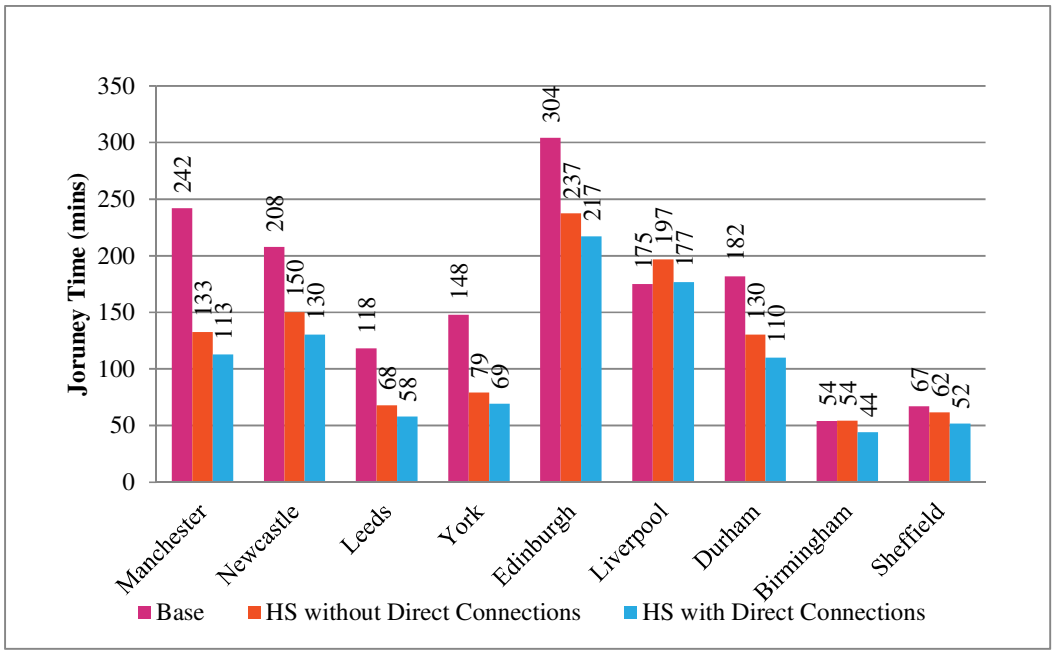
Figure 2: Nottingham GJTs current and HS2 scenario



Journey times decrease for most destinations with the introduction of HS2 and then decrease even more with a direct connection. The journey time between Nottingham and Leeds and areas with direct connections from Leeds such as Durham and Manchester experience the greatest decrease in journey times. This is because current connections to these areas are via a slow service and interchange at either Sheffield or Leeds.

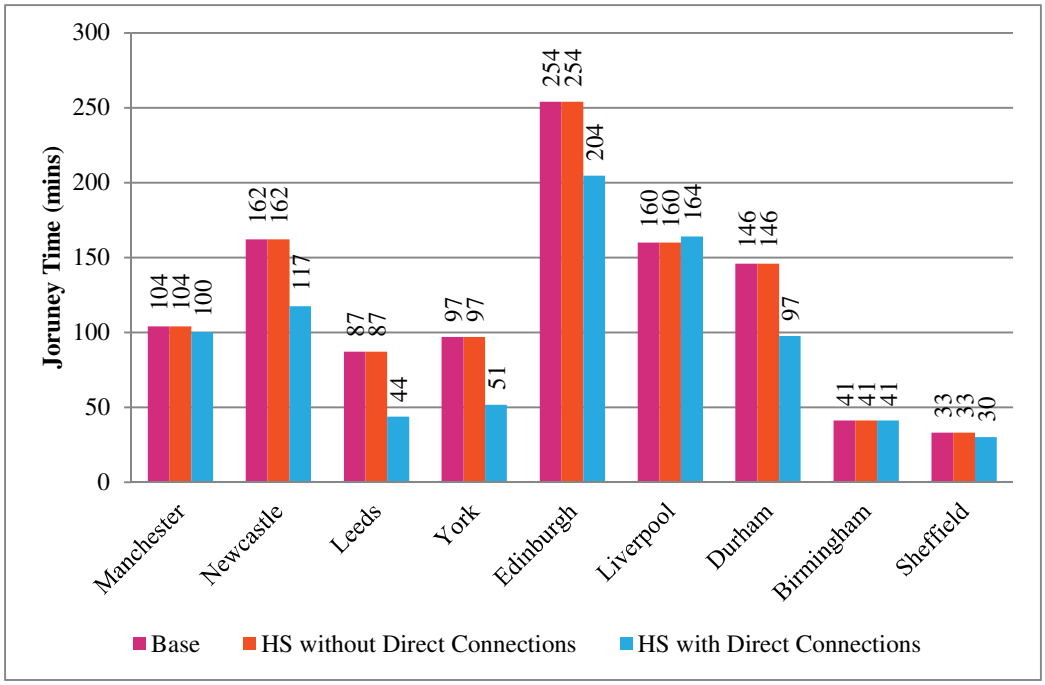
[12] See The Impact of Large Changes in Generalised Journey Time on Rail Passenger Demand (2012), ITS University of Leeds and Mott Macdonald. An elasticity towards the top end of the estimate was used to reflect the truly transformational nature of HS2.

Figure 3: Leicester GJTs current and HS2 scenario



The reduction in journey times from Leicester shows a similar pattern to Nottingham. The greatest reduction is to Leeds and destinations beyond as no direct connection currently exists.

Figure 4: Derby GJTs current and HS2 scenario



Journey times for the base case scenario and the high speed without a direct connection scenario are generally the same. This is because a without the direct connection at Killamarsh it will still be most appropriate for passengers to use existing classic services to their final destinations. The provision of the new connection at Killamarsh would result in most journey times decreasing from the base case.

Journey times will decrease for most of the trips considered as a result of the proposed connections to HS2. The journey times for Nottingham experience the greatest decrease, this is because it is close to the HS2 track and will therefore only travel 11km on conventional track before benefitting from HS2 speeds. Leicester trains will travel 36 km along the existing Midland Main Line before joining the HS2 track. Derby experiences the smallest GJT decrease, this is because the Killamarsh connection is close to Sheffield, and the trains will only travel short distance on the HS2 track, limiting the benefits gained.

3.3.2 Demand

Figures 5, 6 and 7 compare the current demand with the predicted demand under the HS2 scenario for Nottingham, Leicester and Derby respectively.

Figure 5: Demand under base scenario and HS2 Scenario - Nottingham

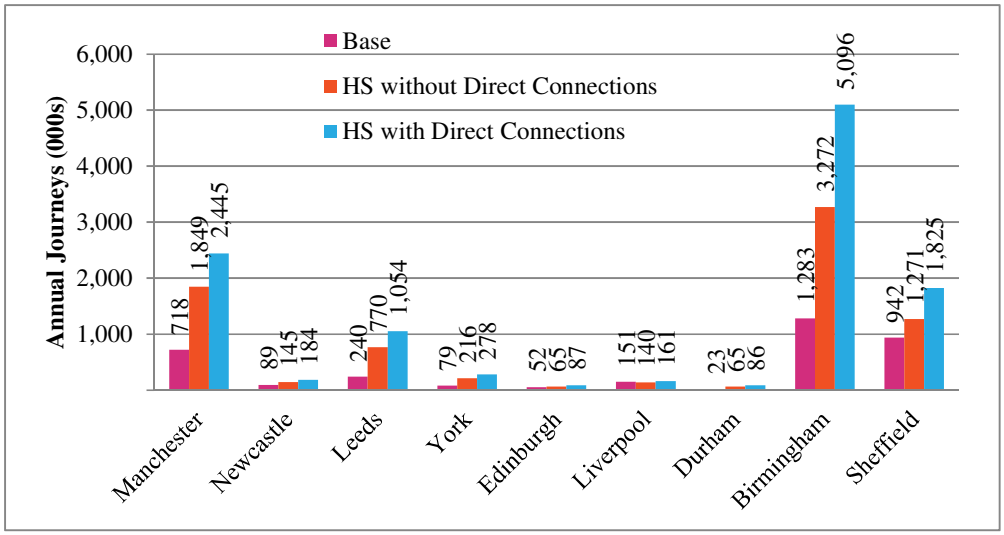


Figure 6: Demand under base scenario and HS2 Scenario - Leicester

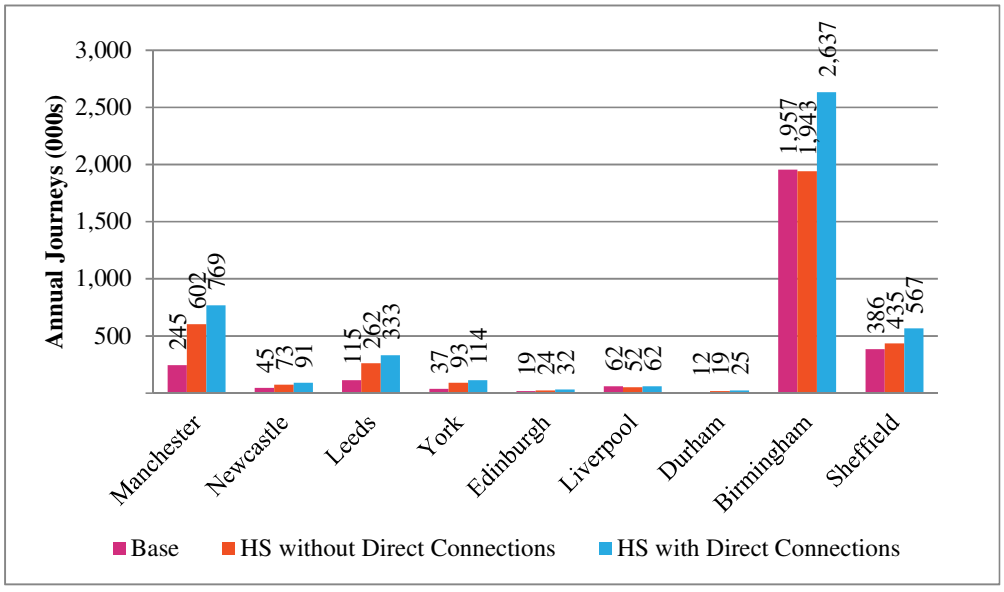
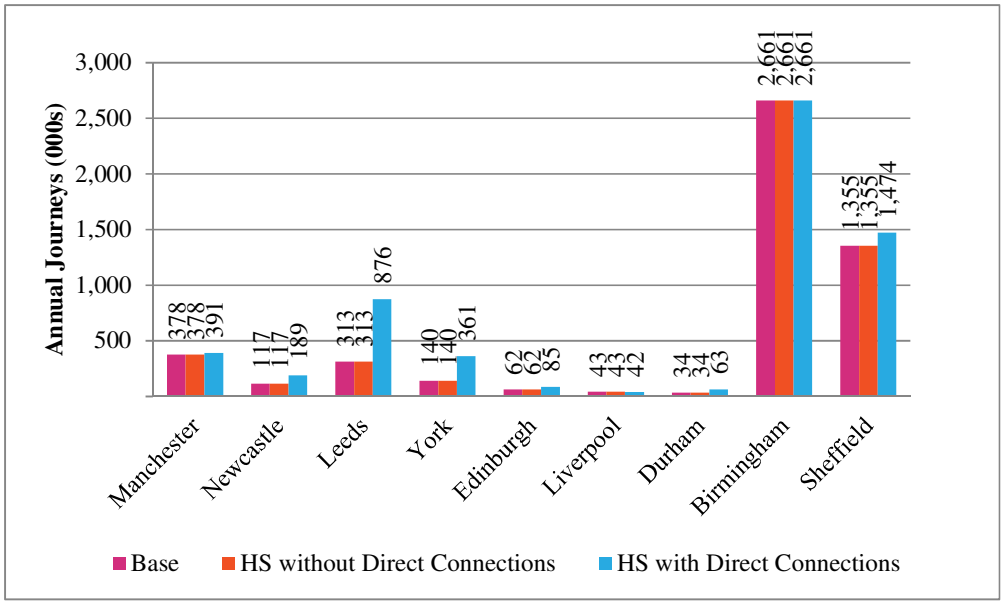


Figure 7: Demand under base scenario and HS2 Scenario – Derby



The demand model suggests that demand will increase significantly for a number of the origin destination pairs considered. The greatest uplifts in demand are as follows:

- Nottingham – Birmingham;
- Nottingham – Leeds;
- Leicester – Leeds;
- Derby – Leeds.

3.4 Summary

Connecting the three East Midlands Cities to the HS2 network will result in significant journey time savings and will therefore result in a substantial increase in demand for the journeys considered within this report.

Nottingham and Leicester will experience the greatest benefits in terms of GJTs to Birmingham and key northern cities such as Leeds, Sheffield, Manchester and the North East.

4 High Level Economic Appraisal

4.1 Introduction

This section provides the results and assumptions behind a high-level economic appraisal of the three proposals [classic compatible connections at East Midlands Hub Station and Killamarsh and a chord at Trowell]. It should be noted that the purpose of this appraisal is to provide an indication of the likely benefits and further, more-detailed assessment work will be required to obtain a clearer picture of the economic rationale of each of the schemes.

4.2 Economic Appraisal

4.2.1 Capital Costs

The capital costs as stated in the main Arup report are:

- East Midlands Hub Station classic connections: £3m;
- Trowel chord: £275m;
- Killamarsh classic connection: £9m.

As per WebTAG guidance, optimism bias has been applied to these costs. The GRIP2 (initial feasibility) level of optimism bias (50%) has been assumed. The costs have also been treated in accordance with WebTAG guidance in terms of inflation and discounting which results in the following costs at outurn:

- Classic connections: £3.4m;
- Trowell chord: £319m;
- Killamarsh connection: £10.4m.

4.2.2 Revenue Benefits

The initial stage of the study identified the changes in demand that would occur over and above the do-minimum if direct connections were provided. This passenger demand has been combined with an average yield (average fare per passenger) for each of the movements considered in order to calculate the direct revenue benefit of the scheme.

4.2.3 Journey Time Savings

As per the revenue benefits, the demand forecasts developed at stage one have been combined with the journey time savings identified within the stage one study. Values of time from WebTAG have been applied to assess the likely value of journey time savings. WebTAG unit 3.5.6 suggests the following average values of time for rail users: work time - £47.18; commute - £6.46; other - £5.71. Combining these figures with the average journey purpose splits in WebTAG gives a value of time of £13.63.

4.2.4 Decongestion Benefits

Benefits will accrue from mode shift from car. These benefits include accident and environmental benefits. WebTAG Unit 3.9.5 provides a detailed methodology for calculating these benefits based on the reduced car mileage. A standard assumption that 26% of additional demand comes from car has been applied and to the demand from individual flows to calculate the total reduction in car mileage. This has then been applied to calculate the total value of the decongestion benefit as per WebTAG.

4.3 Results

4.3.1 Classic Connections at East Midlands Hub Station

The classic connections at the East Midlands Hub Station is estimated to deliver total benefits of around £709,104 over the 60-year appraisal period, which greatly outweighs the estimated £3,480 capital costs for the scheme. The scheme delivers a net present value of £704 million over 60 years.

Classic Connections Economic Appraisal 60 years (£000s)	
Revenue Benefits	£463,460
Journey Time Savings	£9,767
Decongestion Benefits	£72,237
Total Benefits (exc. Webs)	£545,464
Webs (at 30% multiplier)	£163,639
Total Benefits (Inc. Webs)	**£709,104**
Capital Cost	£3,480
NPV	**£705,624**
BCR	**203.8**

4.3.2 Trowell Chord

The Trowell chord will produce benefits of £355,667 over the 60-year appraisal period, which is in excess of the estimated £318,998 capital costs. Resulting in BCR of 1.1, suggesting that the cost of the scheme outweighs the benefits over 60 years, albeit the benefit is marginal.

Trowell Chord Economic Appraisal 60 years (£000s)	
Revenue Benefits	£234,314
Journey Time Savings	£5,993
Decongestion Benefits	£33,282
Total Benefits (exc. Webs)	£273,590
Webs (at 30% multiplier)	£82,077
Total Benefits (Inc. Webs)	**£355,667**
Capital Cost	£318,998
NPV	**£36,668**
BCR	**1.1**

The analysis shows that the Trowell Chord generates a positive BCR applying a standard transport economic appraisal approach, even without taking into account the strong potential for regional economic rebalancing effects in the East Midlands as identified by KMPG. This DfT type appraisal does not include all the wider economic benefits that could be generated.

4.3.3 Killamarsh Connections

The Killamarsh connections will produce benefits in the region of £422,792 which greatly outweighs the capital cost estimates of £10,440. The scheme delivers a net present value of £412 million over 60 years.

Killamarsh Connection Economic Appraisal 60 years (£000s)	
Revenue Benefits	£285,529
Journey Time Savings	£3,891
Decongestion Benefits	£35,805
Total Benefits (exc. Webs)	£325,225
Webs (at 30% multiplier)	£97,567
Total Benefits (Inc. Webs)	**£422,792**
Capital Cost	£10,440
NPV	**£412,352**
BCR	**40.5**

4.4 Conclusions

The high level economic appraisal performed and outlined within this section suggests that all three pieces of infrastructure will offer value for money over a 60-year appraisal period, each one producing BCRs of over 1. The classic connections at Toton which will allow services from Leicester and Nottingham to the north and the Killamarsh connection which will allow services from Derby to the north offer exceptionally good value for money suggesting both of these pieces of infrastructure will generate much greater benefits than the capital costs incurred over the 60-year appraisal period. The Trowell Chord has a positive but modest BCR of 1.1.

5 The Toton proposal (East Midlands Hub Station, EMHS)

5.1 The current classic rail network

The key Network Rail infrastructure within the East Midlands is shown below:

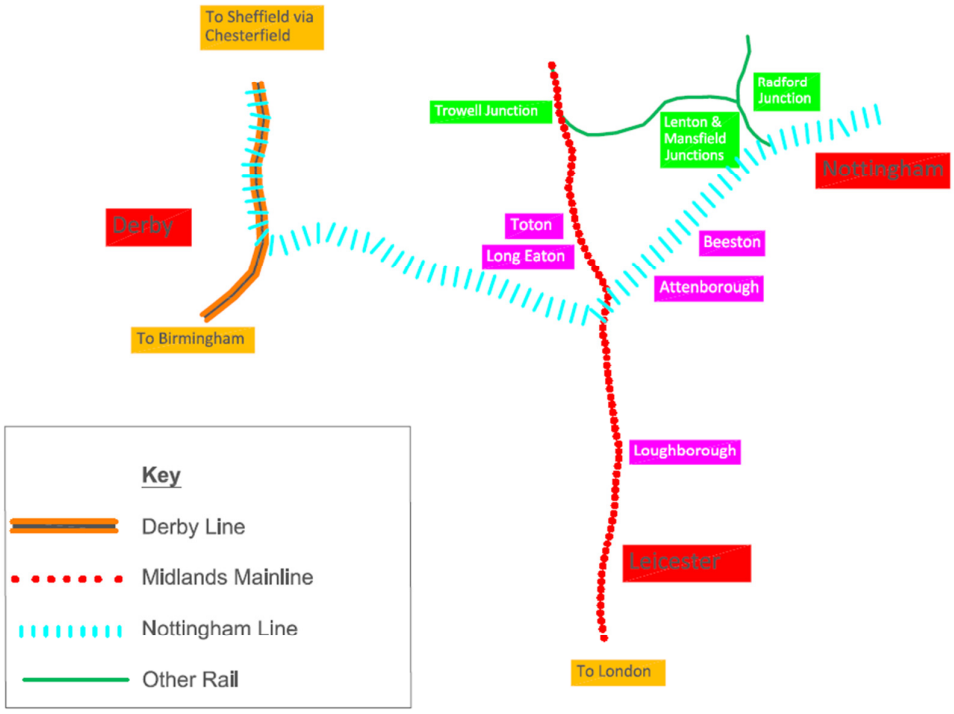


Figure 8: Schematic of East Midlands main Network Rail lines

There are four main rail routes within the East Midlands. The main rail routes are:

- The Midland Mainline – running north from London St Pancras via Leicester to Trent Junction. At Trent Junction the track splits to Sheffield via Derby, Clay Cross via Toton and Nottingham via Beeston;
- The Birmingham to Derby line via Water Orton;
- The Derby to Nottingham line via Trent Junction;
- The Nottingham to Sheffield line via Lenton Junction and Trowell Junction.

5.2 HS2 plans for connectivity

No direct connections are planned. The proposed connectivity is via shuttle to Nottingham and Derby following a change of trains. HS2 plan to add train patterns to connect Leicester into the system.

5.3 The proposed HS2 network

Through Long Eaton the proposed route would approach the hub at Toton along the line of the existing track. The existing low level Derby track would be raised to a high level to allow trains from Derby and East Midlands Parkway to access the East Midlands Hub.

The East Midlands Hub would be a new station on the site of the existing Toton maintenance depot.

5.3.1 The East Midlands Hub Station

The HS2 proposals are for the station to have 8 platforms. HS2 would occupy 4 platform faces for stopping services, and two through lines. To transfer onto the classic rail network, four platform faces would be provided for passengers interchanging with the cities of Derby, Leicester and Nottingham.

5.3.2 Impact on the local highway network

The provision of HS2 will require extensive modifications and improvements to the trunk road and local highway network.

A52 Brian Clough Way

To accommodate the proposed HS2 lines the existing A52 between the M1 J25 and Bardills Island will need modification. Primarily the overbridge will replace to provide clearance to HS2. Additional capacity improvements would be required to provide road access to the East Midlands Hub Station.

Derby Road, Stapleford

North of the A52, the proposed HS2 alignment conflicts with the Derby Road bridge on the Stapleford/Sandiacre border. The bridge structure would require demolition to provide clearance to HS2.

5.4 Arup proposals for connectivity

There is significant freight service in the area. A major freight terminal is located at Toton. The impact on the freight terminal is outside the scope of this report, although it is understood freight connections into the rail network will be maintained.

5.4.1 East Midlands Hub Station – provision of classic compatible connections

This Arup study suggests that provision of a set of classic compatible connections would be simple to implement. The provision of these connections would allow classic compatible trains to run on and off the HS2 network to stations at Derby, Leicester and Nottingham. The connections are suggested to be:

- Northbound – A new chord between the HS2 proposed freight line and HS2 line [connection 1 shown in figure below];
- Northbound – A new chord between HS2 line and the existing Network Rail line [connection 2 shown in figure below];
- Southbound – A new chord between the classic station throat and HS2 line [connection 3 shown in figure below];
- Southbound – A new chord between HS2 and the classic station throat exit [connection 4 shown in figure below].

Arup suggest that as the classic and high-speed lines are in close proximity and around the station area, then only a small amount of additional rail infrastructure would need to be provided.

It is suggested that some minor remodelling of the East Midlands Hub Station (EMHS) may be required to allow connectivity of HS2 into the classic network.

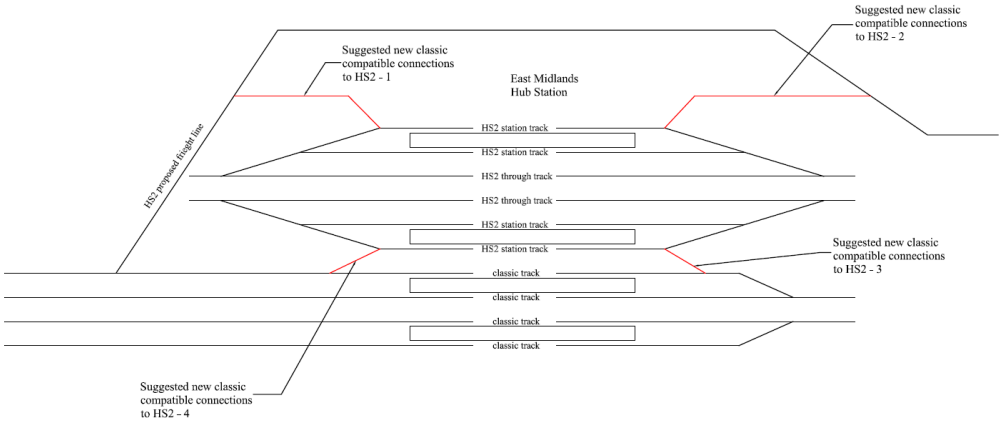


Figure 9: Track schematic of proposed classic connections around East Midlands Hub

At this stage, we suggest that the classic compatible connections account for approximately 2km of additional track with a construction cost in the region of

£3M for the permanent way works, assuming the civils works for the proposed connections are completed as part of the main HS2 works.

5.5 The proposed Trowell chord

The provision of classic compatible connections, detailed above, allows classic compatible trains to turnback at East Midlands Hub Station and route through Attenborough and Beeston to Nottingham.

The provision of a through route into Nottingham for classic compatible HS2 trains into Nottingham Station would enable significantly faster journey times to major cities. A suggested journey time to Birmingham Curzon Street Station could be in the order of 30 minutes from Nottingham City Centre. Provision of the chord at Trowell would allow trains to run through from Nottingham and Birmingham without turnback. A schematic of the suggested chord at Trowell is shown below.

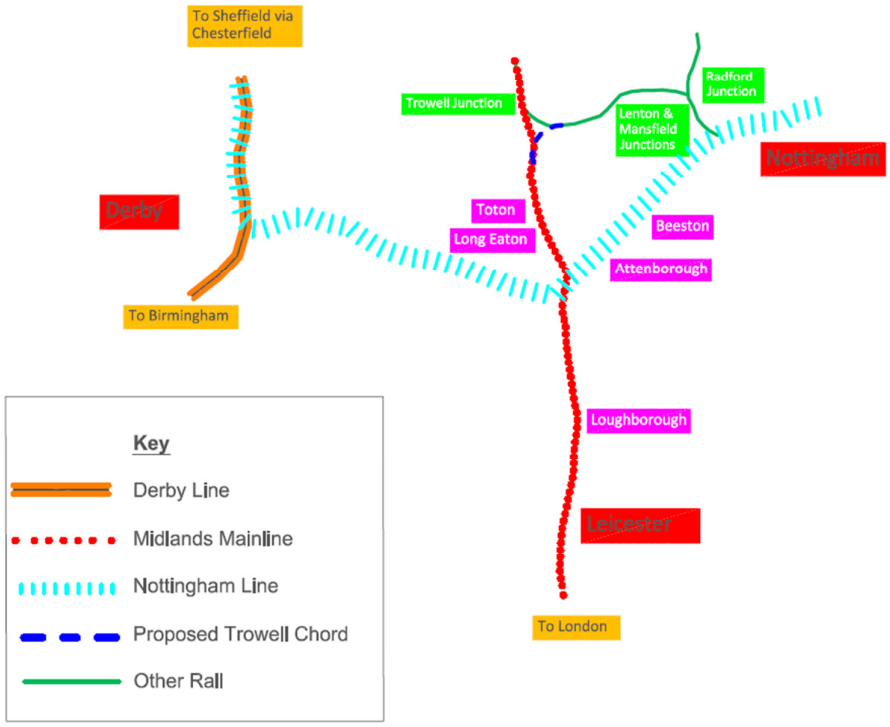


Figure 10: Schematic showing indicative Trowell chord

It is noted that Broxtowe Borough Council have indicated a number of housing units are planned for Field Farm (Broxtowe). The suggested solution for the Trowell chord takes this strategic site into account.

The suggested Trowell chord will turnout from the Sheffield to Nottingham Network Line and continue into a twin bore tunnel before returning to the surface alongside the proposed HS2 line in Stapleford.

The indicative construction cost is likely to be in the region of £275M. This indicative construction cost is presented but not limited to the following assumptions:

- A twin bore 7.95m external diameter tunnel, 2.3km long with associated approach portals;
- Tunnelled material quality, the indicative cost assumes acceptable material;
- Disposal of excavated material will be within the immediate locality;
- No allowance for intervention shafts;
- No propping of roof slabs required to tunnel portals;
- Includes an allowance for M&E;
- Includes an allowance for portal maintenance access tracks;
- Does not include any allowance for utilities diversions;
- Does not include any allowance for land and property compensation;
- Does not include an allowance for demolition;
- Does not include an allowance for the permanent way at this stage [it is intended that this will be included at a later date];
- River diversions, bridges and viaducts are excluded;
- Does not include for electrification of the classic network. It is assumed that the electrification of midland mainline will be completed under other projects.

The potential for provision of a tunnel solution is particularly dependent on the significant mine workings throughout the Trowell area. A desk study and site investigation and possibly area drilling would be required to determine the method of mine works, the presence of abandoned rails, the presence of wood, the presence of gas [free gas and acidic mine water].

5.6 Nottingham loop

The provision of the Trowell chord will complete the rail infrastructure around Nottingham and allow Javelin type trains service the outer conurbations of West Nottingham without turnback manoeuvres. Additional stations could be included within the loop to improve the service. The possible loop is presented in schematic form, below. It is noted that the provision of additional stations would not form a stopping service for HS2, the stations would service the conurbations of Nottingham only.

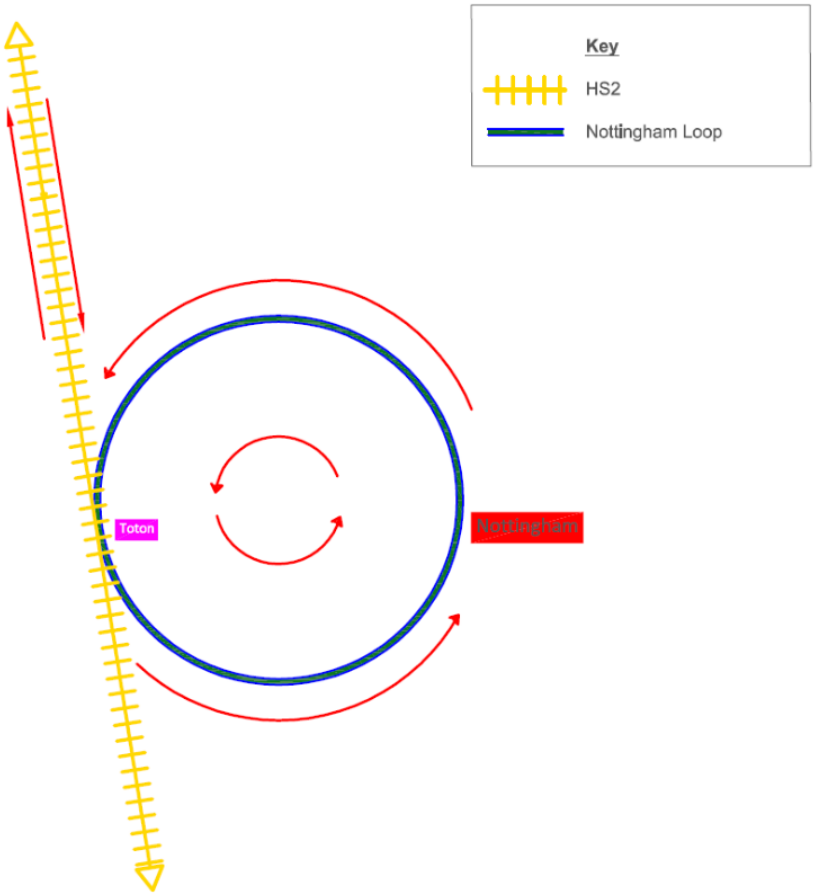


Figure 11: Suggested loop network for Nottingham

The provision of the Trowell chord and loop rail service has the potential to reduce the significance of the proposed changes to the local highway network. It is suggested that the provision of the rail link around Nottingham will reduce vehicular traffic requiring access to the EMHS. It is anticipated that this reduction in vehicular traffic will simplify the remodelling of the trunk road network around M1 J25 and A52 Bardills Island and Sherwin Arms. The scope of the reduction in highway improvements is not known at this stage although it is anticipated that a cost saving could be realised which may offset some of the proposed chord construction costs.

The proposal for this circular rail distribution system is not currently estimated.

5.6.1 Summary

A summary of the route options is presented below:

	The current HS2 proposed route	HS2 + classic compatible connections around EMHS	HS2 + connections + Trowell chord
Provides passenger connectivity to HS2 from cities	Yes, although passengers have to change trains at EMHS	Yes, although turnback manoeuvres are required	Yes, through service is provided
Provides through connections from HS2 into cities	No	Yes	Yes
Suggested journey time Derby to Leeds using 2013 as baseline (- indicating positive benefit)	--	--- 43mins saving GJT	No impact
Suggested journey time Leicester to Leeds using 2013 as baseline (- indicating positive benefit)	--	--- 60mins saving GJT	No impact
Suggested journey time Nottingham – Birmingham using 2013 as baseline (- indicating positive benefit)	--	--- 32mins saving GJT	---- 42mins saving GJT
Suggested rail construction cost impact over HS2 proposals	Baseline	£minor	£££moderate
Suggested highway improvement construction cost impact over HS2	Baseline	No change	££moderate Potential for saving

proposals			
Suggested overall impact on cost to HS2 for construction	Baseline	No noticeable impact	£minor Construction cost of chord offset by reduced highway costs

6 The Killamarsh connection

6.1 The HS2 proposal

The proposed HS2 route adopts the alignment of the existing Chesterfield to Rotherham Railway. In order for the HS2 to utilise this route, the Chesterfield to Rotherham Railway would be slewed to the West by approximately 30m. HS2 suggest that the level of the existing railway would be similar to the proposed HS2 lines. Beyond the Sheffield to Worksop line the proposed HS2 route would deviate from the Chesterfield to Rotherham Railway and adopt an independent alignment.

6.2 The current classic rail network

The key Network Rail infrastructure within proximity of Killamarsh is shown on the following page and in further detail within Appendix B.

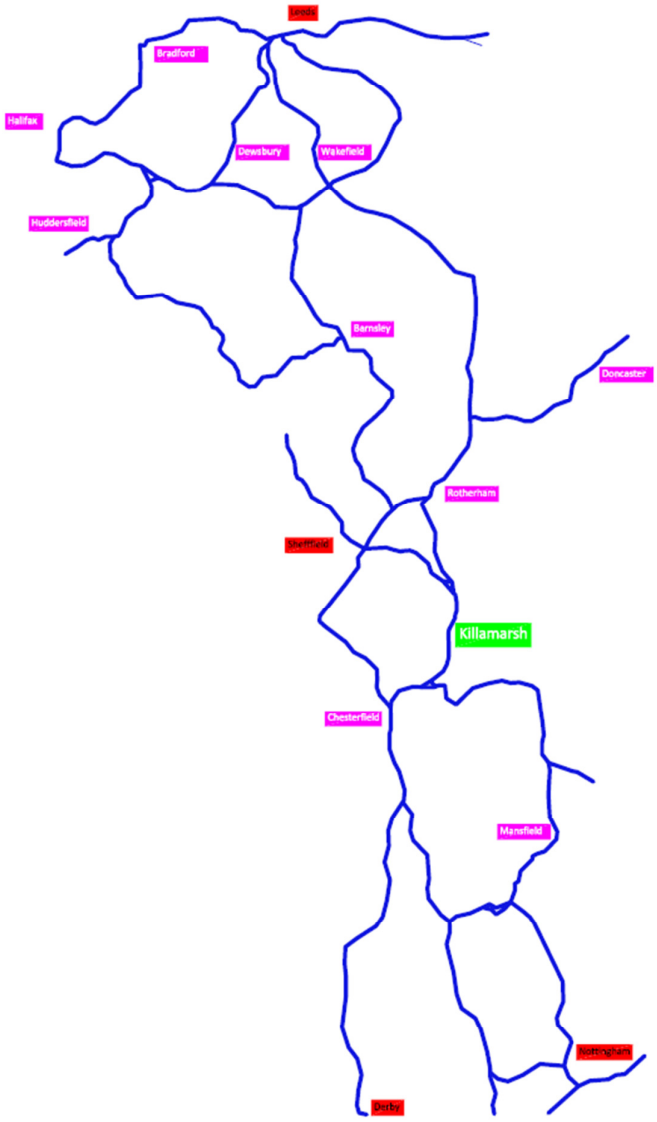


Figure 12: Schematic of the main Network Rail lines in the Killamarsh area

6.3 The Arup proposal

6.3.1 Killamarsh HS2 Connection – provision of classic compatible connections

This Arup study suggests that provision of a set of classic compatible connections would be simple to implement. The provision of these connections would allow classic compatible trains to run on and off the HS2 network and serve stations at Chesterfield and Derby. The connections are suggested to be:

- Northbound - A new chord between HS2 line and existing Network Rail line [connection 1 shown in figure below];
- Southbound – A new chord between HS2 line and existing Network Rail line [connection 2 shown in figure below].

Arup suggest that as the classic and high speed lines are in close proximity and proposed to be at a similar level, then only a small amount of additional rail infrastructure would need to be provided.

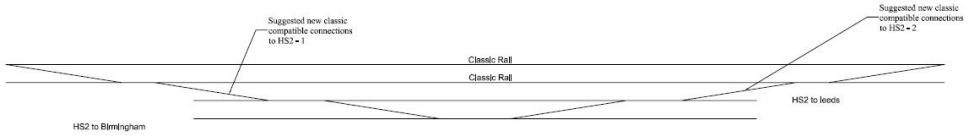


Figure 13: Track schematic of proposed classic connections around Killamarsh

At this stage, we suggest that the classic compatible connections account for approximately 6km of additional track with a construction cost in the region of £9M for the permanent way works, assuming that the civils works for the proposed connections are completed as part of the main HS2 works.

6.3.2 Summary

A summary of the route options is presented below:

	The current HS2 proposed route	**HS2 + classic compatible connections around Killamarsh**
Provides passenger connectivity to cities	Not part of this section of route.	Would provide service to/from Derby and Chesterfield
Provides through connections from HS2 into cities	No	Yes
Suggested journey time Derby to Leeds using 2013 as baseline(- indicating positive benefit)	No impact	--
Suggested rail construction cost impact over HS2 proposals	Baseline	£minor
Suggested overall impact on cost to HS2 for construction	Baseline	No noticeable impact

7 Further options

Three further options for improved connectivity into the HS2 network are presented below. The Sutton Bonington chord is presented to facilitate a southern connection to/from HS2 into Derby. The Derby 'loop' is presented to offer a connection between local towns, Derby and HS2. An alternative to the Trowell chord, the Attenborough chord is presented as a potential enterprise zone connection between Nottingham and Birmingham.

7.1 Sutton Bonington chord

Consideration has been given to an alternative chord provision between Sutton Bonington and the proposed HS2 route at Tonge. The proposed chord is presented in the schematic below:

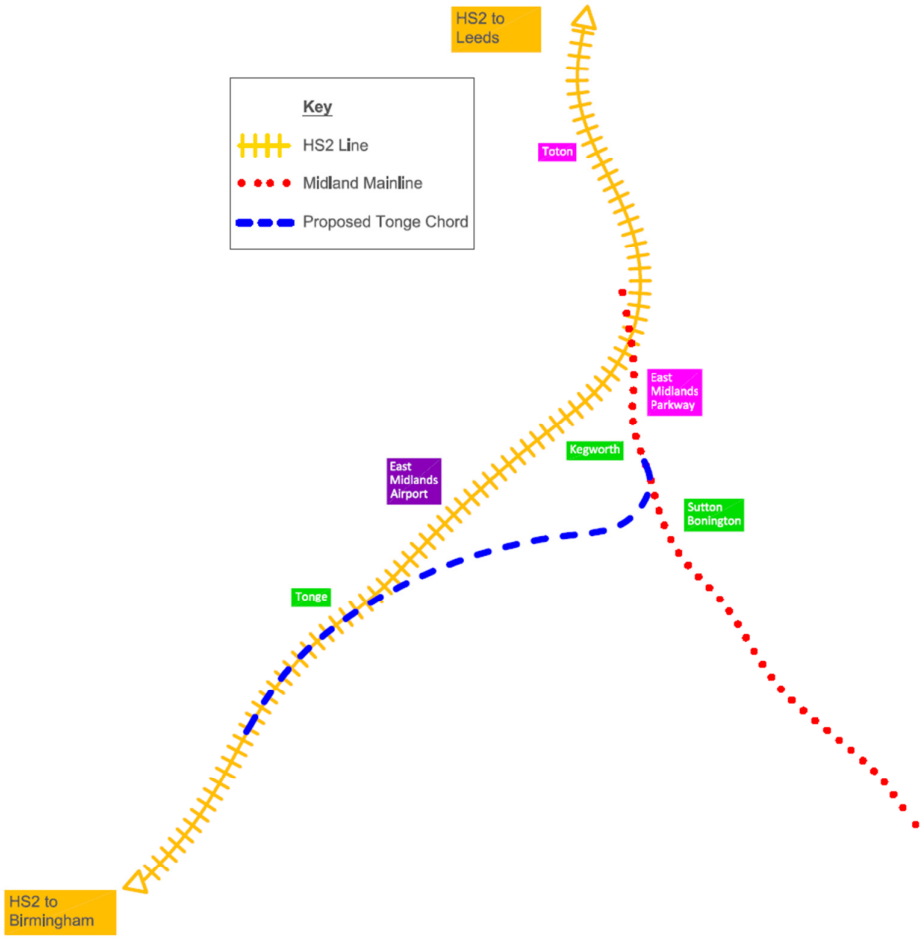


Figure 14: The Sutton Bonington chord

The benefit of this provision would be as follows:

1. Retains and enhances the future use of East Midlands Parkway Station [EMP]. The business case issues for the retention of EMP over EMHS are outside the scope of this study;
2. Classic compatible trains have direct access to the cities of Derby and Nottingham; and
3. A limited diversion route is available.

However the following dis-benefits are suggested:

1. The proposed Sutton Bonington chord is likely to cost in excess of £600M;
2. The promotion of East Midlands Parkway Station may have a detrimental on the business case for the East Midlands Hub Station at Toton;
3. The suggested Sutton Bonington chord does not relieve congestion at Trent Junction nor on the link into Nottingham Station via Beeston;
4. The Sutton Bonington chord would appear to be a duplication of route; and
5. Does not appear to benefit journeys to and from Leicester.

At this stage the Sutton Bonington chord is not recommended given the dis-benefits associated with its provision.

7.2 Derby loop

The 'Derby loop' is presented as a possible future network to provide a rapid Derby to Toton link. This possible network is presented as a very high level option and the feasibility of providing this solution is not currently understood. An outline of the proposal is presented below:

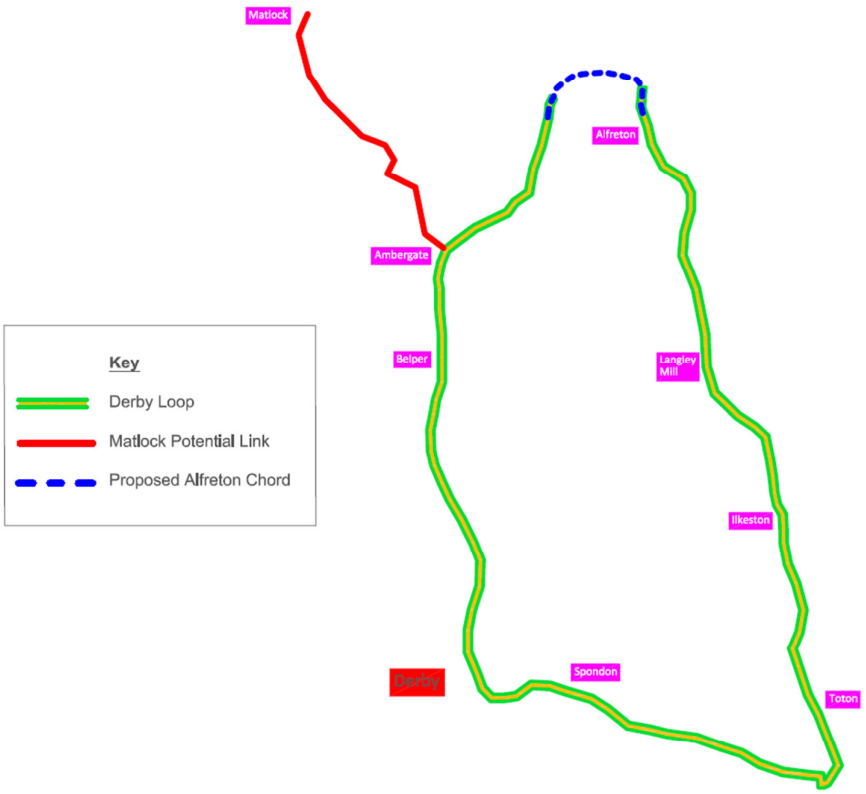


Figure 15: Outline of the Derby loop

The advantages of the 'Derby loop' are presented as follows:

1. Relieves congestion around the Trent Junction;
2. Provides alternative route for journeys between Nottingham and Derby;
3. Connects the towns of Ilkeston, Alfreton, Langley Mill, Ambergate, Belper, Spondon and Long Eaton to Derby and the HS2 network; and
4. Has the potential to connect Matlock and possibly Buxton to Nottingham and the proposed HS2 network.

7.3 The Attenborough chord [southern chord]

Arup are aware of a proposed chord through Attenborough. This proposed chord could provide direct connection to the significant Enterprise Zone at Beeston. However, the proposed chord is not favoured by Arup due to the potential impact on Attenborough Nature Reserve. An outline of the proposal is presented below:

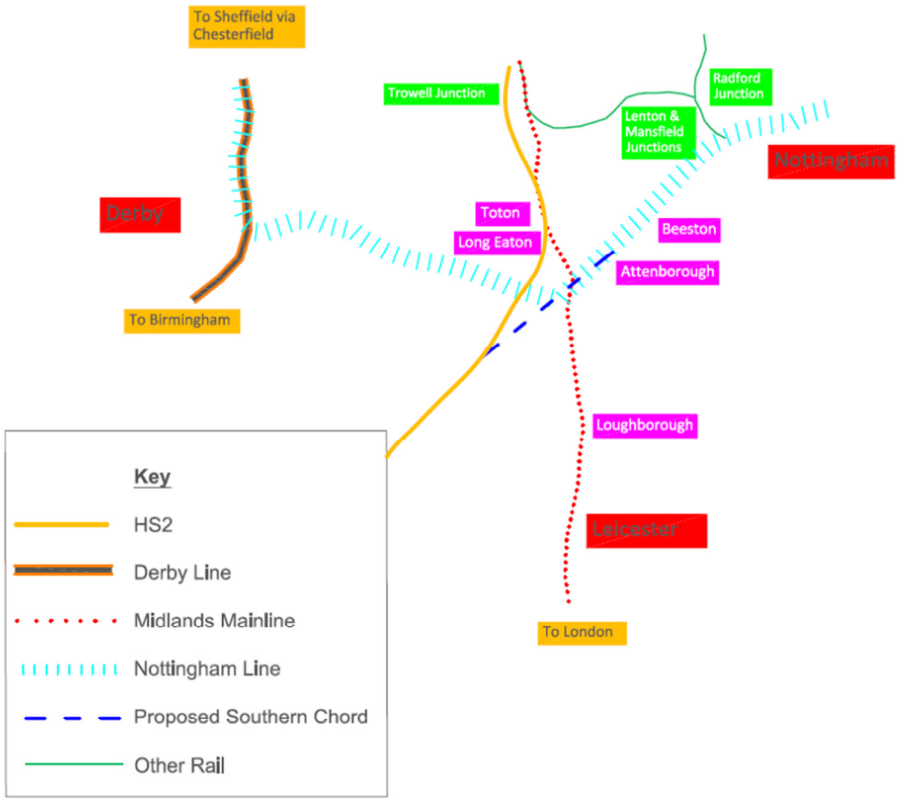


Figure 16: Schematic of the proposed Attenborough chord

The advantages and dis-benefits of the prosed chord through Attenborough are presented below:

+ Has the potential to link enterprise zones in Nottingham and Birmingham;
+ Potentially provides a shorter journey time, Nottingham to Birmingham direct, when compared to the proposed Trowell chord;
- Will potentially impact on the sensitive Attenborough Nature Reserve and SSSI;
- Ideal track alignment will be constrained by the Redhill tunnel;
- Construction cost is likely to be significant, when compared to the proposed Trowell chord;
- Has the potential to undermine East Midlands Hub Station.

8 Findings and Recommendations

This study has undertaken three strands of analysis in relation to direct connections to HS2; examining the economic development case, transport benefits and practical engineering solutions.

The findings suggest that there is a strong economic imperative to ensure that the full potential benefits of this opportunity are therefore realised. The economic analysis undertaken has established that in principle there is a case for direct connections to the proposed HS2 network from the key centres of economic activity in the East Midlands; adding to the overall economic case for HS2. The city centre areas of Nottingham, Leicester and Derby are the economic centres of activity whose growth together as one economic unit must be supported.

The findings of the transport modelling exercise have demonstrated high levels of additional demand through provision of direct classic connections. The results of this analysis show the strongest demand flows on the following routes:

- Nottingham to Birmingham;
- Nottingham to Leeds;
- Leicester to Leeds; and
- Derby to Leeds.

These routes are very important in the context of the further development of the key functional economic relationships that will enable the East Midlands economy to achieve sustainable economic growth.

In particular, the analysis shows a substantial reduction in the Nottingham to Birmingham journey time and an increase in the total number of Nottingham-Birmingham journeys from 1,300 to in excess of 5,000. The results demonstrate a substantial scale of latent demand between cities across the midlands and north, in particular between Nottingham and Birmingham.

These connections are expected to fulfil a critical role in enabling the significant potential regional economic benefits identified of £1.1 billion to £2.2 billion per year in Derby-Nottingham to be fully realised. This is equivalent to between a 2.2% and 4.3% increase in total local economic output in 2037. The provision of these connections adds to the overall business case for HS2 in maximising its economic benefit.

This study has also identified practical and cost effective engineering solutions that would enable the provision of direct classic connections. The analysis suggests that provision of a set of classic compatible connections at the Hub Station where the HS2 and MML tracks run in parallel would be simple to implement with only a marginal cost if built into the final design of the Hub Station. These connections would allow classic compatible trains to run on and off the HS2 network to stations at Derby, Leicester and Nottingham to Leeds and the north east of England. The journey time between Leicester and Leeds would be less than 60 minutes and between both Derby and Nottingham and Leeds of less than 50 minutes.

The provision of the chord at Trowell would allow trains to run through from Nottingham and Birmingham without turnback. This could be located to the

south of the Hub Station or to the north near Trowell. The indicative construction cost for the connections and chord is estimated at approximately £278 million. Whilst this cost is significant, the chord would allow direct connectivity between Nottingham and Birmingham with a journey time of around 30 minutes. It would also potentially increase connectivity between Lincoln and Newark. The scale of latent demand for these journeys is substantial and of a scale such that the long term economic benefits are likely to outweigh the cost.

The analysis has also demonstrated the potential for a linkage at Killamarsh, south of Sheffield. This linkage would improve connectivity from both Derby and Chesterfield and is expected to entail only modest cost.

The importance of the direct classic connections to achieving the economic development potential of the proposed HS2 network in the East Midlands is expected to far outweigh the associated costs of the engineering requirements. A strong recommendation is therefore made to explore the potential for provision of direct connections, chord and linkage at Killamarsh to the HS2 network from the East Midlands as part of the final HS2 proposition.