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1. EXECUTIVE SUMMARY

Network Rail has been asked by the Department for Transport (DfT) to conduct a high level study into the interventions required to deliver a step-change in capacity and connectivity on all north-south rail routes by 2033. This work will assist the DfT in evaluating the potential strategic alternatives to HS2 and is a presented as a technical annex to a more detailed study conducted by Atkins. Both reports should be read in conjunction.

From an understanding of existing capacity constraints over 100 interventions were identified and taken through initial workshops to ascertain their potential level of benefit, outline cost and anticipated delivery impact. Possible future train service specifications were then developed along with the groups of interventions required to deliver them.

The train service specifications and groups of infrastructure interventions required are presented in this report at three levels of output for each route – 'high', 'medium' and 'low' – and in scenarios both with and without Phase One of High Speed 2 being implemented.

The groups of interventions, referred to as 'packages' throughout this report, are at a very early stage of development. Both the train service patterns and interventions required would be expected to evolve as more detailed work was undertaken. If the interventions were to be considered for future implementation, substantial development work would be required to confirm their viability.

The interventions required to deliver the Network Rail 'high' output option across all routes are estimated to cost in excess of £28bn. In order to deliver in timeframes comparable to that for HS2, works on the East Coast, West Coast and Midland Main Lines would need to be delivered concurrently. This work would require line closures at particular locations at weekends for decades.

To deliver the 'high' output option across all routes by 2033, the timeframe proposed for Phase 2 of HS2, would have an even greater impact as it would require significant line closures even at the busiest times.

For the West Coast Main Line, where existing capacity constraints are already severe, even the 'high' output option would only deliver limited connectivity improvements, such as a two minute journey time saving from London to Manchester.

For the 'medium' output option, the total estimated cost would be around £12bn. Whilst being less disruptive to deliver than the 'high' scenario, it would still result in significant travel disruption due to the need for extensive weekend and week night line closures in order to deliver the works.

The 'low' output interventions on the ECML and MML provide a small increment above the 'do minimum' position at a cost of less than £1bn, achieved primarily through train lengthening with a small number of infrastructure interventions to support improvements to train frequency. These would have a much smaller impact on the travelling public. The 'low'

output on the WCML is derived from RP2, which emerged from the earlier 2010/2011 studies[1] of strategic alternatives at a cost of £3bn.

The packages Network Rail has proposed have been refined and developed further by Atkins and their results are presented in that report. Network Rail has assessed the disruption to the network of delivering the interventions taken forward for economic assessment[2] and this is presented in Appendix 1. These packages also result in significant disruption to weekend rail travel on multiple routes over a lengthy period of time.

[1] High speed rail strategic alternatives study: update following consultation - Publications - GOV.UK

[2] HS2 Strategic Alternatives Final Report for the Department for Transport, Atkins, October 2013

2. INTRODUCTION

Network Rail has been asked by the Department for Transport (DfT) to conduct a high level study into the interventions required to deliver a step-change in capacity and connectivity on all north-south rail routes by 2033. This work will assist the DfT in evaluating the potential strategic alternatives to HS2 and is a presented as a technical annex to a more detailed report by Atkins. This report should be read in conjunction with the Atkins report.

Network Rail has worked with DfT to develop packages of possible interventions that have the ability to unlock capacity and connectivity. In developing these, high level consideration was given to forecast demand levels (taken from Network Rail's 2013 draft Market Studies) and capacity and speed constraints on the existing network. The study did not look at developing substantial new rail lines as Network Rail considered this option in its New Lines Study (2009).

Network Rail has produced high level options for increasing capacity and connectivity on the existing railway (both with and without HS2 Phase One). High, medium and low output options were developed for the East Coast Main Line (ECML), Midland Main Line (MML), West Coast Main Line (WCML), Cross Country and freight routes.

This study was undertaken at a high level to identify potential interventions and explore the possibility of their implementation. If the interventions presented were to be considered for implementation, considerable further development would be required to take account of detailed design, cost, environmental considerations, land take issues, individual business cases and deliverability and construction in order to prove their viability.

Network Rail has not undertaken business case modelling and therefore cannot take a view on whether the interventions proposed represent value for money.

The interventions identified may, following further investigation, not be able to fully deliver the assumed capacity benefit or may not be necessary to deliver the assumed train service specification. The intervention cost on implementation may also be considerably different due to local conditions and constraints which have not been explored at this stage of development. Some aspects may also not prove cost effective as they would require an unacceptable level of disruption on the operational railway.

The following sections of this report detail the methodology undertaken to arrive at the options and an explanation of the associated benefits and interventions required to deliver them.

3. SCOPE

DfT requested Network Rail to develop a set of interventions that could offer a step change in capacity and connectivity to the same timescale as HS2 against two scenarios:

- Phase One of HS2 is complete
- No high speed line has been constructed

The following routes are primarily considered in this study:

- West Coast Main Line (WCML)
- Midland Main Line (MML) between London and Nottingham/Derby/Sheffield
- East Coast main Line (ECML) between London and Leeds/Edinburgh
- Cross Country routes between Birmingham and Manchester/York

Criteria for interventions

High, medium and low output options were developed for each route to include cross country and freight services. Groups of interventions were classified by the service level offered.

Each option seeks to achieve the following benefits:

- Improved interurban and long distance connectivity
- Additional rail capacity – for long distance, commuter and freight traffic

The interventions take into account likely changes in technology and operating practices as well as schemes already committed or at a high level of development over the next two decades. Such schemes include (but are not limited to) the substantial increase in electrification across the network and the implementation of new signalling technologies. These are the same 'do minimum' assumptions as used by HS2 (summarised in Chapter 5).

New sections of railway, including re-opened railway lines, have been considered where they deal with specific issues that have been identified.

DfT and Network Rail adopted an approach that the geographic scope of proposed interventions need not be limited to the geographic area where HS2 would be being built [3]. HS2 services would run beyond the HS2 network and help to deliver capacity and connectivity improvements across a much broader geographical area. As such, the Department concluded the strategic alternative upgrade packages should have a similar broad scope.

The DfT requested that Network Rail build on previous strategic alternatives work on the WCML (RP2) as a starting point for considering the scenario where no high speed line has been built. Network Rail previously reviewed these proposals in its 'Review of the Strategic Alternatives to High Speed Two' (2011).

[3] This approach is consistent with that undertaken in earlier phases of the study of strategic alternatives by the Department which examined alternatives to Phase 1 of HS2 which included infrastructure schemes north of Birmingham to ensure that trains to Manchester could run faster and more frequently.

The DfT subsequently asked Network Rail to review the interventions taken forward for case assessment and consider the level of disruption associated with those packages. This assessment is presented in Appendix 1.

4. APPROACH

To consider interventions that could deliver a step change in capacity and connectivity in a similar timeframe to that for HS2 (completion of Phase One by 2026 and Phase Two by 2033), a number of inputs were used to understand the outputs required:

- *Passenger Demand*
  An assessment was made of where demand exceeded supply and therefore supported the need for more on-train capacity for passengers.
- *Freight Growth*
  An assessment was made of how future freight growth requirements might be accommodated on the route.
- *Journey Opportunities*
  An assessment was made of the conditional outputs[4] from the Long Distance Market Study[5] in order to develop potential future journey opportunities that were desirable on the route.

These inputs were used alongside the high level objectives provided by DfT to examine possible train service packages and the infrastructure changes required to support these. The objectives were as follows:

- Improve inter urban and long distance connectivity
- Increase rail capacity for the long term – for long distance, commuter and freight traffic
- Enable faster journeys
- Enable more reliable journeys
- Enable more comfortable journeys (through reduction in crowding)

For ECML there is no direct impact of HS2 Phase One so the only scenario considered was that no high speed line had been built. For the WCML, MML and cross country services, options were considered both with and without HS2 Phase One. For the purpose of this report, the Birmingham to Derby cross country services have been included as part of the WCML as they fall within the London North Western Route.

As is currently planned, the first phase of HS2 will not directly affect the MML in the way that it will on the WCML. However, it does present the opportunity to potentially run services via HS2 Phase One and on to the MML via a new chord and an enhanced Lichfield Freight Line.

[4] The conditional outputs from the market studies are a statement of the long term aspirations for the level of service provided and are required to inform future investment decisions. They form the basis for the rest of the Long Term Planning Process for a market. They are not constrained by considerations of cost and deliverability, which will be considered in subsequent stages of the LTPP.

[5] The market studies have been developed in consultation with rail industry partners and wider stakeholders to build on the success of the route utilisation strategy programme. Each study identifies the strategic goals for the respective market over the next 30 years, forecasts the levels of demand that may need to be accommodated, and formulates conditional outputs that would be needed in order to meet those strategic goals. http://www.networkrail.co.uk/improvements/planning-policies-and-plans/long-term-planning-process/market-studies/long-distance/

It is also possible to run services to destinations currently served by MML via the ECML instead, which is included in the ECML high package. This leads to four possible scenarios for which MML packages have been developed:

- Without HS2
- With HS2 Phase One
- Without HS2, with some services running via the ECML
- With HS2 Phase One, with some services running via the ECML

All options examined that led to a deterioration in the quantum or frequency of service below what is achieved today were discounted. These included:

- Increasing long distance service quantum at the expense of freight capacity north of York or north of Preston
- Increasing peak suburban services at the expense of peak long distance services

High output options were defined first which tried to achieve as large a step-change in capacity and connectivity as possible. This required a large amount of infrastructure intervention and therefore cost to be achieved. Key constraints were then considered and alternative options proposed.

Similar to the ’high’ output options, the ‘medium’ output options were intended to improve both capacity and connectivity by creating new journey opportunities and reducing journey times between key locations. This involves restructuring the current train service offer.

Low output options were intended to provide additional capacity into the future but offer little, if any, opportunities for improving connectivity across the route as they largely maintain the same service structure as the ‘do minimum’.

5. ASSUMPTIONS

This report forms part of a high level study along with work being undertaken by DfT and is at a very early stage of development. Consequently, cost assessments are at an early stage and disruption to the network has been modelled simply through likely Schedule 4 compensation costs[6].

This report does not include any change in costs for maintaining new infrastructure as this would form part of any whole-life business case assessment.

Further work would be necessary to understand whether the proposed infrastructure is fully optimised for the train service modelled, ie whether more or less infrastructure may be required in certain locations. No assessment has been made regarding the ability of the stations to accommodate additional passenger flows as a result of increasing capacity or passengers' ability to transfer to other transport modes.

No additional rolling stock and associated stabling costs has been assessed by Network Rail. This has, however, been considered by Atkins.

A number of other assumptions have also been made:

- The European Rail Traffic Management System (ERTMS) is the standard signalling approach post 2020.
- The infrastructure can be altered to permit 140 mph on extensive stretches
- Where required, the necessary land and consents can be obtained
- There would be no significant economies from combining the schemes with any planned renewals

The 'do minimum'[7] is a representation of the state of the future rail network at 2026 (the opening year for HS2 and for some elements of the strategic alternatives to HS2) based upon the schemes the Department has previously advised. The 'do minimum' used throughout this report is consistent with that used by HS2 Ltd in their modelling. It comprises of schemes covered in the High Level Output Specification (HLOS) document from July 2012. The Control Period 5 programme (2014-2019) electrification of MML is included, as is a four-track railway as far as Kettering, an intervention to segregate crossing freight flows in the Leicester area and the rebuild of Derby station. A total of 6tph are assumed to run to and from St Pancras, and there are journey time savings compared to today from a number of sources. Cross Country services are assumed to move over to electric traction in the early 2020s. On the West Coast the Norton Bridge scheme is assumed to be in place, leading to some minor journey time savings. On the East Coast Main Line, the Intercity Express Programme Phase 2 is assumed it be in place, as is a grade separated entrance to the 'Joint Line'. East West Rail is included, and this facilitates a Southampton to Manchester via

[6] Schedule 4 compensates train operators for the impact of planned service disruption. Compensation is intended to cover fare revenue losses or costs, such as those associated with running replacement buses.

[7] The purpose of the 'do minimum' is two-fold. It provides a basis for testing how the future network will perform against objectives based upon future growth in demand and schemes assumed to progress in the next few years, and therefore gives a starting point for identifying future constraints and issues

Oxford and Milton Keynes service. The 'do minimum' also assumes that ERTMS will become the standard signalling renewals approach after 2020, and includes the pre-2020 roll out of ERTMS on the southern section of the ECML. Planned CP5 power upgrades to support the IEP programme are incorporated.

In order to provide a basis for estimating costs, the infrastructure interventions developed to support the train service specifications define the general remit for each estimate. Schedules of work items that would be deemed necessary to achieve the required output were then developed and a bill of quantities constructed for each intervention. The preliminary estimates broadly align with unit cost data and other early stage Network Rail cost estimates and follow the general structure of Network Rail's Rail Method of Measurement Volume 1. Each measured item in the estimates contains a description of the specification and type of unit wherever possible. Estimates have been peer reviewed to ensure they are robust enough for a study at this level of development. The estimates have been further reviewed with HS2 Ltd to ensure a consistent approach.

Generally drawings and specific mileages for each estimate have not been developed and a desk-based approach was used to quantify the scope of works either as a length of route or the number of stations and structures along each route. The costs and scale of works have been benchmarked against comparable projects wherever possible. Measurement has been undertaken as a desktop exercise – generally no site visits have been undertaken nor has site specific information been incorporated into the estimates - therefore the quantification of each estimate should be considered provisional and further work, including site visits and site investigations, would be required should any of the interventions be progressed.

Network Rail has developed an approach to managing projects in order to minimise and mitigate the risks associated with delivering projects that enhance or renew the operational railway and projects in a High Street environment. This process, "Governance for Railway Investment Projects" (GRIP), is based on best practice within industries that undertake major infrastructure projects and practice recommended by the major professional bodies, including the Office of Government Commerce (OGC), the Association of Project Management (APM) and the Chartered Institute of Building (CIOB). Following this approach, Network Rail refers to the level of development of the various intervention packages described in this report as "Pre-GRIP" or "GRIP 0". This means that not only is the design at a very low level but that the other plans required to manage a complex project, such as environmental management plans, project management plans, selection between options of designs to deliver the required outputs, feasibility assessment, procurement plans, asset management plans and delivering work within possessions plans have also not been completed to enable the interventions/packages to be defined as GRIP 1 or beyond. As such, considerably more development would be required to take each individual intervention to a stage whereby construction could be confirmed; construction occurs at GRIP 6 following detailed design at GRIP5.

The following allowances were applied to the direct cost of each scheme to cover management and execution of the works:

- Design costs: 10% of the direct cost of each scheme
- Contractors preliminaries: 30% of the direct cost of each scheme
- Programme Management: 9% of the direct cost of each scheme;
- Disruption: 10% of the direct cost of each scheme;
- Land costs and statutory processes: 3% of the direct cost of each scheme

In order to be consistent with the approach taken by HS2 Ltd, all costs are presented in 2011 prices.

As the estimates have been prepared for the use in economic analysis, the Department for Transport Guidance on Rail Appraisal (WebTag) has been followed. Due to the early stage of development, no quantitative risk assessment has been undertaken and therefore no contingency has been applied to the base cost. Optimism Bias has subsequently been applied at the rate of 66% as recommended for this stage of development by the WebTag guidance. If projects were to progress beyond this stage of development, specific risk analysis and contingency would need to be developed and applied to the base cost in developing construction budgets.

Package summary costs are presented in this report at the end of each list of infrastructure interventions. All have been developed to the level of detail described above and have the same limitations due to the early stage in development. The Atkins report contains more detail on the cost of particular interventions within those packages.

6. OPTIONS

6.1 East Coast Main Line

6.1.1 Route Context

The East Coast Main Line (ECML) is the electrified high speed route linking London and south east England with Yorkshire & Humberside, the North East, and eastern Scotland. It provides the direct link between the English and Scottish capital cities and is designated as being of Trans European Network (TENS) high speed route status. It carries key commuter flows to the north of London as well as some of the UK's fastest growing intercity flows. It forms a vital part of the cross-country and cross-Pennine long distance networks linking Scotland, the North East and Yorkshire with Liverpool, Manchester, the West Midlands, the Thames Valley and the west of England. Parts of the ECML also handle regional commuter and local passenger services and carry heavy tonnages of freight traffic, particularly over the northern sections.

The Great Northern /Great Eastern Joint Line between Peterborough and Doncaster via Spalding and Lincoln provides a valuable local rail link to the communities along the route and a crucial alternative route to the ECML for freight traffic. To enhance its latter role the line is currently the subject of a major upgrade.

6.1.2 Constraints and assumed infrastructure changes

The table below describes the current constraints on the ECML as well as the infrastructure improvements that are assumed for the 'do minimum' case and the Atkins report presents detail of the train service specifications delivered by it.

Current ECML constraints and impacts of 'do minimum' schemes

Current Constraint	'do minimum' scheme addressing constraint
Freight traffic between Grantham and Doncaster travelling on the East Coast Mainline has to negotiate a broadly two track railway for 52 miles, from south of Grantham (Stoke Junction) to just south of Doncaster (Loversall Car Junction) albeit with some passing loops. This causes a problem because of the speed differential between faster intercity services and slower freight trains;	Upgrade of the Great Northern/Great Eastern route is underway between Peterborough and Doncaster for freight services - an almost parallel route via Lincoln sometimes referred to as the GNGE Joint Line which would allow freight to both avoid the East Coast Main Line and therefore avoid being stopped so that they can be overtaken by fast trains on the East Coast Main Line.
North of Doncaster the interaction of freight with intercity trains is complicated and this complication causes a loss in capacity particularly at Shaftholme and Joan Croft Junctions where freight has to join or	Flyover being constructed at Shaftholme Junction (north of Doncaster) to provide a route for freight services which does not

leave the East Coast Main Line without the benefit of grade separation;	conflict with East Coast Main Line intercity services. The North Doncaster Chord both reduces conflicting crossing moves and also removes slow-moving freight from the ECML
In the London area the existing track layouts at Finsbury Park and Alexandra Palace, as well as at Peterborough stations cause a limited number of fast East Coast Main Line services to conflict with local services and freight services particularly in times of perturbed running;	Layout changes between Finsbury Park and Alexandra Palace, and at Peterborough, which will reduce the conflicts between fast East Coast Main Line services and local / freight services.
Approximately between Alexandra Palace and Stevenage the East Coast Main Line has a parallel two track route via Hertford served by commuter trains but also used as a major diversionary route. At the moment the capacity for turning back trains so that northbound trains can terminate and become southbound services is limited particularly in times of perturbation;	Extra platforms at Stevenage and Gordon Hill stations that will enable local trains to turn back after running from London with less impact on others services at those locations.
At King's Cross the termination of Great Northern trains occupies capacity that could otherwise be used by intercity trains;	Thameslink which reduces the need for trains to terminate at Kings Cross.
At a more route wide level the performance profile of the existing train and the age of the some of the signalling is thought by Network Rail to be capacity limiting – again particularly so during times of perturbation. In particular, the opportunity to run trains faster is constrained.	All franchised services to be provided by modern Class 800 (IEP) trains. ETCS Level 2 is implemented South of Doncaster – that is re-signalling to modern standards with minimal line-side equipment.
The existing train fleet is ageing with limitations on capacity and performance.	The existing fleet is being replaced by the Intercity Express Programme trains which replace the inter-city train fleet.
King's Cross will remain a constraint (although reduced) post the implementation of Thameslink due to the constrained track layout on the approaches and limited lengths of Platforms 9, 10 and 11 on the western side of King's Cross and the constrained approach to platforms 1-4 on the eastern side of Kings Cross where the eastern bores of Copenhagen and Gasworks tunnel (which might potentially allow for a more direct approach without other services) have no track.	Not addressed by DM schemes.
The largely four track section between Alexandra Palace and Woolmer Green Junction of the ECML	Not addressed by DM schemes.

accommodates a variety of services (inner suburban, outer suburban and Intercity). The different speeds of services mean that the faster trains are constrained by the speed of the slower services.	
The section between Huntingdon and Peterborough is a mixture of two and three tracks. The primary constraint on this section is the speed mix of services which use this section with the greatest difference between freight and non-stop 125 mph Intercity services.	Not addressed by DM schemes.
Between Woolmer Green Junction and Digswell there is a two track section that consists of the Welwyn viaduct and tunnels. Welwyn North Station is situated on this two track section, therefore trains calling at Welwyn North further limit the capacity in this area. The alternative route *via* the Hertford loop is also two track and is constrained by freight and an intense inner suburban service.	Not addressed by DM schemes.
Peterborough Station and the Great Northern/Great Eastern route between Peterborough and Doncaster for freight service are being upgraded in Control Period 4, and therefore form part of the 'do minimum'. Peterborough station area remains a constraint post these infrastructure changes due to the need for outer suburban services to cross over the station layout to terminate at Peterborough and the requirement for freight to cross the layout to access the GN/GE Joint Line (although since the packages were proposed by Network Rail DfT has confirmed that they expect grade separation at Werrington Junction just north of Peterborough that will create a route for freight to cross the mainlines to access the GN/GE without conflicting fast passenger trains);	Not addressed by DM schemes.
Between Peterborough and Doncaster the key constraint is the different calling patterns of intercity services over this section at Grantham, Newark North Gate and Retford. Newark Crossing is a constraint where trains between Lincoln and Nottingham cross the ECML on the flat.	Not addressed by DM schemes.
At Doncaster station the number of crossing movements required on flat junctions at the north and south of the station is the primary driver for both capacity and performance which constrains how the station can be used and whether any additional services can be planned.	Not addressed by DM schemes.
The two track route between Doncaster and Leeds carries intercity, suburban and freight services. The different speeds of services mean that the faster trains	Not addressed by DM schemes.

are constrained by the speed of the slower services, particularly north of South Kirkby Junction. Leeds station is also a constraint due to platform capacity and crossing moves at the West end of the station.	
The section between Newcastle and Edinburgh is constrained by the ability of the infrastructure to run longer freight services;	Not addressed by DM schemes.
The two track section between Doncaster and Colton Junction carries both intercity and freight services and the differing speeds of these services cause a constraint. The approaches at both ends of York station are constrained by services crossing the layout to access different routes.	Not addressed by DM schemes.
The section between Northallerton and Newcastle carries a significant amount of freight traffic as well as intercity and inter-urban services. The different speeds on this two track section result in a capacity constraint. Trains calling at Darlington station on both the ECML and the route between Bishop Auckland and Middlesbrough must cross the layout on the flat.	Not addressed by DM schemes.

ECML Service Package A ('High' output scenario)

This option aims to provide increased capacity to support growth in the long distance, freight and suburban market alongside improvements to the service quality in terms of journey time, connectivity and frequency. To support this level of service, a large quantity of infrastructure changes are required.

Overview of ECML service package A:

Intercity:

A total of 11 long distance services are provided per hour all day. This compares to 7 in the 'do minimum'. The indicative service assumed is as follows:

- 2 tph King's Cross – Grantham – Nottingham
- 2 tph King's Cross – Wakefield – Leeds
- 2 tph King's Cross – Leeds via Micklefield
- 2 tph King's Cross – Edinburgh
- 2 tph King's Cross – Newcastle
- 1 tph King's Cross – various locations (at least to Doncaster)

This service package also assumes all long distance services are provided by 10 car units compared to 5 to 9 car units assumed in the 'do minimum'. It provides direct services to Nottingham via the ECML to deliver an improvement in journey times to Nottingham. It also seeks to resolve all day crowding south of Peterborough, between Sheffield and Leeds and between Doncaster and York.

The table below shows the indicative average journey times that were assessed to be achievable with this service level and interventions.

	'Do minimum' Journey Time	High Service Package Journey Time
King's Cross – Leeds	2hr 6mins	1hr 40 to 1 hr 50
King's Cross – Edinburgh	4hr 5mins	3hrs 30 to 3 hrs 45
King's Cross – Nottingham	N/A	1hr 10 to 1hr 20

A range is provided as the infrastructure schemes are not developed to enough detail to provide a detailed assumption for journey times.

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed analysis would be required to confirm that this is achievable with acceptable trailing loads):

- 2 tph London – Peterborough
- 2 - 3 tph Peterborough – Doncaster
- 2 - 3 tph Doncaster – Colton Jn
- 3 - 4 tph Colton Jn - Newcastle
- 1 tph Newcastle - Edinburgh

This package provides infrastructure to allow separation of long distance passenger services from key freight flows therefore allows capacity for further freight growth over and above the 2030 forecasts north of Peterborough.

Cross-country:

This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph where possible. Additional capacity is delivered through two fast trains per hour between Sheffield and Leeds alongside the existing regional services. This partially achieves the conditional output from the Market Study between these two cities by improving journey times and increasing the interval of service.

New journey opportunities are provided by linking a service from Nottingham to the north of the ECML using a new chord at Newark.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work. An increase in quantum on both the Peterborough and Cambridge routes is proposed above the 'do minimum' in the peak hours. An indicative calling pattern has been assumed but would call at stations as demand requires:

- 2 tph Royston (all stations to Stevenage) – King's Cross
- 1 tph Huntingdon (all stations to Stevenage) – King's Cross
- 1 tph Peterborough – King's Cross (semi-fast)

To improve connectivity an additional semi-fast service between Peterborough and King's Cross is proposed in the off peak.

6.1.3 Interventions required to deliver ECML Service Package A

The infrastructure required to deliver this service package aims, as much as possible, to segregate long distance services south of Newcastle from slower freight, regional and suburban services. This allows for the increased quantum of train paths for freight, suburban and long distance services alongside improvements in journey times for key long distance markets as described above.

The largest element of these interventions is the provision of a new two track alignment from Alexandra Palace to Biggleswade which allows segregation of suburban and long distance services to support quantum increases for both markets on the route.

Options were examined to four track Welwyn viaduct and tunnels. Although this removed much of this bottleneck, the mix of services on the fast lines south of Hitchin became the next constraint which limited the improvement to long distance and suburban which could be achieved. Therefore no options were taken forward which four tracked Welwyn viaduct, although an option which partially removed the bottleneck by 4-tracking the tunnels and station was included in another package.

Line speed improvements and capacity interventions to segregate flows are proposed so that journey time improvements for long distance flows can be achieved. A new chord to the

ECML is proposed at Newark North Gate to support improved journey opportunities from Nottingham to the North East.

The interventions required for this service package are;

- King's Cross station throat remodelling
- New Platforms at Harringay and Hornsey
- Additional two tracks between Alexandra Palace and Biggleswade
- Electrification on the GN/GE Joint Line and between Nottingham and Grantham
- New down side platforms at Grantham and doubling to Nottingham Branch Junction
- Newark grade separation and chord
- Dynamic loop between Peterborough and Doncaster
- Doncaster Station grade separation
- Dynamic Loop between Micklefield and Leeds
- Line speed improvements to the fast line between Biggleswade and Darlington
- Level crossing closure programme
- Doncaster – York improved freight capacity
- York Station – northern access improvements
- Fast line platform at Darlington
- Upgrade the Stillington Line
- Re-open and upgrade the Leamside line between Tursdale Junction and Pelaw with new alignment to Chester-Le-Street
- Additional capacity on the corridor between Sheffield and Leeds
- Leeds Station capacity increase

The total cost of delivering these interventions is estimated to be £13.4bn.

6.1.4 ECML Service Package B ('Medium' output scenario)

This package provides improvements above the 'do minimum' to cater for increased demand on intercity, cross-country and suburban services along with some improvements to connectivity and journey time. This is the maximum service that can be accommodated without building more substantial infrastructure interventions as proposed in Service Package A.

Overview of ECML service package B:

Intercity:

A total of 10 long distance services are provided per hour. This compares to 7 in the 'do minimum'. This indicative service assumed is as follows:

- 2 tph King's Cross – Wakefield – Leeds
- 2 tph King's Cross – Leeds
- 2 tph King's Cross – Edinburgh
- 2 tph King's Cross – Newcastle
- 1 tph King's Cross – various locations (at least to Doncaster)
- 1 tph King's Cross - Lincoln

The long distance service package was considering the conditional outputs from the Market Studies. This service package assumes all long distance services are lengthened to 10 car units from 5 to 9 car units and improves capacity between Doncaster and York and south of Peterborough.

The table below presents the indicative average journey times which can be achieved with this service level and interventions.

	'do minimum' Journey Time	Service Package Journey Time
King's Cross – Leeds	2hr 6mins	1hr 55
King's Cross – Edinburgh	4hr 5mins	4 hrs 00

The Service Package Journey Times are the midpoint estimate based on a range of potential times as the infrastructure schemes are not developed enough to provide a detailed estimate for journey times.

Freight:

Based on a high level view of the available capacity the following freight flows have been assumed (further detailed analysis would be required to confirm that this is achievable with acceptable trailing loads);

- 2 tph London – Peterborough
- 2 - 3 tph Peterborough – Doncaster
- 2 - 3 tph Doncaster – Colton Jn
- 3 - 4 tph Colton Jn - Newcastle
- 1 tph Newcastle - Edinburgh

Cross-country:
This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph. Service package B provides an additional two trains per hour between Sheffield and Leeds. This partially achieves the conditional output from the Market Study between these two cities by improving journey times and increasing the interval of service.

Suburban:
The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work. An increase in quantum on both the Peterborough and Cambridge routes is proposed above the 'do minimum' in the peak hours. An indicative calling pattern has been assumed but would call at stations as demand requires:

- 2 tph Royston (all stations to Stevenage) – King's Cross
- 1 tph Huntingdon (all stations to Stevenage) – King's Cross
- 1 tph Peterborough – King's Cross (semi-fast)

6.1.5 Interventions required to deliver ECML Service Package B

The infrastructure required to deliver this service package aims to alter the existing route to remove bottle necks and segregate the different types of services using the route where possible to allow for improvements to journey time.

The interventions required for this service package are:

- King's Cross station throat remodelling
- New Platforms at Harringay and Hornsey and improved S&C
- Huntingdon – Peterborough capacity scheme
- Dynamic loop between Peterborough and Doncaster
- Doncaster Station grade separation and remodelling
- Dynamic Loop between Doncaster and Leeds
- Level crossing closure programme
- Doncaster – York improved freight capacity
- York Station throat improvements
- New platforms at Darlington
- Leeds Station capacity increase
- Welwyn Tunnel four tracking
- Newark grade separation
- Electrification of the GN/GE Joint Line
- Upgrade the Stillington Line
- Re-open the Leamside Line
- Upgrade Leeds – Sheffield route via Barnsley

The total cost of delivering these interventions is estimated to be £5.8bn.

6.1.6 ECML Service Package C ('Low' output scenario)

This package provides a small increment above the 'do minimum' position to accommodate increased demand. This is achieved primarily through a larger proportion of Intercity trains being lengthened to ten car as well as Cross country services being lengthened to ten car. It

would also include one peak outer suburban above the ‘do minimum’ on the Cambridge to London branch. This service package does not deliver any improvements to journey time or journey opportunities.

Overview of ECML service package C:

Intercity:

A total of 7 long distance services are provided per hour, the same as in the ‘do minimum’ but with additional train lengthening taking place. The indicative service assumed is as follows:

- 2 tph King’s Cross – Wakefield – Leeds
- 1 tph King’s Cross – Leeds
- 3 tph King’s Cross – Newcastle (2 continue to Edinburgh)
- 1 tph King’s Cross – various locations (at least to Doncaster)

All long distance services are assumed to be lengthened to 10 car units compared with 5 to 9 car carriages in the ‘do minimum’.

No improvement to journey time was assumed with this service package, and there is very limited improvement to service frequency provided by this option.

Freight:
This option provides no increment above the end of CP5 position for freight growth.

Cross Country:
The ‘do minimum’ quantum and interval of service is retained with all services lengthened to 10 car between Sheffield and Leeds and Doncaster and York.

Suburban:
The 2018 Thameslink service level is assumed as part of the ‘do minimum’ for this work. The key constraint which limits any further suburban services within this package is the two track section at Welwyn Viaduct. It is proposed to run one peak additional service to ease crowding on suburban services although the level of service at Welwyn delivered by this option in the peak may be a performance risk.

6.1.7 Interventions required to deliver ECML Service Package C

No further infrastructure is required as the service output is the same as the ‘do minimum’ and therefore will be resolved through CP5 work. The capital cost is therefore zero.

6.2 West Coast Main Line (WCML)

6.2.1 Route Context

The West Coast Main Line (WCML) is the busiest mixed traffic route in the UK. Long distance services are provided between London Euston, the West Midlands, Stoke, Manchester, Chester and North Wales, Liverpool, Manchester, Lancashire, Cumbria and Scotland. There are three trains an hour between London and Birmingham/Manchester and one train per hour to each of the following destinations: Chester, Liverpool, and Glasgow with some extra services in the peaks.

Regional and Interurban services operate between London and Watford, Milton Keynes, Northampton, Trent Valley, Crewe, and the West Midlands. There also are local services between Bletchley and Bedford and between Watford and St. Albans Abbey with these two lines having 'Community Rail' designation.

An hourly service operates between East Croydon and Milton Keynes joining the WCML at Wembley.

High frequency Metro services are provided by London Underground (Bakerloo) and London Overground between Queens Park and Watford via a dedicated DC route.

Freight services operate over the majority of the WCML serving ports and terminals such as; Channel Tunnel (Dollands Moor) Tilbury, Felixstowe, Southampton, Daventry, Trafford Park and Glasgow.

6.2.2 Constraints and assumed infrastructure changes

The table below describes the current constraints on the WCML as well as the infrastructure improvements that are assumed for the 'do minimum' case. The Atkins report presents detail of the train service specifications delivered by the 'do minimum'.

Current WCML constraints and impact of 'do minimum' schemes

Current Constraint	'do minimum' scheme addressing constraint
In Manchester, and in particular at Manchester Piccadilly Station and on the approaches to Manchester Piccadilly Station, the interaction of local and higher speed services with different stopping patterns and speeds reduces spare capacity;	Completion of the 'Northern Hub' capacity and line speed enhancements, including the Ordsall Chord.
Excepting the West Coast Main Line and on a few local routes the number of electrified tracks are limited in the Manchester area;	North West Electrification.
At Norton Bridge trains to Manchester have to cross the southbound trains on the West Coast Main Line which reduce capacity and in addition there are conflicting movements in the local Stafford Station area which also reduces capacity albeit by significantly less;	Stafford area improvement scheme including the remodelling of Norton Bridge.
In Birmingham the passenger capacity of Birmingham New Street, in particular to handle large numbers of passengers and to act as an interchange, has been limited by the historic design and has resulted in station closure at times of very severe crowding;	Birmingham New Street Upgrade ('Gateway').
The power supply on the West Coast Main Line which Network Rail consider limit the number of	West Coast Main Line Power Supply

Current Constraint	'do minimum' scheme addressing constraint
trains or their performance;	Upgrade.
London Euston to Rugby – available platform capacity at London Euston and constraints at the station throat;	Not addressed by DM schemes
Relatively slow line speeds between WCML north of Birmingham and the junctions to Manchester and Liverpool	Not addressed by DM schemes
Rugby to Stafford: Brinklow Junction to Attleborough South Junction which has only three tracks for around 11 kms; and Shugborough Tunnel where there are only two tracks through the 710 metre tunnel.	Not addressed by DM schemes
Stafford to Crewe - Crewe station area due to large number of crossing moves to the north and south of the station limiting passenger and freight capacity and increasing journey times where services need to cross the main line; and Alsager to Crewe: There is a short single line section which limits capacity.	Not addressed by DM schemes
Colwich Junction to Cheadle Hulme - between Colwich Junction and Stone Junction, Norton Bridge and Stone Junction and Stone Junction and Stoke-on-Trent there is reasonable capacity for growth.	Not addressed by DM schemes
Crewe to Liverpool - Winsford to Hartford: Five miles of two track railway limits the capacity on this section of route and approximately two miles from Acton Bridge to Weaver Junction.	Not addressed by DM schemes
Warrington to Preston - Wigan North Western to Balshaw Lane Junction: Eight mile two track section; Euxton Junction to Preston: Capacity is restricted by crossing moves and the mix of services on this section.	Not addressed by DM schemes
Preston to Scottish Border – this is predominantly a two track railway with differential speeds between faster passenger and slower freight services which constrain capacity. There are also limited passing loops, with the existing ones being restrictive in length. Other constraints due to existing layouts include: Lancaster station; Carlisle station area; and Carstairs.	Not addressed by DM schemes
On the Stoke-on-Trent to Cheadle Hume section, the differing types of passenger services and mix of calling patterns cause high capacity utilisation.	Not addressed by DM schemes
At Cheadle Hume, the lines from Stoke-on-Trent converge with the lines from Crewe and there is a	Not addressed by DM schemes

Current Constraint	'do minimum' scheme addressing constraint
short two track section between Cheadle Hulme and Adswood Road.	
The freight only Crewe Independent lines are constrained by slow line speeds of 15 mph. Between Carlisle station and Floriston, freight services can be routed via Carlisle Kingmoor Yard. The line through this area is restricted to sections of 25 mph, 10 mph and 5 mph, which generates a 20-minute time penalty for through services routed through the yard.	Not addressed by DM schemes
There are also other sections of the route where additional train paths cannot be accommodated without affecting performance. The sections between London Euston and Wolverton, Norton Bridge and Weaver Junction, and Euxton Junction to south of Carlisle Station all fall into this category. There is also limited capacity for growth between Long Buckby and Rugby.	Not addressed by DM schemes

6.2.3 WCML Service Package A ('High' output scenario without HS2 Phase One)

This service package aims to provide increased capacity to support growth in the long distance, freight and suburban market alongside improvements to the service quality in terms of journey time, connectivity and frequency. To support this level of service significant infrastructure enhancements are required.

Overview of WCML Service Package A:

Intercity:

A total of 12 long distance services from London Euston are provided per hour all of which are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. During the peak period all long distance train services will call at Milton Keynes. This compares to 10 in the 'do minimum' off-peak. The indicative long distance services assumed are as follows:

- 1 tph London – Preston – Glasgow
- 1 tph London – Liverpool via Runcorn
- 1 tph London – Glasgow & Liverpool via Chat Moss (train divides at Warrington)
- 4 tph London – Manchester
- 2 tph London – Birmingham New St
- 1 tph London – Wolverhampton via Birmingham New St
- 1 tph London – Shrewsbury via Birmingham New St and Wolverhampton
- 1 tph London – Chester – North Wales
- 1 tph London – Northampton - Crewe (serving Trent Valley stations)

The above shows in theory 13 trains, but in practice there are only 12 trains leaving Euston as one splits at Warrington to enable 2 tph to both Glasgow and Liverpool

The table below presents the indicative journey times which could be achieved on fast trains between key cities.

	'Do minimum' journey time	'High' package journey time
London – Manchester	2 hr 07 min	2 hr 06 min
London – Liverpool	2 hr 11 min	2 hr 05 min
London – Glasgow	4 hr 20 min	4 hr 20 min

Suburban / Commuter – (London to Watford, Tring, Milton Keynes & Northampton)

London Underground services (Bakerloo Line) are extended through to Watford Junction from Harrow and Wealdstone to release platform capacity at London Euston and to enable more slow line services to be run. London Overground services are diverted onto the North London Line with Primrose Hill station reopened. Peak time commuter services between London and Northampton will be 16 cars, albeit such longer train operation has not been undertaken in the UK in this manner before. Other slow line services will be 12 cars.

The indicative Suburban and Commuter service is as follows:

- 2 tph London – Northampton – Rugby – Birmingham (via fast lines & formed of 12 coaches)
- 1 tph London – Northampton - Rugby
- 4 tph London – Milton Keynes – Northampton (on the fast lines)
- 4 tph London – Watford Jn - Bletchley
- 2 tph East Croydon to Milton Keynes via West London Line
- 3 tph Willesden - Camden Rd (London Overground service via DC)
- 3 tph Queens park to Stonebridge Park (London Underground Bakerloo services via DC)
- 6 tph Queens Park to Watford Junction (London Underground Bakerloo services via DC)

Coventry Corridor – (Birmingham New St to Coventry)

Enhancements between Stechford and Beechwood Tunnel, at Birmingham New St and a new connection to Birmingham Moor St will provide additional capacity. The indicative train service on the corridor will be 12 tph:

- 2 tph Cross Country from North West / North East to Thames Valley / South Coast
- 2 tph Birmingham New St – Coventry – Kenilworth – Leamington Spa
- 2 tph Birmingham New St – Coventry (local service)
- 2 tph Birmingham New St – Coventry – Northampton – London Euston
- 2 tph Birmingham New St - Coventry - London Euston (intercity)
- 1 tph Shrewsbury – Birmingham – Coventry – London Euston (intercity)
- 1 tph Wolverhampton – Birmingham – Coventry – London Euston (intercity)

Cross-country (Birmingham – Manchester):

This service package assumes cross-country trains are extended to 5-car electric rolling stock (compared to 4-car in the do min) that is capable of running at 125 mph. It is proposed

to deliver four fast trains per hour between Birmingham and Manchester. This partially achieves the conditional output from the Market Study between these two cities by improving journey times and increasing the interval of service.

The train service specification is as follows;

- 4 tph Birmingham New St to Manchester (all trains increase from 4 to 5 cars)
- Faster journey times achieved through line speed improvements and a reduction in the number of intermediate stops
- Other local services will provide connectivity to the faster trains at interchange stations such as Wolverhampton, Stoke and Crewe.

	'Do minimum' journey time	'High' package journey time
Birmingham – Manchester	1 hr 28 min	1 hr 12 min

Cross-country (Birmingham – Tamworth)

Journey time improvements between Birmingham and Tamworth by segregating freight and passenger services and delivering a 140 mph line speed. Trains will be lengthened from 4 or 5 cars to 10 cars to provide additional seating capacity.

	'Do minimum' journey time	'High' package journey time
Birmingham – Tamworth	15 min	9 min

Freight:

This option seeks to meet the long term growth forecasts. This package provides infrastructure to allow segregation of long distance passenger services with key freight flows.

6.2.4 Interventions required to deliver WCML Service Package A

London to Rugby

- Enabling 16 car peak commuter services
    - Requires complete remodelling of Euston Station and potentially reduce the number of platforms
    - Platform lengthening at all stations from London to Birmingham New St and to Northampton
    - Expansion/remodelling of depots
    - Potentially increase the gap required between trains[8], thereby reducing the frequency by 1 tph
- Reinstate Primrose Hill station and 3 tracks at Camden Rd (North London Line)

[8] 16 car length trains would increase station dwell time in the peaks due to the number of passengers joining or alighting. Over a distance such as Euston to Northampton with 8 stops this could reduce available route capacity due to the overall journey time being extended compared to a 12 car train doing the same run.

- Fourth rail, signalling and power upgrade between Harrow & Wealdstone and Watford (DC)[9]
- Platform works (stepping distances) between Harrow & Wealdstone and Watford (DC) to provide a consistent step height between train and platforms for the full length of the Bakerloo line operation
- Additional turn back facility at Watford Junction
- Grade separation (flyover junction) at Wembley, and Ledburn
- Remodelling of Milton Keynes & Northampton
- Platform extensions at stations between London and Northampton
- Line Speed Improvements between Hanslope Jn, Northampton and Rugby
- Resignalling of London to Northampton route to increase capacity accommodating the additional services

Rugby to Manchester via Coventry and Birmingham

- Four tracks between Beechwood Tunnel and Stechford
- Four tracks between Sandwell and Dudley and Wolverhampton
- Three tracks between Smethwick Galton Bridge and Sandwell and Dudley
- Dynamic passing loops (5 miles long) between Macclesfield and Congleton
- Line speed improvements between Birmingham and Manchester

Rugby to Liverpool, Preston and Glasgow via Trent Valley

- Four tracks between Attleborough to Brinklow (Rugby to Nuneaton)
- Grade separation (flyover junction) at Colwich Junction
- A new two track railway bypassing Stafford (Colwich Jn to Norton Bridge)
- Four tracks between Winsford and Weaver Junction
- Four tracks throughout on the Chat Moss line (approx 3 miles)
- Platform extensions at Warrington Bank Quay
- Remodelling of Winsford, Hartford and Acton Bridge stations
- Remodelling of Crewe, Wigan North Western and Preston
- Dynamic passing loops (5 miles long) between Preston and Lancaster
- Dynamic passing loops (5 miles long) between Oxenholme and Carstairs

Birmingham to Tamworth – Cross Country

- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.

[9] To deliver an increased 'Metro' service frequency between Watford Junction and London (via Bakerloo line instead of today's DC service into Euston) existing Bakerloo line trains that terminate at Harrow and Wealdstone will be extended to Watford Junction. The existing DC services operate on 3rd rail and London Underground trains operate on a 4th rail system – the 4th rail being the return current. The existing signalling is standard and for an increased frequency to Watford Junction from 3tph to 6 tph and to accommodate the Croxley services (Watford Jn to Watford High St) over the same section as Bakerloo trains in-cab signalling is needed as well as an upgrade to the sub stations and power supply.

- Four tracks between Duddeston Jn and Water Orton (approx 8 miles) including re-building Water Orton Station.
- Four tracks from Kingsbury Jn to Tamworth (approx 6 miles) Incl. re-building intermediate stations at Wilnecote and Tamworth
- 140 mph line speed improvements between Birmingham and Tamworth (including platform works at intermediate stations, etc).

The total cost of delivering these interventions is estimated to be £9.5bn.

6.2.5 WCML Service Package B ('Medium' output scenario without HS2 Phase One)

This service package aims to provide increased capacity to support growth in the long distance, freight and suburban market alongside improvements to the service quality in terms of journey time, connectivity and frequency. To support a 'medium' output level of service significant infrastructure enhancements are required.

Overview of service package B:

Intercity:

A total of 12 long distance services from London Euston are provided per hour all of which are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. This compares to a maximum of 11tph in the 'do minimum'. During the peak period all long distance train services will call at Milton Keynes. The indicative service assumed is as follows:

- 1 tph London – Preston – Glasgow
- 2 tph London – Liverpool (1tph via Runcorn and 1 tph via Chat Moss)
- 4 tph London – Manchester
- 2 tph London – Birmingham New St
- 1 tph London – Wolverhampton via Birmingham New St
- 1 tph London – Shrewsbury via Birmingham New St and Wolverhampton
- 1 tph London – Chester – North Wales (serving Trent Valley stations)
- 1 tph London – Northampton - Crewe (serving Trent Valley stations)

The above shows in theory 13 trains, but in practice there are only 12 trains leaving Euston as one splits at Warrington to enable 2 tph to both Glasgow and Liverpool

The table below presents the indicative journey times which could be achieved on fast trains between key cities.

	'Do minimum' journey time	'Medium' package journey time
London – Manchester	2 hr 07 min	2 hr 06 min
London – Liverpool	2 hr 11 min	2 hr 05 min
London – Glasgow	4 hr 20 min	4 hr 20 min

Suburban / Commuter – (London to Watford, Tring, Milton Keynes & Northampton)

London Underground services are extended through to Watford Junction to release platform capacity at London Euston. London Overground services are diverted onto the North London Line with Primrose Hill station reopened. Peak time commuter services between London and Northampton will be 12 cars.

The indicative service is as follows:

- 2 tph London – Northampton – Rugby – Birmingham
- 2 tph London – Milton Keynes - Northampton
- 4 tph London – Watford Jn - Bletchley
- 2 tph East Croydon to Milton Keynes via West London Line

- 3 tph Willesden - Camden Rd (London Overground service via DC)
- 3 tph Queens park to Stonebridge Park (London Underground Bakerloo services via DC)
- 6 tph Queens Park to Watford Junction (London Underground Bakerloo services via DC)

Coventry Corridor – (Birmingham New St to Coventry)

Service frequency and enhancements on the Coventry Corridor in the 'Medium' output scenario will be the same as the 'High' output (Service package A)

Cross-country (Birmingham – Manchester):

The difference between the 'High' output and the 'Medium' output on this route is that in the 'Medium' scenario there are additional calling points which increases journey times and thus the dynamic passing loops between Macclesfield and Congleton are not required.

	'Do minimum' journey time	'Medium' package journey time
Birmingham – Manchester	1 hr 28 min	1 hr 14 min

Cross-country (Birmingham – Tamworth):

Journey time improvements between Birmingham and Tamworth by segregating freight and passenger services. Trains will be lengthened from 4 or 5 cars to 10 cars to provide additional seating capacity.

	'Do minimum' journey time	'Medium' package journey time
Birmingham – Tamworth	15 min	12 min

Freight:

This option seeks to provide for long term future growth forecasts. This package provides infrastructure to allow segregation of long distance passenger services with key freight flows.

6.2.6 Interventions required to deliver WCML Service Package B:

London to Rugby

- Platform alterations at London Euston
- Reinstate Primrose Hill station and 3 tracks at Camden Rd (North London Line)
- 4th rail, Signalling and power upgrade between Harrow & Wealdstone and Watford (DC)
- Platform works (stepping distances) between Harrow & Wealdstone and Watford (DC)
- Additional turn back facility at Watford Junction
- Grade separation at Ledburn Junction

- Hanslope Jn – Northampton – Rugby line speed improvements

Rugby to Manchester via Coventry and Birmingham

- Four tracks between Beechwood Tunnel and Stechford
- Four tracks between Sandwell and Dudley and Wolverhampton
- Three tracks between Smethwick Galton Bridge and Sandwell and Dudley
- Line speed improvements between Birmingham and Manchester

Rugby to Liverpool, Preston and Glasgow via Trent Valley

- Four tracks between Attleborough to Brinklow (Rugby to Nuneaton)
- A new two track railway bypassing Stafford (Colwich Jn to Norton Bridge)
- Four tracks between Winsford and Weaver Junction
- Four tracks throughout on the Chat Moss line (approx 3 miles)
- Remodelling of Winsford, Hartford and Acton Bridge stations
- Remodelling of Crewe, Wigan North Western and Preston
- Dynamic passing loops (5 miles long) between Oxenholme and Carstairs

Birmingham to Tamworth – Cross Country

- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.
- Four tracks between Duddeston Jn and Water Orton (approx 8 miles) including re-building Water Orton Station.

The total cost of delivering these interventions is estimated to be £6bn.

6.2.7 WCML Service Package C ('Lower' output scenario without HS2 Phase One)

This package is effectively an augmented version of RP2 whereby one of the intercity trains splits en-route at Warrington providing an enhanced service frequency to Liverpool and Glasgow

Overview of WCML service package C:

Intercity:

The service level for long distance services is the same as the 'Medium' output in that a total of 12[10] long distance services from London Euston are provided per hour all of which are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. This compares to a maximum of 11 in the 'do minimum'. During the peak period all long distance train services will call at Milton Keynes. The indicative service assumed is as follows:

- 1 tph London – Preston – Glasgow

[10] One service from Euston splits to provide a service to Liverpool and Glasgow

- 2 tph London – Liverpool (1tph via Runcorn and 1 tph via Chat Moss)
- 4 tph London – Manchester
- 2 tph London – Birmingham New St
- 1 tph London – Wolverhampton via Birmingham New St
- 1 tph London – Shrewsbury via Birmingham New St and Wolverhampton
- 1 tph London – Chester – North Wales (serving Trent Valley stations)
- 1 tph London – Northampton - Crewe (serving Trent Valley stations)

The table below presents shows the indicative journey times that could be achieved on fast trains between key cities.

	'Do minimum' journey time	'Low' package journey time
London – Manchester	2 hr 07 min	2 hr 07 min
London – Liverpool	2 hr 11 min	2 hr 11 min
London – Glasgow	4 hr 20 min	4 hr 20 min

Suburban / Commuter – (London to Watford, Tring, Milton Keynes & Northampton)

The 2013 service level patterns on the Slow Lines and the Watford DC route will apply in the 'Low' output scenario. Peak time commuter services between London and Northampton will be 12 cars.

Coventry Corridor – (Birmingham New St to Coventry)

The December 2013 timetable will operate with extension of Birmingham to Coventry local services to Kenilworth and Leamington Spa.

Cross Country – (Birmingham New St to Manchester)

No additional infrastructure enhancements and no increase in existing service level or faster journeys. Additional seating capacity will be provided by lengthening all services from 4 to 5 cars.

Cross-country (Birmingham – Tamworth):

Trains lengthened from 4 to 5 cars to 10 cars to provide additional seating capacity.

Freight:

No significant infrastructure enhancements delivered.

6.2.8 Interventions required to deliver WCML Service Package C:

London to Rugby, Coventry and Birmingham

- Minor platform alterations at London Euston
- Grade separation at Ledburn Junction
- Hanslope Jn – Northampton – Rugby line speed improvements

Rugby to Liverpool, Preston and Glasgow via Trent Valley

- Four tracks between Attleborough to Brinklow (Rugby to Nuneaton)
- Four tracks between Winsford and Weaver Junction
- Four tracks throughout on the Chat Moss line (approx 3 miles)
- Remodelling o f Crewe, Wigan North Western and Preston

Birmingham to Tamworth - Cross County

- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.

The total cost of delivering these interventions is estimated to be £3.0bn. This cost has been further refined into the Atkins report.

6.2.9 WCML Service Package D ('High' output scenario with HS2 Phase One)

This service package aims to provide increased capacity to support growth in the long distance, freight and suburban market alongside improvements to the service quality in terms of journey time, connectivity and frequency. It assumes that Phase One of HS2 has already been built and the services are a mixture of HS2 services, HS2 classic compatible services and services running on the existing network.

To support this level of service a number of high-cost infrastructure enhancements are required.

Overview of WCML service package D:

Intercity:

A total of 16 long distance services from London Euston are provided per hour all of which are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. Eleven out of the sixteen long distance train services per hour will depart from the high speed station at Euston with the other five departing from the 'Classic' Euston station. This compares to 11 in the 'do minimum'. During the peak period all long distance train services will call at Milton Keynes. The indicative service assumed is as follows:

- 2 tph London HS – Preston – Glasgow
- 4 tph London – Manchester (3 x HS and 1 x Domestic)
- 3 tph London HS – Birmingham Curzon St
- 2 tph London HS – Liverpool (via Runcorn)
- 1 tph London – Wolverhampton via Birmingham New St
- 1 tph London – Shrewsbury via Birmingham New St and Wolverhampton
- 1 tph London HS – Preston – Carlisle
- 1 tph London – Chester – North Wales
- 1 tph London – Crewe (serving Trent Valley stations) – formed of 12 coaches

The long distance service package was developed to support an increase in journey opportunities and improvement in journey times between key cities.

The table below presents the indicative journey times that could be achieved on fast trains between key cities.

	'Do minimum' with HS2 Phase 1 journey time	'High' package journey time
London – Manchester	1 hr 40 min	1 hr 35 min
London – Liverpool	1 hr 46 min	1 hr 45 min
London – Glasgow	3 hr 54 min	3 hr 54 min

Commuter services:

This has been developed from the HS2 updated economic case for HS2 (August 2012): Explanation of the service patterns[11].

- 4 tph London – Northampton – Rugby – (via fast lines & formed of 12 coaches)
- 3 tph London to Tring
- 2 tph London - Milton Keynes – Northampton – Rugby – Coventry - Birmingham
- 2 tph East Croydon to Milton Keynes via West London Line
- 2 tph London to Watford Junction (additional to DC services)
- 1 tph London to Bletchley
- 1 tph London to Milton Keynes

Coventry Corridor – (Birmingham New St to Coventry)

The level of service is:

- 2 tph Cross Country from North West / North East to Thames Valley / South Coast
- 2 tph Birmingham New St – Coventry – Kenilworth – Leamington Spa
- 2 tph Birmingham New St – Coventry (local service)
- 2 tph Birmingham New St – Coventry – Northampton – London Euston
- 2 tph Wolverhampton / Shrewsbury – Birmingham – Coventry - London Euston

Cross-country (Birmingham – Manchester):

This service package assumes cross-country trains are extended to 5-car electric rolling stock that is capable of running at 125 mph. It is proposed to deliver four fast trains per hour between Birmingham and Manchester. This partially achieves the conditional output from the Market Study between these two cities by improving journey times and increasing the interval of service.

The level of service is:

11 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244033/Updated_economic_case_for_HS2__August_2012__-_Explanation_of_the_service_patterns__January_2013_.pdf

- 4 tph Birmingham New St to Manchester (all trains increase from 4 to 5 cars)
- Faster journey times with a reduction in the number of intermediate stops
- Other local services will provide connectivity to the faster trains at interchange stations such as Wolverhampton, Stoke and Crewe.

	'Do minimum' with HS2 Phase 1 journey time	'High' package journey time
Birmingham – Manchester	1 hr 28 min	1 hr 16 min

Cross-country (Birmingham – Tamworth):

Journey time improvements between Birmingham and Tamworth by segregating freight and passenger services and delivering a 140 mph line speed. Trains will be lengthened from 4 or 5 cars to 10 cars to provide additional seating capacity.

	'Do minimum' journey time	'High' package journey time
Birmingham – Tamworth	15 min	9 min

Freight:

This option seeks to provide for long term growth forecasts. This package provides infrastructure to allow segregation of long distance passenger services with key freight flows.

6.2.10 Interventions required to deliver WCML Service Package D

- A new two track railway bypassing Stafford (Colwich Jn to Norton Bridge)
- Grade separation (flyover junction) at Colwich Junction
- 140 mph capability Handsacre Jn to Weaver Junction and in-cab signalling (ETCS)
- Increase in fast line speed through Crewe Station from 80 mph to 140 mph
- Four tracks between Winsford and Weaver Junction
- Remodelling of approach lines to Crewe, Wigan North Western and Preston
- Dynamic passing loops (5 miles long) between Preston and Lancaster
- Dynamic passing loops (5 miles long) between Oxenholme and Carstairs
- Line speed improvements between Birmingham and Manchester
- Dynamic passing loops (5 miles long) between Macclesfield and Congleton
- Four tracks between Sandwell and Dudley and Wolverhampton
- Three tracks between Smethwick Galton Bridge and Sandwell and Dudley
- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.
- Four tracks between Duddeston Jn and Water Orton (approx 8 miles) including re-building Water Orton Station. This will include upgrade of existing goods lines.
- Four tracks from Kingsbury Jn to Tamworth (approx 6 miles) Incl. re-building intermediate stations at Wilnecote and Tamworth
- 140 mph line speed improvements between Birmingham and Tamworth (including platform works at intermediate stations, etc).

The total cost of delivering these interventions is estimated to be £6.5bn.

6.2.11 WCML Service Package E ('Medium' output scenario with HS2 Phase One)

This package provides improvements above the 'do minimum' to cater for increased demand on intercity, cross-country and suburban services along with some improvements to connectivity and journey time. All trains are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. This is the maximum service that can be accommodated without building more substantial infrastructure interventions as proposed above in Service Package D.

Overview of WCML service package E:

Intercity:

In the 'Medium Output' scenario the same level of Intercity service (as shown above) will be provided as the 'High Output' (service package A) with the key difference being increased journey times due to a maximum route speed of 125 mph instead of 140 mph between Handsacre Jn and Weaver Jn.

The table below presents the indicative journey times that could be achieved on fast trains between key cities.

	'Do minimum' with HS2 Phase 1 journey time	'Medium' package journey time
London – Manchester	1 hr 40 min	1 hr 37 min
London – Liverpool	1 hr 46 min	1 hr 47 min
London – Glasgow	3 hr 54 min	3 hr 56 min

Suburban / Commuter – (London to Watford, Tring, Milton Keynes & Northampton)
The level of service is the same as service package D.

Coventry Corridor – (Birmingham New St to Coventry)
The level of service is the same as service package D.

Cross Country – (Birmingham New St to Manchester)
The level of service is the same as service package D

	'Do minimum' journey time	'Medium' package journey time
Birmingham – Manchester	1 hr 28 min	1 hr 12 min

Cross-country (Birmingham – Tamworth):
The level of service is the same as service packages D

	'Do minimum' journey time	'Medium' package journey time
Birmingham – Tamworth	15 min	12 min

Freight:

This option seeks to provide for the long term growth forecasts. This package provides infrastructure to allow segregation of long distance passenger services with key freight flows.

6.2.12 Interventions required to deliver WCML Service Package E

- A new two track railway bypassing Stafford (Colwich Jn to Norton Bridge)
- Grade separation (flyover junction) at Colwich Junction
- 125 mph capability Euston to Glasgow and in-cab signalling (ETCS)
- Increase in fast line speed through Crewe Station from 80 mph to 125 mph
- Remodelling of approach lines to Crewe, Wigan North Western and Preston
- Four tracks between Winsford and Weaver Junction
- Dynamic passing loops (5 miles long) between Oxenholme and Carstairs
- Line speed improvements between Birmingham and Manchester
- Dynamic passing loops (5 miles long) between Macclesfield and Congleton
- Four tracks between Sandwell and Dudley and Wolverhampton
- Three tracks between Smethwick Galton Bridge and Sandwell and Dudley
- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains that are stabled there – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.
- Four tracks between Duddeston Jn and Water Orton (approx 8 miles) including re-building Water Orton Station. This will include an upgrade of existing goods lines.

The total cost of delivering these interventions is estimated to be £3.3bn.

6.2.13 WCML Service Package F ('Lower' output scenario with HS2 Phase One)

This package provides a small increment above the 'do minimum' position to accommodate increased demand. All trains are assumed to be 11 carriages compared to a mixture of 9 and 11 carriages in the 'do minimum'. This is achieved primarily through train lengthening with a small number of infrastructure interventions to support improvements to train quantum and is therefore the lowest cost option. This service package does not deliver significant improvements to journey time or journey opportunities.

Overview of WCML service package F:

Intercity:

The level of service frequency is the same as that shown in service packages A and B ('High' and 'Medium' outputs) achieved through delivering HS2 Phase One. The low output does not deliver Stafford Bypass, 125 mph line speed throughout the London to Glasgow route or dynamic passing loops. In the 'Low' output scenario infrastructure enhancements include; grade separation at Colwich Jn, passing loops at Shap and Beattock and four tracks between Winsford and Weaver Junction.

The table below presents the indicative journey times that could be achieved on fast trains between key cities.

	'Do minimum' with HS2 Phase 1 journey time	'Low' package journey time
London – Manchester	1 hr 40 min	1 hr 39 min
London – Liverpool	1 hr 46 min	1 hr 49 min
London – Glasgow	3 hr 54 min	3 hr 58 min

Suburban / Commuter – (London to Watford, Tring, Milton Keynes & Northampton)

The level of service is the same as service packages D and E.

Coventry Corridor – (Birmingham New St to Coventry)

The level of service is the same as service packages D and E.

Cross Country – (Birmingham New St to Manchester)

The level of service is:

- 2 tph Birmingham New St to Manchester (all trains increase from 4 to 5 cars), no increase in train frequency or reduction in end to end journey times.

Cross-country (Birmingham – Tamworth):

Trains lengthened from 4 to 5 cars to 10 cars to provide additional seating capacity with no decrease in journey time or increase in train frequency.

	'Do minimum' journey time	'Low' package journey time
Birmingham – Tamworth	15 min	15 min

6.2.14 Interventions required to deliver WCML Service Package F

- Grade separation (flyover junction) at Colwich Junction
- Increase in fast line speed through Crewe Station
- Remodelling of approach lines to Crewe, Wigan North Western and Preston
- Four tracks between Winsford and Weaver Junction
- Static 775m passing loops provided at Shap and Beattock in CP5
- Infrastructure works at Reading depot to accommodate 10 car Cross Country trains – west junction remodelling to allow Plats 1 to 3 to be extended from 5 cars to 10 car length: with associated signals and permanent way.

The total cost of delivering these interventions is estimated to be £0.9bn.

6.3 Midland Main Line

6.3.1 Route Context

The rail network in the East Midlands serves a diverse set of markets ranging from long distance and commuter travel into London, commuting and leisure travel into the three cities of Derby, Leicester and Nottingham, plus a mixture of long distance and commuter travel on the interurban services that pass through the area together with some slightly lighter-used services to the east. The route is also of vital importance to freight, particularly as a link in the intermodal network, but also in supplying coal fired power stations and providing aggregates from several quarries in the East Midlands to major construction projects, particularly in the south east.

The Midland Main Line (MML) connects much of the East Midlands, the northern half of the Thameslink corridor, with London. The electrified corridor between London and Bedford supports an intensive inner and outer suburban service in addition to intercity services proceeding further north, principally to Derby, Nottingham and Sheffield. The northern part of the route also provides a key element of the north east – south west cross-country route giving access from Scotland, the North East and Yorkshire to Birmingham and places beyond. It allows intercity services to operate at speeds of up to 125 mph.

6.3.2 Constraints and assumed infrastructure changes

The table below describes the current constraints on the WCML as well as the infrastructure improvements that are assumed for the 'do minimum' case.

MML Current constraints and impacts of 'do minimum' schemes

Current Constraint	'do minimum' scheme addressing constraint
The lack of electrification between Bedford, Nottingham and Sheffield;	Electrification from Bedford to Nottingham and Sheffield
The lack of a 4 track railway between north of Bedford (Sharnbrook Junction) and just north of Kettering, Kettering North Junction;	4 tracking from Bedford to Kettering to increase capacity and reduce journey times
Crossing movements in the Leicester area by east-west freight conflicting with north-south passenger services;	Scheme at Leicester to segregate MML passenger services from E-W freight and increase capacity
Derby Station crossing movements due to conflicts between Birmingham/Sheffield and Nottingham/London flows	Remodelling of Derby station to segregate flows and improve journey times
The lack of track capacity and electrification between Birmingham and Derby;	Birmingham to Derby assumed to be electrified in CP6
The lack of electrification in South Yorkshire, particularly Sheffield to Doncaster and Wakefield.	Sheffield to Doncaster and Wakefield (South Kirkby)

	assumed to be electrified in CP6
Kettering – Corby/Manton. Limited capacity as a result of single line between Kettering North Junction and Corby station and signalling between Corby and Manton Junction. Infrastructure works to double the track from Corby and improve signalling headways to Manton.	Doubling Kettering to Corby included in the DM
Nottingham area - high level of conflicting moves at Trent Junctions.	Not addressed by the 'do minimum'
Platform congestion in Derby Station and high level of conflict between services, particularly to the south of the station at London Road Junction.	Development work is underway to remodel the layout at Derby and is included in the do minimum.
There is limited capacity at Dore Junction as a result of high level of conflicting moves between services.	Development work is underway as part of the Northern Programme to redouble the chord between Dore West Junction and Dore station Junction, provide a new platform, lengthen Heeley loop and the south between West Junction and South Junction. Doubling of the Dore junction is included in the do minimum.
London – Bedford - Speed differentials and mixed calling patterns between Thameslink, intercity and freight services. No mitigations planned or committed.	Not addressed by DM schemes
London St Pancras International Station (high level) -Platform congestion as intercity trains restricted to four platforms. An additional train per hour is planned in CP5 which will further increase congestion in the platforms. Development work is underway to identify the impact of different types of rolling stock configurations on the platforms at St Pancras and it is likely that some works will be required in CP5 although the extent and nature of the interventions will depend on the type of rolling stock selected to operate the electric intercity services on the MML.	Not addressed by DM schemes
Carlton Road Junction - High level of conflict between Thameslink services crossing from fast to slow lines, intercity trains into London and trains from the Tottenham and Hampstead line. The increase in quantum of train services planned in CP5 will place further pressure on this junction. Beyond plans committed in CP4 to increase the linespeed through the junction as part of the Peak Forest to London Train Lengthening scheme, there are no mitigations planned	Not addressed by DM schemes

or committed at this location.	
Bedford Station - Platform congestion as a result of the number of terminating services, difficulties accessing the depot at Cauldwell and the lack of a fast line platform for intercity services. The number of empty coaching stock moves into Cauldwell and Jowett sidings before the morning peak, will necessitate timetable and infrastructure changes in the Bedford area to support the increase in quantum of train services planned in CP5. Analysis is underway to identify the alternative options which are likely to include a reduction in the number of services terminating at Bedford combined with alternative facilities to turn round services either north or south of Bedford station. These interventions are likely to be developed as part of the MML Capacity scheme that was included in the Strategic Business Plan (SBP).	Not addressed by DM schemes
Beyond CP5, the implications of the introduction of additional freight and/or passenger services as part of the Electric Spine are still being investigated. However, any further increase in train services through the Bedford station area is likely to require major capacity interventions.	Not addressed by DM schemes

6.3.3 MML Service Package A ('High' output option without HS2 Phase One)

This package does not assume the implementation of HS2 and assumes that the MML all continues to serve as now. It aims to provide increased capacity to support growth in the long distance, freight, cross-country and suburban markets.

Journey time and connectivity improvements are assumed on intercity, suburban and cross-country services. To support this level of service, various major infrastructure upgrades are provided along the route and a section of new route is provided from Corby into Nottingham station.

Overview of MML service package A:

Intercity:

A total of six long distance services are provided per hour, as per the 'do minimum' and is primarily comprised of lengthening services. The indicative service pattern assumed is as follows:

- 1tph London St Pancras – Sheffield via Derby
- 1tph London St Pancras – Sheffield via Erewash
- 1tph London St Pancras – Derby
- 1tph London St Pancras – Nottingham via main line
- 1tph London St Pancras – Nottingham via Corby (new route)
- 1tph London St Pancras – Sheffield via Corby and Nottingham (new route)

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

Journey times to Sheffield are reduced as a result of linespeed enhancements along the route (including by-passes at Wellingborough and Market Harborough) and one of the two Sheffield trains being diverted via an upgraded Erewash line. Nottingham and Corby journeys are also faster due to a combination of linespeed enhancements and alterations to calling patterns.

A new route in to Nottingham is provided from the Corby line. No direct journey time reduction has been attributed to this new route as the scheme is not developed enough to understand this. However, the route is shorter than the existing route to Nottingham and so additional journey time reductions may be possible.

One of the Sheffield trains is assumed to go via this new route and continue to the Erewash line, where it could potentially call at Erewash stations to connect these stations to the southern end of the route.

The table below presents the indicative journey times that could be achieved on fast trains with this service level and interventions.

	‘do minimum’ journey time	High package journey time
London - Sheffield (via Derby)	1hr 55 (3 calls)	1hr 47 (4 calls)
London - Sheffield (via Erewash)	Journey does not exist in the do minimum.	1hr39 (3 calls)
London - Nottingham (via mainline)	1hr 45 (8 calls)	1hr35 (6 calls)
London - Nottingham (via Corby)	1hr 08 to Corby (4 calls) This London – Nottingham route does not exist in the do minimum.	52mins to Corby (no stops) 1hr23 to Nottingham (assumes same JT as mainline. May be able to reduce by 1 - 5 mins depending on new route alignment)

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

It may also provide the opportunity for additional freight paths between West Midlands and South Yorkshire, due to the route upgrades that are assumed to support the increase in cross-country quantum.

Cross-country:

This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph. This is to take advantage of infrastructure enhancements which are assumed on the Tamworth – Burton and Chesterfield – Dore corridors along with the route upgrades that are assumed in the East Coast Main Line packages.

These infrastructure improvements are also assumed to facilitate an increase to three trains per hour between Birmingham and Sheffield to meet usage estimated for 2036 and improve connectivity.

New journey opportunities are provided by extending a service from Nottingham to the north of the ECML, via Newark. This provides two trains per hour between Nottingham and Doncaster, York and Newcastle, with one train an hour extended to Edinburgh.

The Birmingham – Leicester service is assumed to be extended to Nottingham to improve connectivity and the Leicester to Lincoln train is faster due to alterations to calling patterns.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

Four peak-busting services are proposed to run from Luton into London St Pancras International high level over and above those train services operated in the 'do minimum'. These services would only run in the peak and would call at stations south of Luton as demand requires. This would also provide significant connectivity benefits as it would double the number of peak services from Luton and St Albans, with other stations also benefitting.

Infrastructure upgrades are proposed to support these additional services, including upgrading the Hendon Lines and a tunnel between Carlton Road and Finchley Road.

6.3.4 Interventions required to deliver MML Service Package A

The packages all assume MML intercity rolling stock at speeds no higher than 125 mph as this would remain the prevailing linespeed on the majority of the route under all scenarios. However, where possible, the infrastructure recommended in these packages is specified at 140 mph in order to futureproof the route, as it is assumed DfT may wish to pursue a progressive enhancement of the remaining infrastructure as renewals are undertaken and decisions are made about future rolling stock. The journey time assumptions in this report are too high level for the differential between 125 mph and 140 mph on the sections in question to make a significant impact.

- Platform and infrastructure work at London St Pancras International to support this train lengthening alongside additional suburban services
- High speed grade separated junction between Harpenden and Luton Airport Parkway
- Wellingborough by-pass: construction of two straight tracks on a viaduct to by-pass Wellingborough
- Market Harborough by-pass: construction of two straight tracks on a viaduct to by-pass Market Harborough
- Straighten the lines between Sileby and Loughborough to support 140 mph
- Erewash track realignment to increase linespeeds to 140 mph
- Connect Corby to Nottingham through refurbishment and new tracks to 140 mph
- Remodel Sheffield Station to include one new platform and remove potential conflicts
- Electrify the lines between Corby and Manton
- Increase linespeeds from Leicester to Bedford to 140 mph
- Install static freight loop in the Manton area to accommodate 775m freight
- Install 1.5 miles of twin track tunnel at Kentish Town
- Upgrade Hendon lines to 110 mph
- Turnback in the Luton area
- Four track Tamworth to Burton at 140 mph
- Rebuild Burton on Trent station to accommodate fast line down centre of station
- One additional platform at Chesterfield station and extend platforms
- Upgrade Chesterfield to Dore line to 140 mph
- Grade separate Stenson junction

The total cost of delivering these interventions is estimated to be £5.6bn.

6.3.5 MML Service Package B ('Medium' output scenario without HS2 Phase One)

This package provides a small increment above the 'do minimum' to cater for increased demand on intercity and cross-country services. This is achieved through train lengthening. Two additional suburban services are also provided to help meet the usage predicted for 2036.

A small journey time reduction is assumed on the cross-country services via provision of a freight loop on the Up line at Elford to improve interworking on the corridor. Additionally, journey time savings are assumed on the fast Sheffield services by diverting the train via an upgraded Erewash line.

Overview of MML service package B:

Intercity:

A total of six long distance services are provided per hour, as per the 'do minimum' train service assumptions.

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Analysis undertaken in the East Midlands RUS examined 11x23m and 10x26m EMU vehicles and indicated that this level of service would likely cater for demand into the 2030s. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

This package offers minimal improvement to connectivity, as it does not include the linespeed enhancements at the southern end of the route that were included in the high package. A journey time improvement has been assumed on the fast Sheffield service by re-routing via an upgraded Erewash line.

The table below presents the indicative journey time which could be achieved with this service diversion.

	'do minimum' journey time	Medium package journey time
London St Pancras International – Sheffield via Erewash	Journey does not exist in the do minimum.	1hr 46 (2 calls via upgraded Erewash)[12]

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford

[12] This journey time includes a three minute reduction from this service not being able to call at Derby station as the fast Sheffield train does today (resulting in only two calls instead of three).

- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

Cross-country:
Cross-country trains are extended to 10-car electric rolling stock to provide additional capacity.

A freight loop is also provided on the Up line at Elford to accommodate freight growth on the corridor alongside the cross-country service. This would improve interworking on the corridor and allow some performance allowance to be removed from the cross-country services, which would enable minor journey time improvements.

Suburban:
The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

Two peak-busting services are proposed to run from Luton into London St Pancras International high level over and above those train services operated in the 'do minimum'. These services would only run in the peak and would call at stations south of Luton as demand requires.

These services are supported by the infrastructure work at London St Pancras International and the provision of a turnback in the Luton area. It is thought that if these services are operated by high speed electric rolling stock, and flighted with the other services to optimise the capacity of the route; they may be able to be accommodated on the remaining 'do minimum' infrastructure. However, even if this is possible, it may impact on route performance and so inclusion of infrastructure enhancements at Hendon and Carlton Road would need to be considered.

6.3.6 Interventions required to deliver MML Service Package B

- Platform and infrastructure work at London St Pancras International to support train lengthening alongside additional suburban services
- Upgrade Hendon lines to 110 mph
- Erewash track realignment to increase linespeeds to 140 mph
- Turnback in the Luton area
- Install static freight loop in the Manton area to accommodate 775m freight
- Electrified freight loop at Elford
- One additional platform at Chesterfield station and extend platforms

The total cost of delivering these interventions is estimated to be £0.4bn.

6.3.7 MML Service Package C ('Lower' output scenario without HS2 Phase One)

This package provides a small increment above the 'do minimum' position to accommodate increased demand on intercity and cross-country services. This is achieved through train lengthening.

Additionally, minor journey time savings are assumed on the fast Sheffield services by diverting the train via the Erewash line.

Overview of MML service package C:

Intercity:

A total of six long distance services are provided per hour, as per the 'do minimum' train service assumptions.

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Analysis undertaken in the East Midlands RUS examined 11x23m and 10x26m EMU vehicles and indicated that this level of service would likely cater for demand into the 2030s. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

This package offers minimal improvement to connectivity. A journey time improvement has been assumed on the fast Sheffield service by re-routing via the Erewash line, though the journey time benefit is limited by the characteristics of the line.

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

Cross-country:

This package offers no increase in the quantum of cross-country services on the route. Trains are extended to 10-car electric rolling stock to provide additional capacity.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work. No capacity relief is provided beyond that included in the 'do minimum' train service specifications.

6.3.8 Interventions required to deliver MML Service Package C

- Platform alterations and infrastructure work at London St Pancras International to support intercity train lengthening
- Extend Chesterfield station platforms

The total cost of delivering these interventions is estimated to be £40m.

6.3.9 MML Service Package D ('High' output scenario with HS2 Phase One)

This package assumes the implementation of HS2 with a connection into the existing network at Handsacre Junction. This provides the opportunity to run some services to MML destinations via HS2 and a new connection into an upgraded Lichfield freight line. The package aims to provide increased capacity to support growth in the long distance, freight, cross-country and suburban markets.

Journey time and connectivity improvements are assumed on MML intercity, suburban and cross-country services, supported by infrastructure upgrades along the route. The cross-country improvements also benefit those services coming off the HS2 network as they are assumed to run via the same route into Derby.

Overview of MML service package D:

Intercity:

A total of eight long distance services are provided per hour. . This compares to six in the 'do minimum'. The indicative service pattern assumed is as follows:

- 2tph HS2 – Sheffield via Derby
- 2tph London St Pancras – Nottingham via main line
- 1tph London St Pancras – Nottingham via Corby-Manton-Syston corridor
- 1tph London St Pancras – Derby
- 1tph London St Pancras – Sheffield
- 1tph London St Pancras - Corby

The fast trains from London to Sheffield run via HS2 and the upgraded cross-country route, resulting in a considerable journey time reduction at the southern end of the MML. The Nottingham – Leicester flow also benefits from improvements to cross-country services.

Nottingham and Corby journeys are also faster due to a combination of linespeed enhancements on the MML (including by-passes at Wellingborough and Market Harborough) and alterations to calling patterns.

Some services are assumed to run through Corby and on to Nottingham via the via Corby-Manton-Syston corridor. This is supported by electrification of the Corby – Manton route and would potentially enable calls at Melton Mowbray and Oakham, subject to demand.

The semi-fast Sheffield train is assumed to run via the Erewash line, where it could potentially call at Erewash stations to connect these stations to the southern end of the route.

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

The table below presents the indicative journey times that could be achieved on fast trains with this service level and interventions.

	'do minimum' journey time	High package journey time
HS2 - Sheffield	1hr 55 (2 calls) via mainline	1hr20 - 1hr25 (2 calls on MML)
HS2 - Sheffield	1hr 55 (3 calls) via mainline	1hr23 - 1hr28 (3 calls on MML)
London - Nottingham	1hr 33 (3 calls)	1hr20 (2 calls)
London - Nottingham	1hr 33 (3 calls)	1hr 17 (1 call)
London - Corby	1hr 08 (4 calls)	1hr 05mins (3 calls)

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

It may also provide the opportunity for additional freight paths between West Midlands and South Yorkshire, due to the route upgrades that are assumed to support the increase in cross-country quantum.

Cross-country:

This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph. This is to take advantage of infrastructure improvements that are assumed on the Tamworth – Burton and Chesterfield – Dore corridors along with the route upgrades that are assumed in the East Coast Main Line packages.

These infrastructure improvements are also assumed to facilitate an increase to three trains per hour between Birmingham and Sheffield to provide additional capacity and improve connectivity.

The Birmingham – Leicester service is assumed to be extended to Nottingham to improve connectivity and the Leicester to Lincoln train is faster due to alterations to calling patterns.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

Four peak-busting services are proposed to run from Luton into London St Pancras International high level over and above the services in the 'do minimum'. These services would only run in the peak and would call at stations south of Luton as demand requires. This would also provide significant connectivity benefits as it would double the number of peak services from Luton and St Albans, with other stations also benefitting. However, even if this is possible, it may impact on route performance and so inclusion of infrastructure enhancements at Hendon and Cartlon Road are desirable.

6.3.10 Interventions required to deliver MML Service Package D

- Platforms and infrastructure work at London St Pancras International to support this train lengthening alongside additional suburban services
- High speed grade separated junction between Harpenden and Luton Airport Parkway
- Wellingborough by-pass: construction of two straight tracks on a viaduct to by-pass Wellingborough
- Market Harborough by-pass: construction of two straight tracks on a viaduct to by-pass Market Harborough
- Straighten the lines between Sileby and Loughborough to support 140 mph
- Erewash track realignment to increase linespeeds to 140 mph
- Connect Corby to Nottingham through refurbishment and new tracks to 140 mph
- Remodel Sheffield station to include one new platform and remove potential conflicts
- Electrify the lines between Corby and Manton
- Increase linespeeds from Leicester to Bedford to 140 mph
- Install static freight loop in the Manton area to accommodate 775m freight
- Grade separate Wichnor junction at 140 mph
- Upgrade Lichfield freight lines to 140 mph
- Install new chord from HS2 to Lichfield freight line to allow 140 mph
- Turnback in the Luton area
- Rebuild Burton on Trent station to accommodate fast line down centre of station
- One additional platform at Chesterfield station and extend platforms
- Increase linespeeds from Nottingham to Newark to 140 mph
- Grade separate Stenson junction

The total cost of delivering these interventions is estimated to be £5.6bn.

6.3.11 MML Service Package E ('Medium' output scenario with HS2 Phase One)

This package assumes the same long distance service structure as the 'With HS2 High' scenario, including running via HS2 and connecting into Lichfield freight line, but does not implement any line speed enhancements on the MML or cross-country routes. This means the journey time reductions are not as great.

A small journey time reduction is assumed on the cross-country services via provision of a freight loop on the Up line at Elford to improve interworking on the corridor. To additional suburban services are provided to provide additional capacity.

Overview of MML service package E:

Intercity:

A total of six long distance services are provided per hour, as per the 'do minimum' train service assumptions.

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Analysis undertaken in the East Midlands RUS examined 11x23m and 10x26m EMU vehicles and indicated that this level of service would likely cater for demand into the 2030s. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

This package assumes the same long distance service structure as the 'With HS2 High' scenario, including running via HS2, but does not implement any line speed enhancements on the MML or cross-country routes. This means the journey time reductions are not as great.

The table below presents the indicative journey times that could be achieved on fast trains with this service level and interventions.

	'do minimum' journey time	Medium package journey time
HS2 – Sheffield	1hr 55 (3 calls) via mainline	1hr40 (2 calls on MML)
HS2 – Sheffield	1hr 55 (3 calls) via mainline	1hr43 (3 calls on MML)
London St Pancras – Nottingham	1hr 30 (3 calls)	1hr27 (2 calls)
London St Pancras – Nottingham	1hr 30 (3 calls)	1hr 24 (1 call)
London St Pancras - Corby	1hr 08 (4 calls)	1hr 05mins (3 calls)

Freight:

Based on a high level view of the available capacity to meet long term freight forecasts, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford

- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

Cross-country:
Cross-country trains are extended to 10-car electric rolling stock.

A freight loop is also provided on the Up line at Elford to accommodate freight growth on the corridor alongside the cross-country service. This would improve interworking on the corridor and allow some performance allowance to be removed from the cross-country services, which would enable minor journey time improvements.

Suburban:
The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

Two peak-busting services are proposed to run from Luton into London St Pancras International high level over and above those in the 'do minimum'. These services would only run in the peak and would call at stations south of Luton as demand requires.

6.3.12 Interventions required to deliver MML Service Package E

- Platform and infrastructure work at London St Pancras International to support this train lengthening alongside additional suburban services
- Electrify the lines between Corby and Manton
- Increase linespeeds from Leicester to Bedford to 140 mph
- Install static freight loop in the Manton area to accommodate 775m freight
- Grade separate Wichnor junction at 70 mph
- Install new chord from HS2 to Lichfield freight line to allow 140 mph
- Turnback in the Luton area
- Extend platforms at Chesterfield station
- Electrified freight loop at Elford

The total cost of delivering these interventions is estimated to be £1.3bn.

6.3.13 MML Service Package F ('Lower' output scenario with HS2 Phase One)

This package provides a small increment above the 'do minimum' position to accommodate increased demand on intercity and cross-country services. This is achieved through train lengthening. There are no interventions targeted at relieving suburban crowding, however some capacity relief would be provided from the lengthening of the intercity trains.

Additionally, minor journey time savings are assumed on the fast Sheffield services by diverting the train via the Erewash line, though the journey time benefit is limited by the characteristics of the line. The package seeks to cater for long term freight growth forecasts and those indicated in the draft Freight Market Study.

Overview of MML service package F:

Intercity:

A total of six long distance services are provided per hour, as per the 'do minimum' train service assumptions.

All long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group compared with between six to eight carriages in the 'do minimum'. Analysis undertaken in the East Midlands RUS examined 11x23m and 10x26m EMU vehicles and indicated that this level of service would likely cater for demand into the 2030s. Infrastructure work at London St Pancras International has been included in the package to support this train lengthening alongside additional suburban services.

This package offers minimal improvement to connectivity, a minor journey time improvement has been assumed on the fast Sheffield service by re-routing via the Erewash line.

The table below presents the indicative journey time that could be achieved with this service diversion

	'do minimum' journey time	Low package journey time
London St Pancras – Sheffield via Erewash	Journey does not exist in the do minimum.	1hr 49 (2 calls via Erewash)[13]

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

Cross-country:

This package offers no increase in the quantum of cross-country services on the route. Trains are extended to 10-car electric rolling stock.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

[13] [13] This journey time includes a three minute reduction from this service not being able to call at Derby station as the fast Sheffield train does today (resulting in only two calls instead of three).

No capacity relief is provided beyond that included in the 'do minimum' train service specifications. Some limited capacity relief would be provided from the lengthening of intercity services.

6.3.14 Interventions required to deliver MML Service Package F

- Platform alterations and infrastructure work at London St Pancras International to support intercity train lengthening
- Extend Chesterfield station platforms

The total cost of delivering these interventions is estimated to be £0.04bn.

6.3.15 MML Service Package G ('High' output scenario without HS2 Phase One and running some services via ECML)

This package does not include trains running via HS2 but is assumed to operate in conjunction with the ECML High package, which allocates two train paths per hour to run to MML destinations. These services run to Nottingham, via an upgraded route between Nottingham and Newark, resulting in reduced journey times. The package aims to provide capacity to support growth in the long distance, freight, cross-country and suburban markets. Journey time and connectivity improvements are assumed on MML intercity, suburban and cross-country services, supported by infrastructure upgrades along the route.

Overview of MML service package G:

Intercity:

A total of eight long distance services are provided per hour:

- 2tph London King's Cross – Nottingham via ECML
- 1tph London St Pancras – Sheffield via Erewash
- 1tph London St Pancras – Sheffield via Derby
- 1tph London St Pancras – Nottingham via main line
- 1tph London St Pancras – Derby
- 1tph London St Pancras – Corby
- 1tph London St Pancras – Nottingham via Corby-Manton-Syston corridor

The fast Nottingham trains are routed via the ECML which results in journey time reductions and released capacity at the southern end of the MML to better serve intermediate markets, such as improved London – Leicester connectivity. Sheffield and Corby journeys are also faster due to a combination of linespeed enhancements on the MML (including by-passes at Wellingborough and Market Harborough) and alterations to calling patterns.

Some services are assumed to run through Corby and on to Nottingham via the via Corby-Manton-Syston corridor. This is supported by electrification of the Corby – Manton route and would potentially enable calls at Melton Mowbray and Oakham, subject to demand.

All MML long distance services are assumed to be lengthened to the equivalent of 11x23m vehicles in the peak, depending on what is most appropriate for the service group.

The table below presents the indicative journey times that could be achieved on fast trains with this service level and interventions.

	'do minimum' journey time	High package journey time
King's Cross- Nottingham	1hr 30 (3 calls) via mainline	1hr15 (no calls)
London St Pancras- Nottingham	1hr 45 (8 calls)	1hr28 (5 calls)
London St Pancras – Sheffield (via Erewash)	Journey does not exist in the do minimum.	1hr39 (3 calls)
London St Pancras – Sheffield (Derby)	1hr 53 (3 calls)	1hr 53 (6 calls)
London - Corby	1hr 08 (4 calls)	1hr 05mins (3 calls)

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

It may also provide the opportunity for additional freight paths between West Midlands and South Yorkshire, due to the route upgrades that are assumed to support the increase in cross-country quantum.

Cross-country:

This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph. This is to take advantage of infrastructure improvements which are assumed on the Tamworth – Burton and Chesterfield – Dore corridors along with the route upgrades that are assumed in the East Coast Main Line packages.

These infrastructure improvements are also assumed to facilitate an increase to three trains per hour between Birmingham and Sheffield providing additional capacity and improve connectivity.

New journey opportunities are provided by extending a service from Nottingham to the north of the ECML, via Newark. This provides two trains per hour between Nottingham and Doncaster, York and Newcastle, with one train an hour extended to Edinburgh.

The Birmingham – Leicester service is assumed to be extended to Nottingham to improve connectivity and the Leicester to Lincoln train is faster due to alterations to calling patterns.

Suburban:

The 2018 Thameslink service level is assumed as part of the 'do minimum' for this work.

Four peak-busting services are proposed to run from Luton into London St Pancras International high level compared to the services operated in the 'do minimum'. These services would only run in the peak and would call at stations south of Luton as demand requires. This would also provide significant connectivity benefits as it would double the number of peak services from Luton and St Albans, with other stations also benefitting.

Infrastructure upgrades are proposed to support these additional services and it is thought that they would need to be operated with high speed electric rolling stock in order to be flighted with the other services on the route.

6.3.16 Interventions required to deliver MML Service Package G

- Additional platform and infrastructure work at London St Pancras International to support this train lengthening alongside additional suburban services
- High speed grade separated junction between Harpenden and Luton Airport Parkway
- Wellingborough by-pass: construction of two straight tracks on a viaduct to by-pass Wellingborough
- New Chord at Newark to allow cross country trains to run onto the ECML
- Market Harborough by-pass: construction of two straight tracks on a viaduct to by-pass Market Harborough
- Increase linespeeds from Grantham to Nottingham to 140 mph
- Straighten the lines between Sileby and Loughborough to support 140 mph
- Erewash track realignment to increase linespeeds to 140 mph
- Remodel Sheffield station to include one new platform and remove potential conflicts
- Electrify the lines between Corby and Manton
- Increase linespeeds from Leicester to Bedford to 140 mph
- Install static freight loop in the Manton area to accommodate 775m freight
- Install 1.5 miles of twin track tunnel at Kentish Town
- Upgrade Hendon lines to 110 mph
- Turnback in the Luton area
- Four track Tamworth to Burton at 140 mph
- Rebuild Burton on Trent station to accommodate fast line down centre of station
- One additional platform at Chesterfield station and extend platforms
- Upgrade Chesterfield to Dore line to 140 mph
- Increase linespeeds from Nottingham to Newark to as close to 140 mph as possible
- Grade separate Stenson junction

The total cost of delivering these interventions is estimated to be £5.2bn.

6.3.17 MML Service Package H ('High' output scenario with HS2 Phase One and running some services via ECML)

This package is assumed to operate in conjunction with the ECML High package, which allocates two train paths per hour to run to MML destinations. These services run to Nottingham, via an upgraded route between Nottingham and Newark, resulting in reduced journey times.

This package also assumes the implementation of HS2 with a connection into the existing network at Handsacre Junction. This provides the opportunity to run some services to MML destinations via HS2 and a new connection into an upgraded Lichfield freight line.

Journey time and connectivity improvements are also assumed on cross-country services, supported by infrastructure upgrades along the route. The cross-country improvements also benefit those services coming off the HS2 network as they are assumed to run via the same route into Derby and Sheffield.

The package also increases capacity to support growth in the long distance, freight, cross-country and suburban markets.

Overview of MML service package H:

Intercity:

A total of ten long distance services are provided per hour:

- 2tph London King's Cross – Nottingham via ECML
- 2tph HS2 – Sheffield
- 1tph London St Pancras – Sheffield via Derby
- 1tph London St Pancras – Sheffield via Corby and Erewash
- 1tph London St Pancras – Derby
- 1tph London St Pancras – Corby
- 1tph London St Pancras– East Midlands Parkway
- 1tph London St Pancras - Nottingham

The fast Nottingham trains are routed via the ECML and fast Sheffield trains are assumed to run via HS2, which results in journey time reductions for both service groups. Running these trains via alternative routes also releases significant capacity at the southern end of the MML. This package has utilised this capacity to better serve intermediate markets such as the North Northamptonshire commuter belt, however, it could also be utilised to run more freight services on the route.

Some services are assumed to run through Corby and on to Sheffield via the via Corby-Manton-Syston corridor. This is supported by electrification of the Corby – Manton route and would potentially enable calls at Melton Mowbray and Oakham, subject to demand.

The semi-fast Sheffield train is assumed to run via the Erewash line, where it could potentially call at Erewash stations to connect these stations to the southern end of the route.

All MML long distance services are assumed to be lengthened to the equivalent of 11x23m or 12x20m EMU vehicles in the peak, depending on what is most appropriate for the service group. However, no infrastructure enhancements are targeted at reducing MML intercity journey times in this package, as this is largely delivered by routing the Nottingham and Sheffield trains via alternative routes.

The table below presents the indicative journey times that could be achieved on fast trains with this service level and interventions.

	'do minimum' journey time	High package journey time
King's Cross- Nottingham	1hr 33 (3 calls) via mainline	1hr15 (no calls)
HS2 – Sheffield	1hr 55 (3 calls) via mainline	1hr40 (2 calls on MML)
HS2 – Sheffield	1hr 55 (3 calls) via mainline	1hr43 (3 calls on MML)
London St Pancras – Sheffield via Derby	1hr 53 (3 calls)	2hrs (5 calls)
London St Pancras – East Midlands Parkway	1hr20 (2 calls)	1hr20 (2 calls)
London St Pancras - Corby	1hr 08 (4 calls)	1hr 08mins (4 calls)

Freight:

Based on a high level view of the available capacity, the following freight flows have been assumed (further detailed work would be required to confirm that this is achievable):

- 2tph Carlton Road - Bedford
- 3tph north of Bedford
- 2tph Felixstowe to Nuneaton (crosses MML at Leicester)
- 3tph Birmingham - Sheffield (1 via Dore, 2 via Tapton)

It may also provide the opportunity for additional freight paths between West Midlands and South Yorkshire, due to the route upgrades that are assumed to support the increase in cross-country quantum.

Cross-country:

This service package assumes cross-country trains are extended to 10-car electric rolling stock that is capable of running at 140 mph. This is to take advantage of infrastructure improvements that are assumed on the Tamworth – Burton and Chesterfield – Dore corridors along with the route upgrades that are assumed in the East Coast Main Line packages.

These infrastructure improvements are also assumed to facilitate an increase to three trains per hour between Birmingham and Sheffield to provide additional capacity and improve connectivity.

New journey opportunities are provided by extending a service from Nottingham to the north of the ECML, via Newark. This provides two trains per hour between Nottingham and Doncaster, York and Newcastle, with one train an hour extended to Edinburgh.

The Birmingham – Leicester service is assumed to be extended to Nottingham to improve connectivity and the Leicester to Lincoln train is faster due to alterations to calling patterns.

Suburban:

The 2018 Thameslink service level is assumed and therefore there is no further increase in train services above the 'do minimum' and therefore there is no further increase in train services above the 'do minimum'.

6.3.18 Interventions required to deliver MML Service Package H

- One additional platform and Infrastructure work at London St Pancras International to support this train lengthening alongside additional suburban services
- Remodel Sheffield station to include one new platform and remove potential conflicts
- New Chord at Newark to allow cross country trains to run onto the ECML
- Electrify the lines between Corby and Manton
- Install static freight loop in the Manton area to accommodate 775m freight
- Increase linespeeds from Grantham to Nottingham to 140 mph
- New chord from HS2 to Lichfield freight line to allow 140 mph
- Grade separate Wichnor junction at 140 mph
- Upgrade Lichfield freight line to 140 mph
- Four track Tamworth to Burton at 140 mph
- Rebuild Burton on Trent station to accommodate fast line down centre of station
- One additional platform at Chesterfield station and extend platforms
- Upgrade Chesterfield to Dore line to 140 mph
- Increase linespeeds from Nottingham to Newark to as close to 140 mph as possible

The total cost of delivering these interventions is estimated to be £3.1bn.

7. OPERATIONAL RESILIENCE

In 2012, Network Rail undertook a study to understand the relationship between reliability, capacity and cost. The southern section of the West Coast Main Line (107 miles) was selected as the study area given its status as a key intercity passenger route in the UK as well as its handling of a significant proportion of the UK's rail freight traffic. A system level modelling tool produced by Det Norske Veritas (DNV) Ltd was used to estimate the effect of increasing frequency on reliability. The study looked at scenarios with more trains per hour than assumed in any of the packages discussed in this report.

The study found that the implementation of a high capacity future timetable[14] without measures to improve resilience would result in a significant deterioration from current performance levels, including an increased number of train cancellations. The operation of higher frequencies whilst delivering an acceptable level of performance would require additional investment in both infrastructure and rolling stock. This might include providing the ability for a vehicle to recover lateness by having trains that can accelerate faster, brake harder and travel faster than scheduled over certain sections of route.

In developing the train service specifications and associated infrastructure for the packages described in this report, reliability has not been specifically modelled. The infrastructure specified is capable of delivering the train service specifications but no detailed consideration has been made as to whether additional infrastructure would be required to ensure resilience of the services. As such, the cost estimates provided do not include any additional infrastructure that may be required to ensure resilience at higher frequencies.

[14] It should be noted that the study did consider scenarios with higher trains per hour than assumed in the packages presented in this report.

8. DELIVERABILITY

In developing the options required to deliver a step-change in capacity and connectivity, Network Rail has assessed the disruption to the existing network that would result from implementing them.

To deliver the benefits by 2033, many of the proposed interventions would need to be delivered at the same time and across multiple routes. This would have a significant impact on the entire network.

Whilst lessons have been learnt from Network Rail's delivery of the 10-year West Coast Route Modernisation Programme, the scale of infrastructure intervention required to deliver either the high or medium options would lead to weekend disruption on sections of the WCML, ECML and MML at the same time.

Based on previous works of similar nature (Thameslink Key Output 1, a £2Bn scheme comprising many of the type of interventions proposed in this report and requiring 21,000 hours of disruptive possessions and Hitchin, a £50m scheme of grade separation requiring 450 hours of disruptive possessions) an indication of the impact of the work can be broadly assessed on the basis of the total cost of the packages.

For the high option packages, the total disruption would be around 229,000 hours of possessions (around 4,400 weekends), a large proportion of this being west coast and east coast. Delivering three or four works at the same time would require 10's of years of weekend blockades.

For the medium option, the total disruption would be around 113,000 hours of possession (around 2,100 weekends). Delivering three or four works at the same time would require between 10 and 13 years of weekend blockades.

For the low options, the total disruption would be around 44,000 hours of possession (around 850 weekends). Delivering three or four works at the same time would require between 4 and 5 years of weekend blockades.

The higher output options in particular require substantial infrastructure to be constructed in areas of the network that are, by definition, bottlenecks and constraints. The impact of construction in these areas would both reduce the services able to be delivered through those sections and significantly degrade the capability of the network to respond to problems.

The lower level packages are much more readily deliverable but only deliver very modest levels of benefit.

These projects require complex planning and logistical organisation and normally only a few are carried out at any one time. There would also be a major requirement for buses and drivers for replacement services.

Network Rail's assessment of the disruption arising from the implementation of the interventions taken forward for economic case assessment in the Atkins report, is presented in Appendix 1.

APPENDIX 1: DELIVERABILITY OF INTERVENTIONS TAKEN FORWARD FOR ECONOMIC CASE ASSESSMENT

Introduction

Network Rail has assessed the strategic alternative upgrade packages presented in the HS2 Strategic Alternatives Report for the Department for Transport by Atkins for their disruption to the existing network.

To deliver the benefits by 2033, many of the proposed interventions would need to be delivered at the same time and across multiple routes. This would have a significant impact on the entire network.

Whilst lessons have been learnt from Network Rail's delivery of the 10-year West Coast Route Modernisation Programme, the scale of infrastructure intervention required to deliver either the high or medium options would lead to weekend disruption on sections of the WCML, ECML and MML at the same time.

Disruptive possessions are times when works are undertaken and train services are reduced or stopped on sections of the railway to allow construction works to be undertaken without trains passing through the construction area. The disruption can be quantified as the number of hours when trains are to be prevented form entering the worksite.

Those schemes identified in the 'high' and 'medium' categories for each route in particular require significant works in areas of the network that are, by definition, bottlenecks and constraints. The impact of construction in these areas would both reduce the services able to be delivered through those sections and significantly degrade the capability of the network to respond to problems.

Additional programme planners, engineers, construction workers, plant, locomotives and specialist equipment would be required. The blockades required to deliver the work have far reaching effects in terms of diverting services and/or the transfer of passengers to bus replacement services. They require complex planning and logistical organisation and normally only a few are carried out at any one time. Where no suitable diversionary route exists there would also be a major requirement for buses and drivers for replacement services, all utilised at weekends and occasional weeknights only.

In the main, Network Rail utilise blockades at Christmas and Easter to deliver the more significant items of work; the recent weekday blockade at Nottingham for several weeks is outside this norm. These blockades have far reaching effects in terms of diverting services and the transfer of passengers to bus replacement services. They require complex planning and logistical organisation and normally only a few are carried out at any one time.

Estimated number of possessions and extent of potential travel impact

In order to illustrate the extent of the disruption that might occur were the existing network to be upgraded, a high level benchmarking exercise was undertaken using the refined

packages presented in the Atkins report. Based on previous works of similar nature (the first phase of Thameslink, a £2bn scheme comprising many of the type of interventions proposed in this report and requiring 21,000 hours of disruptive possessions, and Hitchin, a £50m scheme of grade separation requiring 450 hours of disruptive possessions) an indication of the impact of the work can be broadly assessed on the basis of the total cost of the packages.

In terms of programming the delivery of infrastructure required, it is anticipated that the majority of disruptive possessions would be scheduled to take place at weekends. Weeklong blockades would have the effect of shortening the build duration, but would preclude access to parts of the network during the weekday period. Longer term closures of the railway would reduce the total build time still further, but the disruption to commuter and business travel becomes prohibitive. Conversely, it would be possible to deliver works using only Sunday possessions or Saturday and Sunday night possessions to minimise disruption during weekend daytimes. However, this would allow only a limited number of hours of work to be undertaken before the railway needs to be returned to operational readiness. This would have the effect of significantly increasing the total duration of the construction time required.

The estimated number of weekend possessions required to deliver all of the infrastructure works for the options taken forward by Atkins are presented in the table below. It makes no allowance for any efficiencies that might be derived by simultaneous delivery of works.

	Package P1	**Package YA**	**Package YB**	**Package P2A**	**Package P2B**
Total hours of closures for all three routes	21,000 hours	144,900 hours	144,000 hours	123,600 hours	126,600 hours
Total weekend closures for all three routes	410 weekends	2,790 weekends	2,770 weekends	2,380 weekends	2,430 weekends

Assuming that all three routes would be worked on concurrently, undertaking multiple schemes on a given route simultaneously is possible but would bring additional logistical challenges. These include the nature and extent of the project, the availability of equipment and personnel, and the need to resource other construction activities elsewhere on the network. It has not been possible at this early level of development to provide a detailed assessment of the opportunities that might be available for work to be undertaken at more than one point on the network at a time. However, to give an indication of the time savings that might be realised, we have looked at the effect of one, two and three schemes being delivered at the same time.

The table below summarises the estimated level of disruption arising from the delivery of the packages, taking into account the above factors. This is presented both in terms of the total number of hours of disruptive possessions required as well as the equivalent number of Saturday / Sunday blockades required to deliver those hours. Equivalent weekends are

calculated by dividing the number of hours by 52 hours (the length of a weekend possession) and further dividing by 52 weekends per year. The critical path is determined by the route that has the highest level of disruptive works, which is the East Coast Main Line in all packages with the exception of package P1. Within the critical path window, it is assumed that works on the other routes take place within this timescale to ensure delivery by the planned high speed rail delivery dates of 2026 and 2033 for Phase 1 and Phase 2 respectively.

The table shows the likely disruption based on one, two and three schemes taking place on each route on every weekend of the year at any one time. It also shows the length of disruption assuming 24 hour working all year. In practice however, the later would not be possible.

It should be noted that these estimates are illustrative and would require considerable additional planning and refinement before they could be considered robust. Nevertheless, the exercise provides an idea of the scope of disruption that would occur should such a programme be instigated.

Summary of Disruptive Possessions Required by Package *[Note 1]*

	Package P1	Package YA	Package YB	Package P2A	Package P2B
Most affected route, which drives critical path	WCML	ECML	ECML	ECML	ECML
Number of hours of possessions	21,000 hours	77,000 hours	72,000 hours	74,000 hours	77,000 hours
Number of weekends of possessions (at 52 hours per weekend)	410 weekends	1,500 weekends	1,380 weekends	1,420 weekends	1,500 weekends
Years of disruption every weekend of the year assuming **1 scheme** on each route at any one time	8 years	29 years	26 years	27 years	29 years
Years of disruption every weekend of the year assuming **2 simultaneous schemes** on each route at any one time *[Note 2]*	4 years	14 years	13 years	14 years	14 years
Years of disruption every weekend of the year assuming **3 simultaneous schemes** on each route at any one time	3 years	10 years	9 years	9 years	10 years
Years of disruption working 24 hours a day, all year with **3 simultaneous worksites**.	0.8 years	2.9 years	2.7 years	2.8 years	2.9 years

Note 1: As a comparison, Thameslink Key Output 1 has a value of £2bn and has used 21,000 hours of disruptive possessions. For Packages YA, P2A and P2B, no disruption has been assumed for the off network work in constructing the new tracks from Alexandra Palace to Biggleswade

Note 2: Simultaneous worksites are undertaken on a route with other routes taking place concurrently. The driver for the duration of disruption is the ECML for all packages apart from P1 which is only delivered on the WCML.

In order to deliver in timeframes comparable to that for HS2, schemes on all three routes would need to be delivered concurrently. As can be seen, the number of disruptive possessions required ranges from 21,000 hours to 77,000 hours depending on the critical path. Assuming between two and three scheme could be delivered on each line simultaneously, the above table shows that it would take between 3 to 4 years to deliver Package P1 and between 10 and 14 years to deliver Package YA.

This does not mean that the whole line would be closed for this duration, and good planning, careful staging of works and the use of diversionary routes can serve in part to mitigate the impact on passengers. Nevertheless, Network Rail's conclusion is that, with the exception of P1, there is no way to undertake the upgrade programmes of this magnitude without it resulting in significant disruption to weekend rail travel on multiple routes over a lengthy period of time.

Illustrative Example of Passenger Experience

The specific impact on passengers would depend on factors such as the level of demand on the affected section, and the existence of diversionary routes. For instance, works on the Grantham to Nottingham section would clearly be less intrusive than works on the main ECML, and the existence of an electrified Joint Line would significantly mitigate disruption for works between Peterborough and Doncaster, whereas no similar alternative exists between York and Northallerton.

In order to demonstrate the potential effects on passenger travel of concurrent closures on the network, the following is a theoretical example where King's Cross Station throat remodelling, Huntingdon to Peterborough four-tracking and the construction of the Newark flyover and chord are occurring at the same time. At present, no work has been undertaken on planning a programme of works and this combination of schemes has been chosen purely by way of illustration.

Passenger journey: Leeds to London
Day of travel: Saturday
Normal journey time: approximately 2 hr 24
Normal frequency (direct): ½ hourly

1 - King's Cross Station throat remodelling

The effect of the work on passenger journeys depends on the complexity of the final scheme. If additional tunnels and platform lengthening is involved, modifications to the layout at Finsbury Park are likely to be required, involving a total blockade. This would require services either to be diverted via Cambridge to Liverpool Street or terminated at Stevenage with passengers being transferred onto rail replacement buses.

If the alterations are less extensive, it may be possible to do the works in partial platform blockades sweeping across from one side to the other to complete the works.

The effect of either option on train services, facilities, and passengers is extensive and would involve those using an alternative station due to the number of additional passengers involved.

Passenger experience assuming total blockage:
Effect on train service frequency: probably reduced
Effect on passenger journey time: increased by up to 60 minutes

2 - Huntingdon to Peterborough four-tracking

Weekend blockades would be required for connecting new lines into existing lines, assuming one new line on either side and one existing line can be blocked at a time. Occasional all line blocks will be required to close level crossings along the route. There would be extensive disruption to train services and passengers. Trains would either need to be diverted via Ely and Cambridge to Hitchin or via Cambridge to Liverpool Street. Alternatively, passengers would need to use rail replacement buses from Peterborough to Huntingdon or St Neots for local journeys or Peterborough to London.

Passenger experience:
Effect on train service frequency: probably reduced
Effect on passenger journey time: increased by 30 to 60 minutes.

3 - Newark flyover & chord

Weekend blockades would be required when connecting new lines into existing lines, although only one would be required to tie back into the ECML itself (the other blockages would affect the Nottingham – Lincoln Line). The proposed grade separated junction would require land take and may require rebuilding bridges in the way. This will inevitably have an impact on passengers and train services with passenger services diverted via the Joint Line.

Passenger experience:
Effect on train service frequency: probably reduced
Effect on passenger journey time: increased by 40 to 60 minutes

Overall impact of the three schemes in this example:

During construction, the effect of these schemes occurring simultaneous could be to increase the weekend journey time from Leeds to London by 130 minutes or more, almost double the normal scheduled time and possibly transferring to bus replacement services. In normal circumstances, passengers from the north of England would be advised to use the Transpennine route to travel to Manchester and then to London via the WCML, which adds approximately one hour to the journey. However, the need to upgrade the WCML at the same time as the ECML means that this option may not be available as the WCML would also encounter concurrent disruption.

Glossary

Acronym	Meaning
Classic Compatible	HS2 trains compatible with the existing network
ECML	East Coast Main Line
Existing Rail Network	The rail network as it will be in 2033 not including HS2 (Phase One or Two)
HS2	High Speed 2
MML	Midland Main Line
NR	Network Rail
NSP	Network Strategy and Planning
WCML	West Coast Main Line
ERTMS	The European Rail Traffic Management System (ERTMS) is an initiative backed by the European Union to enhance cross-border interoperability and the procurement of signalling equipment by creating a single Europe-wide standard for train control and command systems. The two main components of ERTMS are the European Train Control System (ETCS), a standard for in-cab train control, and GSM-R, the GSM mobile communications standard for railway operations. The equipment can further be subdivided between on-board and infrastructure equipment.
ETCS	The European Train Control System (ETCS) is a signalling, control and train protection system designed to replace the many incompatible safety systems currently used by European railways, especially on high-speed lines. ETCS requires standard trackside equipment and a standard controller within the train cab and is a key component of ERTMS.
HLOS	The High Level Output Specification (HLOS) sets out information for the Office of Rail Regulation and for the rail industry about what the Secretary of State wants to be achieved by railway activities during a railway control period.
IEP	The Intercity Express Programme is an initiative of the Department for Transport (DfT) to procure new trains to replace the InterCity 125 fleet on the East Coast Main Line and Great Western Main Line.
LSI	Line Speed Improvement
OLE	Overhead Line Equipment

Long Distance Market Study	The market studies have been developed in consultation with rail industry partners and wider stakeholders to build on the success of the route utilisation strategy programme. Each study identifies the strategic goals for the respective market over the next 30 years, forecasts the levels of demand that may need to be accommodated, and formulates conditional outputs that would be needed in order to meet those strategic goals. The market studies are available from the NR website.
Conditional Output	The conditional outputs from the market studies are a statement of the long term aspirations for the level of service provided and are required to inform future investment decisions. They form the basis for the rest of the Long Term Planning Process for a market. They are not constrained by considerations of cost, value for money and deliverability, which will be considered in subsequent stages of the LTPP.
Schedule 4 compensation	Schedule 4 compensates train operators for the impact of planned service disruption. Compensation is intended to cover fare revenue losses or costs, such as those associated with running replacement buses.
SBP	Strategic Business Plan