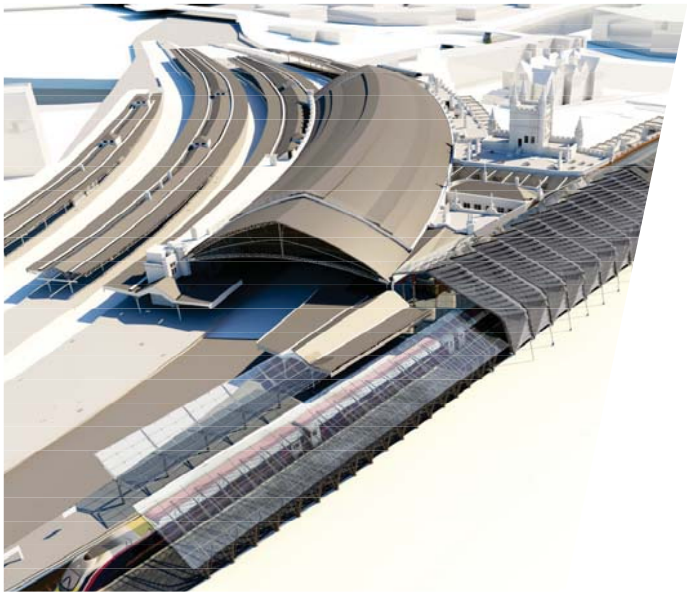
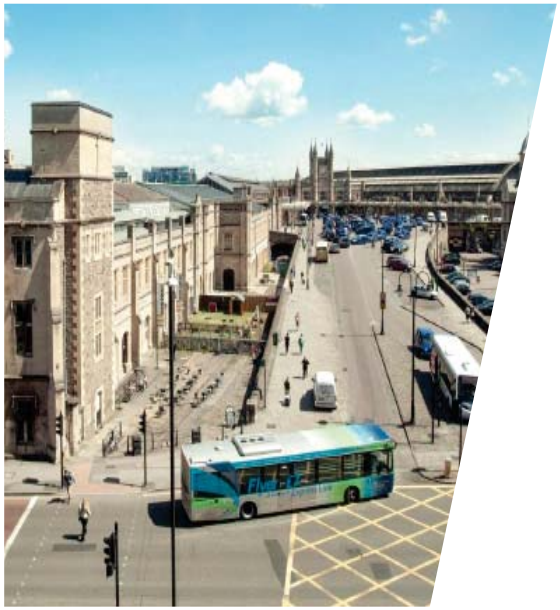
Western Route Study

Long Term Planning Process





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Foreword

We are delighted to present the Western Route Study, which sets out the strategic vision for the future of this vital part of the rail network over the next 30 years.

Today, the railway carries tens of millions of passengers a year. Working closely with industry stakeholders, Network Rail is delivering an ever expanding service provision for those passengers, and for freight users. More people are choosing to travel by train, and high levels of growth are predicted to continue, particularly around London Paddington and Bristol. Demand for freight is also expected to continue to grow, as it is increasingly recognised as an economically sensible and environmentally efficient form of transport.

This success brings challenges. Already improvement work has begun – removing the constraints at Reading, redoubling the Cotswold lines, increasing the linespeed on the Bristol to Birmingham corridor whilst preparing for Crossrail, the Intercity Express Programme, and the electrification of the Great Western Main Line to Newbury, Oxford, Bristol and South Wales.

The Western Route will be significantly transformed over the next five years which substantially impacts on requirements for the longer term. The longer-term planning horizon to 2043 is deliberate. It enables consideration of these changes in the context of longer-term developments underway, such as High Speed Two, with a view to creating a prioritised context of requirements for the next Control Period (Control Period 6, 2019 – 2024).

Development of this strategy has followed the Long Term Planning Process. Using future service characteristics (such as capacity, frequency, journey times) which the industry aspires to deliver over the next 30 years, the Western Route Study has developed options to deliver these outputs subject to value for money, deliverability and affordability. Analysis was undertaken into where the capacity and capability of the network in 2019 will be insufficient to accommodate these requirements, with a number of 'choices' identified initially utilising the existing network before identifying interventions for further infrastructure. These choices are presented in the strategy.

The dominant issue is the need to provide sufficient capacity in the peak periods, specifically to and from London but also for key centres such as Reading, Bristol and Exeter. It recognises the difficulties of seasonal variation in demand, station capacity requirements for pedestrian throughput and the need to improve resilience of the railway in order to maintain connectivity. The strategy identifies future opportunities for improving capacity, connectivity, journey times and optimising the delivery of interventions to achieve the best industry cost.

We would like to thank industry stakeholders for their participation in the Long Term Planning Process to develop this strategy. We would also like to thank all who took the time to provide their comments on the Draft for Consultation. Details on the consultation process can be found in Chapter 7.

Network Rail has led the production of this Route Study on behalf of the industry and as such it has been developed collaboratively with industry partners and wider stakeholders, including passenger and freight operators, the Department for Transport, Transport for London, Local Authorities and Local Enterprise Partnerships. We thank them all for their contribution.

Paul Plummer

Group Strategy Director

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Route Managing Director, Western

Executive Summary

The Western Route Study is a key part of the rail industry's Long Term Planning Process (LTPP); the choices presented are vital to inform decisions for Control Period 6 (CP6, 2019 - 2024).

It is recognised that the 2019 baseline used for the Western Route Study has the potential to change, with influences such as the Secretary of State for Transport-announced review of Network Rail's Control Period 5 enhancement programme and the recent Great Western Franchise Direct Award driving evolution of the current baseline.

As the options within the study represent a longer term view over the context of the next 30 years, the implications of any baseline revision are likely to be limited to the timing of the implementation of these options rather than the specific future choices themselves. We are therefore publishing this strategy noting that it reflects a point in time which could change. Should any influences significantly change the outputs of, and options identified within the strategy, we will review and update accordingly as part of the ongoing process to maintain the validity of the strategy.

Introduction

The LTPP consists of different elements of analysis which when taken together, seek to define the future capacity and capability requirements of the railway over the next 30 years. Individual elements include Market Studies, Route Studies and Cross-Boundary Analysis; all of which are detailed further in this document.

The Market Studies, established in December 2013, set future aspirations for the rail industry articulated as long-term strategic goals, demand forecasts over a 10- and 30-year horizon and Conditional Outputs. These Conditional Outputs are aspired levels of service in terms of frequency, journey time and/or passenger capacity on key flows. These Conditional Outputs are dependent on affordability, feasibility and value for money and they need to be deliverable technologically, operationally and physically.

The Conditional Outputs reflect emerging requirements building upon the previous planning and specification work that culminated in the publication of the suite of Network and Route Utilisation Strategies (RUSs). The Western Route Study assesses and develops choices to accommodate the mix of Conditional Outputs as applicable to the scope area for the Western Route Study and has sought to refine this analysis, using outputs from the Market Studies and RUSs, in the context of continuing development of major interventions such as Crossrail, Electrification and High Speed Two (HS2).

Scope

The Western Route Study sets out a strategy for a particular part of the rail network, the scope of which is extensive and diverse. The key axis is the Great Western Main Line (GWML) which operates over 320 miles and creates main line links from London to the West of England and South Wales. Extending from this are radial routes to Oxford, the Cotswolds, Birmingham, the South Coast and the South West. Branch lines into the inner and outer London suburbs, around Bristol and to the Devon and Cornish coasts plus dedicated freight-only lines complete the range of routes considered. This Route Study area plays a crucial role in the core cross-country network, linking the South Coast, Reading and South West of England with the Midlands, the North and Scotland. The scope area of the Western Route Study adjoins the Wessex, Anglia, West Midlands and Chilterns, and Welsh (including Wales and parts of the border counties of England) Route Studies which are all being developed as part of the LTPP.

Timeframe

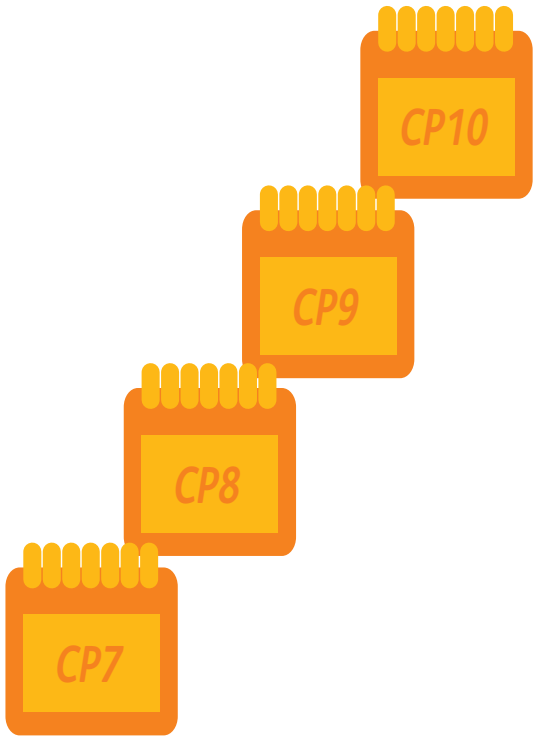
The planning horizon for the LTPP is a 30-year context from 2013 to 2043. The rail industry has developed this longer-term view to take into account consideration of network-wide, long-term strategic investments in the rail network such as HS2, further electrification and changes to signalling technology as well as requirements for the Digital Railway and future maintenance and renewal strategies, alongside a growing operational railway. The longer-term view inevitably brings uncertainties. Because of this, the LTPP is iterative. Future planning cycles will enable an updated view to take into account the changing context, economy and industry aspirations, and to re-prioritise requirements where necessary.

The objective of the LTPP is to understand this longer-term context whilst creating a prioritised view of requirements for the next Control Period. The LTPP provides a key part of the evidence base for future investment in the rail network. The Western Route Study considers the implications of growth, and the increased role the railway could play, over the next 30 years, with a primary focus on CP6 in order to present a clear strategy. The final output from the Route Studies is evidence-based choices for funders to determine the long-term use and development of the network. The industry's formal planning input for CP6 commences in September 2016 with the Initial Industry Plan (IIP).

Process

The starting point for the Western Route Study has been to construct a new base position for what the Western Route will look like in 2019. This is anticipated to be substantially different from today in terms of infrastructure, trains and service provision. The baseline takes today's rail network and adds any committed schemes or other specific interventions that are funded through development as detailed in Chapter 2.

Given the degree of change, there are a number of uncertainties in



developing the baseline for the Route Study. This is especially apparent regarding the proposed timetables resulting from the Intercity Express Programme (IEP), introduction of Crossrail services and First Great Western's Direct Award (from September 2015 to March 2019). The most recent development timetable for 2019 (known as 'Iteration 5') has been used as a basis for analysis. However, there are limitations with this which are subject to further, more detailed modelling. This includes requirements for future maintenance, engineering and access to train maintenance depot or stabling locations. Noting that Iteration 5 is unconfirmed, the Route Study has incorporated the high-level principles established within it, recognising that these may be subject to further change as work continues to develop and confirm the precise timetable through existing industry processes. Further timetable work will combine and commit the service specifications, along with wider requirements for access, to ensure their compatibility and accommodation on the network and as a result, further infrastructure interventions may be identified to be necessary.

The Market Studies have forecast demand for passenger and freight traffic over the next 10 and 30 years, and proposed Conditional Outputs for the industry to meet subject to feasibility, affordability and value for money. The Western Route Study has interpreted these Conditional Outputs to determine the specific aspirations in terms of capacity and connectivity for the geographical area.

These outputs have been consolidated into an Indicative Train Service Specification (ITSS) for a typical off-peak hour in 2043. This ITSS is initially developed as being unconstrained by network capacity. The ITSS was overlaid on the anticipated 2019 baseline infrastructure, taking account of committed schemes and other known interventions. This identifies constraints where the baseline infrastructure cannot accommodate the Conditional Outputs. These constraints were analysed to understand choices to address them. These choices include making best use of existing infrastructure, prior to enhanced infrastructure being considered. Consideration is given to the trade-offs between capacity, connectivity, journey times, performance and access requirements, in conjunction with assessments of affordability and value for money.

Detailed demand analysis has been undertaken to forecast growth utilising the demand forecasts from the Market Studies and tailoring these to create specific forecasts for geographical areas. The analysis identifies where forecast demand is likely to be mismatched with anticipated capacity and thus identifies where interventions such as train lengthening or additional services may be required to accommodate growth in demand (over and above those in the ITSS).

Choices for Funders in Control Period 6

To identify the strategy for CP6, the longer-term requirements to 2043 have been prioritised, the process of which has been based on the Long Term Planning Process criteria:

- the intervention is required to accommodate passenger and/or freight demand in CP6
- there is a renewal due in CP6 that presents an opportunity for enhancement and would represent the lowest Whole Life Cost for delivery
- the intervention delivers whole-industry cost savings
- identified funder priorities for CP6
- investing in better connectivity to HS2.

Electrification is a strategic option that relates to the overall rail network. This is being addressed through a refresh of the Network RUS: Electrification Strategy. It is not intended to duplicate it in this Route Study. Discussion of electrification has been included where it presents a choice to accommodate Conditional Outputs, or where electrification is an identified funder priority.

The Route Study has identified the need in the longer-term to reduce planning headways (and so increase track capacity) on several sections across the area: London Paddington – Didcot – Oxford, Reading – Taunton, Didcot Parkway – Bristol Parkway, Newton Abbot – Plymouth and the Paignton line. Introduction of proposed new signalling technology and rail traffic management systems creates an opportunity to consider the planning headways required on routes as the new technology is introduced. Elsewhere conventional resignalling is likely to represent the lowest cost opportunity to provide reduced planning headways and this should

be considered at the time of renewal.

Analysis has shown that a more standardised fleet of rolling stock, providing greater harmonisation of train speeds and acceleration, would enable greater efficiency in the utilisation of network capacity in key areas. This would also reduce conflicts in terms of differing rolling stock speed capabilities and the impact on end to end journey times. The Network RUS: Rolling Stock explored the potential for significant economies of scale through procuring a smaller, standardised range of stock types targeted at specific market sectors. The Western Route Study has provided evidence to support this particularly on the routes into London Paddington, to Basingstoke and on the Berks & Hants line to Taunton.

The choices identified as part of the Western Route Study are summarised below with a more detailed description provided in Chapter 5. The outline strategy for CP6 is presented in Chapter 6.

Forecasts of rail passenger demand for Relief Line services between London Paddington and Reading indicate that the capacity anticipated to be provided in the 2019 ITSS is sufficient to accommodate inner suburban demand until 2023; beyond 2023, additional capacity will be required. Analysis also indicates that further capacity will be required to accommodate forecast passenger demand from 2026, following the opening of the proposed HS2 station at Old Oak Common. The analysis does not however take into account the impact on demand of the proposal, developed outside of this Route Study, to extend Crossrail services to destinations on the West Coast Main Line (WCML).

It is therefore essential to consider system requirements beyond 2024 as part of the CP6 strategy, to ensure that interventions in CP6 are part of a long-term, affordable and deliverable strategy. Choices may include longer trains and/or additional or modified services which may or may not require infrastructure interventions.

Additional capacity will be required on peak long distance and outer suburban services in CP6. In 2019, long distance services are assumed to be provided by Super Express Trains as part of IEP (either 5/10-car bi-mode or 9-car electric) or High Speed Trains (HSTs) (on the line from London Paddington to Exeter and further west). Outer suburban services are assumed to be operated by Electric Multiple Units (EMUs) in 4, 8 or 12-car formations.

The Route Study has assessed interventions to increase peak capacity specifically for the Oxford and Newbury corridors through lengthening of the assumed 8-car EMU trains to 12-car EMUs. An alternative option to increase capacity from Newbury is to lengthen the peak long-distance services with associated issues noted regarding extended journey times and the performance implications of operating longer and slower HSTs.

Further capacity is also required to serve commuters on long distance services between London Paddington, Reading, Didcot and Swindon. There is an option to amend anticipated calling patterns in the 2019 ITSS so that additional long distance services call at these stations during the peak periods, to help smooth demand. However, whilst this could provide additional capacity, it is not sufficient on its own to accommodate all predicted passenger demand. Such additional calls may also be inconsistent with the improved inter-urban journey times anticipated by IEP.

To accommodate this forecast passenger demand in CP6 an option has been identified to provide two additional services between London Paddington and Swindon, in the morning and evening high-peak periods (in the peak direction), calling at Didcot Parkway and Reading. These services would use the Main Lines and would need to have the requisite rolling stock performance characteristics to be compatible with other services. Additional infrastructure is likely to be required to accommodate these services. The scale of infrastructure changes depends on choices that exist to maximise the use of existing network capacity on the core corridor between London Paddington and Reading through separation of the Main and Relief line railway. This offers optimum utilisation of main line paths for long distance services only. Additional infrastructure capacity may also be necessary at either Swindon or Chippenham station areas.

The junction renewal at Ladbroke Grove, west of London Paddington, offers the opportunity to consider provision of the optimum layout for the junction and the approaches into London Paddington to accommodate CP6 and longer-term growth requirements as an incremental enhancement at the time of renewal. The Route Study has developed an intervention that would provide a grade-separated junction and rationalisation of the approaches to London Paddington Station. This would enhance capabilities and the functionality of the area to enable more trains to operate, increase timetable flexibility, improve maintenance/ engineering opportunities and access to depot and stabling

locations, and simplify the track layout, making it safer and easier to maintain whilst supporting continuous performance improvements. This scheme needs to be developed further to understand its full value.

An option to increase the frequency of the service to two trains per hour on the Henley-on-Thames branch has been identified – either with electrification to reduce journey times or by means of an amended calling pattern. Linespeed opportunities will also be assessed on this and the other Thames Valley branch lines, particularly in line with electrification and renewal activities.

There is an aspiration to improve journey times from stations between London Paddington and Reading, particularly from the west end of this corridor to London. The Route Study has examined a number of possible ways to achieve this. A pure timetable solution does not appear to be practicable as the detriments to other users would exceed the benefits gained. There are options to provide infrastructure enhancements to either the Main or Relief Lines but the case for these needs to be further examined to understand the full benefits that might be achieved, such as performance, resilience and engineering access, to improve the business case.

The Western Rail Link to Heathrow (WRLtH) is anticipated to be operational in CP6 (subject to funding, a value for money assessment and agreement of acceptable terms with the aviation industry), and the new HS2 station at Old Oak Common is expected to open in 2026. This presents opportunities to optimise connectivity with future network developments. This could include a service from London Paddington to Southampton (or Bournemouth) via Heathrow Airport, Reading and Basingstoke to create new journey opportunities between Old Oak Common, Heathrow Airport and stations in the **Wessex Route Study** area.

The **Wessex Route Study** has identified the junction at Basingstoke (where the line towards Reading diverges from the line to London Waterloo) as a constraint and the case for grade separation is being assessed. The Western Route Study has examined options to increase capacity at Southcote Junction (south of Reading) and between Southcote Junction and Oxford Road Junction (where the lines towards Reading and Didcot diverge). This option includes grade separation of Southcote Junction and provision of a third, bi-directional line between the two junctions, largely for use by freight trains on the Didcot – Southampton axis. A line of route analysis is being undertaken, in conjunction with the Wessex Route and the **Network RUS: Freight**, to clarify requirements for growth between Southampton – Reading – Oxford and the North. This would support more passenger services as well as allowing the forecast increase in intermodal freight growth from Southampton to the Midlands and North to be accommodated on an already constrained corridor.

Lengthening of cross-country services from the South Coast to Reading and beyond will be required in order to accommodate forecast peak passenger demand into Reading.

The remodelling of the Reading Station area was completed in 2015. This allows consideration of options to utilise the new infrastructure provided to offer connectivity improvements with new journey opportunities. Supporting a through-station operation, by linking services across Reading, would reduce the number of trains terminating in the station area and make more efficient use of available platform capacity. In particular, consideration ought to be given to providing through journeys to London Heathrow from the Oxford and Basingstoke corridors on completion of WRLtH and the proposed electrification of the line between Reading and Basingstoke. Similar opportunities would be available if electric operation were feasible between Reading and Gatwick Airport, which is considered further in the **Wessex Route Study** and the refresh of the **Network RUS: Electrification Strategy**. Detailed timetable modelling would be required to establish the feasibility of any connectivity options, given the timetable proposals that exist on each route to ensure the optimum service pattern is developed.

Analysis suggests that in 2019, the infrastructure between Didcot and Oxford will already be significantly constrained following the growth in services anticipated in Control Period 5 (CP5, 2014 – 2019). Any increase in the service specification above these levels, and depending on the routeing proposed, will drive requirements for infrastructure interventions that could include grade separation at key junctions, four-tracking and an additional platform at Oxford Station. Further development work will be undertaken to determine the outputs required and how they may be delivered.

Should growth in rail passenger demand exceed that forecast then interventions may be required on the North Cotswolds line between

Oxford and Worcester. These could be achieved by train lengthening or through the addition of further peak services. There is also the potential for additional services to Hanborough/ Charlbury to serve rail passenger demand more efficiently on this line of route, noting that this may drive requirements for infrastructure interventions including platform lengthening at Hanborough Station.

Further infrastructure requirements exist between Didcot and Swindon to accommodate the forecast growth in passenger and freight traffic. The Route Study has examined the provision of 12-mile 'dynamic' loops in each direction, to allow more trains to operate without increasing journey times.

Demand analysis demonstrates that more train capacity will be required on the corridor between Cheltenham Spa, Bristol Temple Meads and Taunton in order to accommodate forecast increases in peak passenger demand. Capacity for peak passenger demand on local services into Exeter would also require increasing to accommodate demand in CP6, even with the anticipated changes assumed to be provided in capacity in the baseline with the rolling stock redeployment following electrification elsewhere.

Consideration of long-term train service provision supports the case for an enhancement to Bristol East Junction when renewed in CP5. By enhancing the junction it is possible to mitigate requirements for other infrastructure interventions on the Severn Beach branch line and on the single-track loop serving Weston-super-Mare. The enhanced layout provides the necessary capacity and functionality to support growth across the greater Bristol area whilst providing the optimum layout for capacity, journey time improvements, maintenance and engineering access.

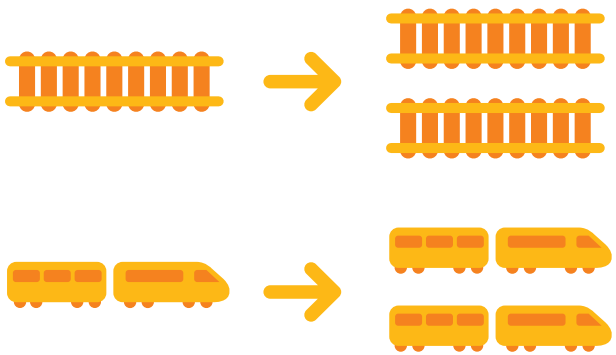
Abbotswood Junction, south east of Worcester, is also due for renewal in CP6. The current layout of the junction constrains capacity and the Route Study has considered the case for an enhancement at the time of renewal. There appears to be a business case to provide a double rather than single-lead junction at the time of renewal.

Provision of an additional stopping service between Exeter St Davids and Axminster would support forecast passenger demand into Exeter in the peak periods as an alternative to substantial train lengthening of the London Waterloo service. The additional service would create a pattern of two trains per hour which aligns with Devon County Council's Devon Metro aspirations. In order to deliver this enhanced service frequency, a new loop would be required. The additional infrastructure would also support the delivery of a sustainable diversionary route should the GWML be closed for engineering activities, weather related or other incidents. There would be considerable resilience benefits to be achieved that have been captured in the assessment led by the **Wessex Route Study**. A value for money case appears to exist for an intervention that could provide for either an additional local train service or a diverted long-distance train each hour.

Analysis undertaken since the draft Route Study shows that forecast passenger demand will exceed capacity on the Exmouth and Falmouth lines during CP6 with the lengthening of some train services required to accommodate it. This may drive requirements for the extension of platforms at specific stations on the lines.

Several stations will require capacity interventions to accommodate the number of passengers forecast to use them in the future. These include London Paddington, Oxford, Bristol Parkway and Bristol Temple Meads Stations. It is expected that the necessary changes at Bristol Parkway will be delivered by IEP, and the requirements will feed into master planning proposals at the other locations. A number of additional stations have also been highlighted as potentially requiring a review in CP6 following initial high-level capacity assessments as part of the Route Study. These include Hanborough, Newbury and Bath Spa. Those stations impacted by MetroWest and Devon Metro should also be reviewed in light of emerging demand in CP6 from service changes proposed with train lengthening and/or increased service frequency. St Erth Station is likely to require the implementation of proposals identified in the Station Capacity Assessment to accommodate predicted growth in demand.

Since the Draft for Consultation was published, the Route Study has undertaken further analysis to understand the effects of seasonal variation on demand, particularly for the summer months in Devon and Cornwall. The analysis shows that for the three branch lines (to Looe, Falmouth and Newquay) with the most variable demand, summer peak passenger journeys have increased by three per cent



per annum on average. The Route Study extrapolates this historic trend to forecast the level of demand should this rate of growth continue. Further details on this are provided in Chapter 3.

The proposed accelerated signalling renewal between Totnes and Penzance in CP5 will provide the infrastructure necessary to deliver an improved frequency of two trains per hour, which would meet the connectivity Conditional Outputs for this area.

Opportunities for improving journey times are under review as part of the Western Route Journey Time Improvement Programme. This is ongoing with progress to date reported in Chapter 5.

The Longer Term to 2043

Beyond 2024, the Route Study takes a longer-term view, acknowledging the level of uncertainty within this timeframe.

Forecasts suggest an increase in rail passenger demand into London Paddington of 298 per cent on Relief Line services and 99 per cent on Main Line services to 2043. For Bristol the equivalent, high-growth forecast is 111 per cent.

The Route Study predicts that in the long term, 24 trains per hour (tph) would be required to operate on the Main Lines in the peak between London Paddington and Reading in order to accommodate forecast passenger demand, compared with the 20tph which are anticipated to operate in 2019. Additional seats per train would also be required to avoid the need to operate an even greater number of trains. Due to the increased frequency of services, train speeds would be limited to those of the slowest trains on the Main Lines; therefore to maintain journey times as frequency increases, it becomes more difficult to accommodate services calling at stations on the Main Lines between London Paddington and Reading.

The increased frequency would require improvements to the planning headways along this route section as well as harmonisation of rolling stock characteristics such as speed and acceleration. Additional infrastructure would also be required to support connectivity, journey times and maintenance and engineering access requirements whilst also delivering a high-performing railway.

As the number of services increases, it becomes increasingly difficult to perpetuate some of the existing service patterns such as a number of Relief Line services to London Paddington that cross to the Main Lines for part of their journey. Options to maintain connectivity are assessed, with a high-level view of the additional infrastructure that would be required in order to continue with the 2019 ITSS and the growth in services envisaged for 2043.

Proposals to accommodate the significant growth forecast in passenger demand are presented using a combination of options to address peak crowding to 2043.

In the long term, there is limited capacity remaining for additional services to cross between the Main Lines at Didcot and the lines to/from Oxford beyond that anticipated in the 2019 ITSS. Depending on the future service specification there may be a case to provide a grade-separated junction east of Didcot to reduce timetable conflicts and allow more services to operate by separating traffic flows. In particular, a requirement for fast services between Oxford and Reading to extend to Heathrow Airport or Gatwick Airport as part of connectivity improvements, in addition to other service provision, would drive the need for this kind of intervention.

Between Didcot and Oxford, the long-term train service specification could be accommodated if the number of calls at intermediate stations is maintained at baseline levels, and if there is not a requirement to accommodate additional services (as above).

There is no available capacity to accommodate more trains north of Oxford crossing to/from the Milton Keynes/Bedford/Marylebone direction (i.e. the East West Rail route). Two possible interventions to accommodate any growth in services are grade separation north of Oxford, or provision of four tracks between Didcot and Oxford, together with changes to the platforming of services at Oxford Station to avoid the need for grade separation at Oxford. Both options require provision of a fourth through platform to achieve this enhanced overall network capacity.

The Route Study has considered the costs of further redoubling of the North Cotswold line between Oxford and Worcester. The long-term service specification could require further areas of double-tracking to allow a robust two trains per hour service

frequency. In the short term, increased service frequency at the Oxford end of the route may provide an efficient means of serving demand growth compared with running longer, 10-car bi-mode trains over the full length of the line. If this option were to be achieved by the extension of services from London Paddington terminating at Oxford onto the Cotswold line, then the possible rolling stock options need to be considered. Use of bi-mode SETs or independently-powered EMUs (IPEMUs) is likely to present a better value alternative to the electrification of the route between Wolvercot Junction and Hanborough or Charlbury.

A similar option exists on the route between Swindon and Gloucester/Cheltenham where the extension of peak services from Swindon to Kemble could provide additional peak capacity to address demand; electrification would, however, be costly so bi-mode SET or IPEMU rolling stock alternatives may be more appropriate. Such extensions could also avoid the need for an intervention in the Swindon or Chippenham area to accommodate additional peak trains to/from London.

Extending electrification to Westbury is a possible choice to allow improvements to the service offering on the Reading to Taunton route, by reducing the differential in speed between freight and passenger trains to avoid the need for a significant length of additional tracks to accommodate additional train services. The practicality of converting freight trains to electric traction would depend on the economics of the traffic concerned, which has not been tested.

Wootton Bassett Junction, west of Swindon, where the lines to Bristol Temple Meads and South Wales diverge, is due for renewal in 2036. This would be the best opportunity to consider remodelling the junction to increase the current 75mph speed limit for services to/from the South Wales direction that could contribute to improvements in overall end to end journey times.

Westerleigh Junction and the section of route east of Bristol Parkway are expected to be unable to accommodate all of the forecast services in the 2043 ITSS. Given constraints elsewhere on the rail network that would also limit the number of services which could operate, and the significant cost of interventions needed to address those constraints, the Route Study has not looked in detail at options in this particular area.

The Route Study has reviewed the provision of main line platforms at Gloucester to enable services on the Bristol or Swindon to Worcester or Birmingham axis to call at Gloucester, without the reversal and journey time penalty currently incurred. The option is relatively expensive due to the location of the site and the works required to provide access. There is also an issue if and how the platforms would be connected to the existing station platforms and/or city centre to maintain connectivity particularly for passenger access other than by car.

The Route Study has reviewed interventions to accommodate the expected increase in services on the corridor between Westerleigh Junction (east of Bristol Parkway) and Abbotswood Junction (south east of Worcester). A value for money business case has not been found for the full set of interventions. However should electrification of the Bristol – Birmingham corridor proceed then there would be a case to consider the provision for future strategic requirements to enable additional capacity to be provided when required.

Cogload Junction, north of Taunton, is due to be renewed in CP6 so there is an opportunity to consider the case for an enhancement at this point. At this junction the lines from Exeter towards Bristol and London diverge. The renewal presents the opportunity to consider an enhancement to the junction and any further capacity improvements required to accommodate long-term connectivity Conditional Outputs.

In the longer term, to accommodate the full 2043 ITSS, provision of four tracks between Exeter and Newton Abbot would be required. It would be difficult to achieve this alongside the existing coastal route, therefore one of the alternative route options developed as part of the West of Exeter Route Resilience Study may provide additional capacity and an alternative route that requires further consideration.

Other network capacity improvements will be required to accommodate long-term growth in the South West, with proposals identified between Newton Abbot and Paignton, at Exeter St Davids and between Exeter St Davids and Cowley Bridge Junction.

01 Background

This chapter sets out the development of the Long Term Planning Process, and its relationship with the established suite of Route Utilisation Strategies and other emerging workstreams. The governance arrangements for the new process is outlined, as well as the structure of the remainder of this document.

1.1 Planning Background

Since the late 1990s the national rail network has enjoyed a period of unprecedented demand growth. More passengers are using the network than ever before and the increase in the amount of goods transported by rail is considerable. The Department for Transport (DfT) recognises that the provision of attractive rail services is a significant driver of economic growth and this recognition is demonstrated by Government's continuing desire to invest significantly in the provision of railway services, most recently through Network Rail's **Control Period 5 Delivery Plan (CP5, 2014 – 2019)**, which proposes significant enhancements to the network on the Western Route.

The Market Studies, established in 2013 as part of the Long Term Planning Process (LTPP), indicate that demand for rail services will continue to grow strongly across all market sectors. The studies also articulate the economic and demographic factors that continue to work in rail's favour before suggesting a number of Conditional Outputs that will deliver the DfT's strategic goals of:

- economic growth
- reducing environmental impact; and
- improving the quality of life for communities and individuals.

It is against this background that the industry, working collaboratively, has developed this Western Route Study to present the case for further investment in the rail network for Control Period 6 (CP6, 2019 – 2024) and beyond.

1.2 The Long Term Planning Process

The Western Route Study is a key output of the rail industry's LTPP, which has been designed to consider the role of the railway in supporting the UK economy over the next 30 years. The LTPP comprises a set of activities and documents that:

- address the demands that are likely to be placed on Britain's rail network over the next 30 years
- capture stakeholder aspirations to develop new train services in the light of continuing rail investments
- present investment choices for funders to accommodate demand and future aspirations.

The LTPP consists of a number of different elements which seek to define the future capability of the rail network:

- Market Studies, which forecast future rail demand and develop Conditional Outputs for future rail services. These outputs are based on stakeholders' views of how rail services can support delivery of the industry and Government's strategic goals
- Route Studies, which develop options for future services and for investment in the rail network. Options are based on the Conditional Outputs and demand forecasts from the Market Studies and are assessed against industry appraisal criteria to provide choices for funders
- Cross-Boundary Analysis, which considers options for services that run acorss multiple routes to make consistent assumptions in respect of these services
- The Network Route Utilisation Strategies (RUS), which look at issues affecting the whole national rail network and address future capacity and technology-related issues for the railway.

The LTPP assumes the delivery of High Speed Two (HS2); however its scope is limited to the existing 'classic' network.

1.3 The Role of the Network RUS

The Network RUS considers issues which potentially affect the entire rail network of Great Britain. Its network-wide perspective is supported by a stakeholder group with wide expertise which enables the development of a consistent approach on a number of key strategic issues which underpin the future development of the network.

The Network RUS with its broad range of stakeholders has a number of interfaces with other key strategic workstreams. As a result, the Network RUS has developed a meeting structure, industry consultation and programme to ensure that it produces relevant, timely and thoroughly consulted deliverables.

Five Network RUS documents have been published and established with the Office of Rail and Road (ORR):

- Network RUS: Scenarios and Long Distance Forecasts (June 2009)
- Network RUS: Electrification (this RUS is being refreshed)
- Network RUS: Stations (September 2011)
- Network RUS: Passenger Rolling Stock (September 2011)
- Network RUS: Alternative Solutions (July 2013)
- Network RUS: Freight (in progress).

The Network RUS enables the industry, its funders, users and suppliers to develop strategies which are underpinned by a network wide perspective of rail planning. The development of such strategies ensures that issues which by their very nature cross geographic boundaries (for example the development of future rolling stock families and electrification strategy) are dealt with consistently throughout the long term planning framework, drawing upon best practice for different sectors of the railway.

1.3.1 'Improving Connectivity': this study was published for consultation by Network Rail in December 2014. It puts forward proposals for an alternative approach to planning the network to improve passenger connectivity across a network, using East Anglia as a case study. The alternative approach described therein has not yet been adopted by the industry so this Western Route Study maintains a more conventional approach to network planning.

1.4 Market Studies

In October 2013, Network Rail published four Market Studies. Three of the Market Studies focussed on the passenger market: **Long Distance**, **London & South East**, **Regional Urban** and the fourth focussed on **freight**. All have been established by the ORR and are available on the Network Rail website, **Network Rail Long Term Planning Process**.

The passenger Market Studies have three key outputs:

- identification of the long-term strategic goals which define the successful provision of rail services to each of the three market sectors
- demand forecasts for the sector, over a 10- and 30-year planning horizon
- Conditional Outputs for the sector.

The Conditional Outputs are aspired levels of service in terms of, for example, frequency, journey time and/or passenger capacity on key flows in the sector. The Conditional Outputs reflect stakeholder views of how rail can support delivery of their strategic goals in light of opportunities created by planned investments. The aim of the Market Studies is to provide demand forecasts and Conditional Outputs that are consistent across the Route Studies. Conditional Outputs should be viewed as aspirations for the future rather than recommended investment decisions.

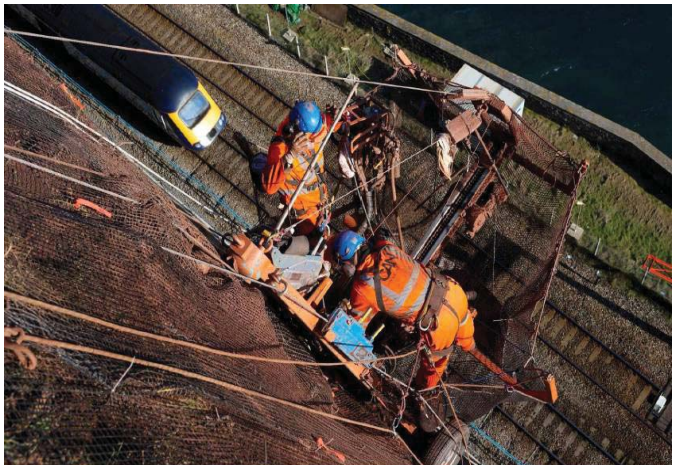
The **Freight Market Study** has three key deliverables:

- identification of the long-term strategic goals for the market sector, based on the aspirations of current and likely future rail industry funders
- production of long term demand scenarios for each of the key market sectors
- identification of Conditional Outputs for the specification of train services in the long term which will achieve the strategic goals forecast for each market sector, given future circumstances identified in the demand scenarios.

Since the Draft for Consultation, certain freight forecasts contained in the **Freight Market Study** have been revised. This is referenced, where relevant, in the text.

It is important to note that the Conditional Outputs are conditional on affordability, fundability and a value for money business case for any interventions that subsequent Route Studies, as part of the LTPP, may consider as a way to deliver them. Equally, the Conditional Outputs need to be deliverable – technologically, operationally and physically.

Further details on the Market Studies and Conditional Outputs are available in Chapter 3 – Interpreting the Conditional Outputs.



1.5 Route Studies

There is generally one Route Study for each of Network Rail's devolved Routes. The full Route Study programme can be found on the Network Rail website, **Route Studies**.

In a few cases, a devolved Route may be covered by more than one Route Study, where part of the Route is largely self contained. Equally, where the likely service pattern to address a particular market needs to cover more than one Route to a significant degree, a Route Study may consider these services as a whole, irrespective of Route boundaries.

A Route Study develops and assesses choices for the long-term use and development of the network. Its starting point is to determine whether the Conditional Outputs from the relevant Market Studies can be accommodated on the existing network within the Route Study scope area with committed enhancements. These Conditional Outputs reflect the emerging requirements for capacity and connectivity building on the substantial volume of planning and specification that culminated with the publication programme of RUSs. The Western Route Study has sought to refine that previous analysis, using outputs from the established Market Studies and Networks RUSs, in the context of continuing development of major interventions such as Crossrail, Electrification and HS2.

The Route Study develops train service options, corresponding to different uses of the network (and hence to different trade-offs between stakeholders' strategic goals) to meet the Conditional Outputs. After looking at options for making best use of the existing network, the Route Study considers options involving infrastructure investment. Options are assessed against funders' decision making criteria. This includes quantitative assessment as in the previous RUS process. Where appropriate, this includes a wider assessment against factors such as strategic fit, wider economic impacts and affordability.

The output from the Route Study is evidence-based choices available to Network Rail and industry funders to determine the long-term use and development of the network. The Route Studies draw together key themes and strategies as appropriate:

1.5.1 Safety

Network Rail has set out its vision for safety entitled '**Transforming Safety & Wellbeing**' which sets the strategy through to 2024. Many of the choices for funders in this document are at an early stage of development and safety will be considered in depth as proposals are further developed. By their very nature however, proposals that remove junction conflicts, eliminate crossing movements and ease the flow of passengers at stations, will improve the safe operation of trains, and the users of those trains. Where proposals have the potential, for example, to eliminate level crossings, these have been identified and will be highlighted if those choices for funders are developed further.

1.5.2 Performance

In CP5, Network Rail has been set targets to improve performance; these are set out in detail within Network Rail's Control Period 5 **Delivery Plan**. The trajectory of these changes is to improve performance, measured through the Public Performance Measure (PPM) and Freight Delay Measure (FDM) such that 92.5 per cent is reached in England, Wales and Scotland by the end of CP5 (March 2019).

The performance objectives for the rail industry in CP6 are not yet known. However it is assumed the trajectory for CP5 and the trend for performance improvement is likely to continue. The CP6 choices set out in Chapter 5 are developed at a high level referred to as 'pre-Governance of Railway Investment Projects' (GRIP) or 'GRIP 0', at this stage, it is too early to undertake any performance modelling beyond commentary of the possible impact of the scheme. As the proposals are developed further through GRIP, performance assessments (including modelling where appropriate) will be considered in more detail.

1.5.3 Resilience

The resilience of the rail network was brought into sharp focus by the winter storms of early 2014 and the breach of lines on the Cambrian and Cumbrian Coast lines, as well as at Dawlish on the Great Western Main Line west of Exeter; the latter resulted in the closure of the line to Plymouth, Paignton and Cornwall for eight weeks. Whilst these line breaches were on the coastline, line blockages also occurred due to inland flooding, significant landslips

of embankments or cuttings and fallen trees. This caused significant delays and a number of long periods of line closures.

These events have increased focus on changes in climate, the possible vulnerability of the railway to storm damage and the incidence of weather related events. Whilst the tactical response in addressing these problems has been well received, there is also a need to consider in more depth what the strategic issues for the railway might be.

Each Route is developing a **Weather Resilience and Climate Change Adaptation Plan** (WRCCA). For Western, the WRCCA was published on 30 September 2014 . This document sets out a management plan for weather resilience and climate change supported by an evaluation of the resilience of rail infrastructure to historical weather events and an awareness of potential impacts from regional climate change projections. The approach taken is consistent across all Network Rail's Routes, providing an opportunity to improve the future reliability of the entire railway network to develop a railway fit for the future.

1.5.4 The Digital Railway

The Digital Railway is a rail industry-wide programme designed to benefit Great Britain's economy by accelerating the digital enablement of the railway.

The scope of the Digital Railway vision is to be defined during CP5. The business case framework will be aligned to the LTPP and supported by DfT. The real challenge facing the industry is to reach consensus on the elements of the vision that can be accelerated, to build a plan for how this can be realised, and to build the business case for Government to invest in achieving that vision. This will need to consider the operational processes and people- related changes as well as technological acceleration.

The Digital Railway programme is setting out to build the industry business case to accelerate the digital enablement in several key areas of the railway, namely:

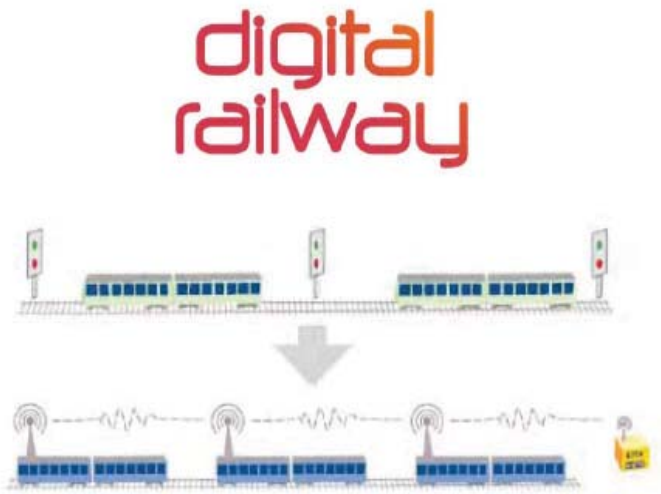
- **Train operation** – transforming the rolling stock landscape, tariffs, journey sale and settlement, and potentially even the franchise operating model. This is the 'Digital Train Operator'
- **Capacity allocation** – long-term network planning through to sale of access to capacity in real-time. This is the 'Digital System Operator'
- **Passenger** – simplifying journeys, from planning, purchase to on-the-day travel. This is the 'Digital Passenger'
- **Infrastructure** – digital assets, digital workforce and digital operations, known as the 'Digital Asset Manager'
- **Stations and Interchanges** – retail and transport hubs with key interconnects to other modes of transport including driverless electric cars. This is the 'Digital Station'.

In most areas, work to develop technical capability is already underway. The programme will seek to determine what is required to align and accelerate different initiatives to bring them into a single roadmap underwritten by the whole industry. The output of the programme will be a business case to Government, presented through the Initial Industry Plan (IIP) in September 2016.

However, as these proposals are still at an early stage of development, for the purposes of the Western Route Study, no assumptions on any changes arising from the Digital Railway have been made. The options developed in the Route Study are conventional in the sense that they use established technology. These options will then act as a baseline for comparison against which possible future 'Digital Railway' options can be assessed. References to timescales for the introduction of the European Train Control System are based on asset renewal dates. These dates may change as a result of the Digital Railway proposals and the impact of this would need to be considered accordingly when known, as would any other proposals that may arise that could impact on the Western Route Study.

1.5.5 Rolling Stock Strategy

The Long Term Passenger Rolling Stock strategy for the rail industry (3rd edition) was published by the Rail Delivery Group (RDG) in February 2015 on behalf of the rail industry. This sets out out a range of forecasts for the likely size and mix of the national rolling stock fleet to accommodate future passenger numbers over 30 years. It is produced by a pan-industry group comprising vehicle owners, operators and maintainers, Network Rail and RDG. The analysis is based on the same medium and long-term forecasts of peak passenger demand as the Route Study. Further details are



shown in Chapter 3.

Over the next two to three years it is expected that the Rolling Stock Strategy will become increasingly focused on providing inputs to the industry-wide planning process for CP6.

The LTPP therefore does not seek to develop a rolling stock strategy. The Route Study considers where rolling stock changes, e.g. more capacity or better performance, could be an option to deliver one or more Conditional Outputs. Further details are shown in Chapter 3.

1.5.6 Interoperability

The Railways (Interoperability) Regulations 2011 and associated Technical Specifications for Interoperability (TSI) apply to the entire United Kingdom rail network with the exception of the exclusions defined on the DfT website.

Network Rail, along with other Infrastructure Managers in the UK, is legally obliged to comply with the Interoperability Regulations when the nature of the works being undertaken so requires.

European and UK legislation defining objectives for Interoperability and the Trans European Transport Network (TEN-T) have been taken into account during the development of this Route Study. Network Rail and the wider rail industry have sound practical experience in applying the respective regulations and associated TSI. The experience has been used to good effect to:

- demonstrate legal compliance with the requirements and provide feedback to Government and the European Railway Agency on practical issues of application
- leveraging the benefits associated with the Interoperability principles
- developing plans to assess the full potential of an interoperable network, including connectivity with continental Europe.

For works being carried out on the UK component of the TEN-T, European Union funding support is available for qualifying projects. Network Rail will work with the DfT to ensure that the UK takes maximum benefit from this opportunity.

1.5.7 Congested Infrastructure

In the event that a declaration of congested infrastructure is made pertaining to an element of infrastructure covered by this Route Study, it is intended that a number of the analyses, infrastructure and service capacity improvement options or other relevant material will be relied upon to meet as many of the resulting capacity analysis and improvement planning obligations as possible. These are set out in European Commission Directive 2012/34 and the Great Britain Access and Management Regulations.

1.6 Cross-Boundary Analysis

Services that run across more than one Route Study area are considered in a separate "Cross-Boundary" workstream. This workstream has developed and assessed options for cross-boundary services (passenger and freight). The output from the Cross-Boundary Analysis is a set of common assumptions that Route Studies should adopt regarding cross-boundary services. Assumptions include the frequency and calling pattern of passenger services and the frequency and operating characteristics (for example, gauge, speed, tonnage) of freight services. Further details are available in Chapter 4.

1.7 LTPP Governance Arrangements

The LTPP is designed to be as inclusive as possible with contributions encouraged from the rail industry and wider stakeholders. Overall governance responsibility for the process lies with the Rail Industry Planning Group (RIPG) whose membership comprises:

- Department for Transport
- Freight Operators
- London Travel Watch
- Network Rail
- Office of Rail and Rail
- Passenger Focus
- Passenger Transport Executive Group
- Rail Delivery Group
- Rail Freight Group
- Railway Industry Association

- Rail Freight Operators Association
- Rolling Stock Leasing Companies
- Transport for London (TfL)
- Transport Scotland
- Welsh Government.

RIPG meets bi-monthly and provides strategic direction and endorsement of the constituent publications of the LTPP process.

1.8 Route Study Governance Arrangements

A four tier structure for stakeholder dialogue has been established to oversee and support the production of the Western Route Study:

- Route Study Programme Board, chaired by Network Rail's Route Managing Director Western, with senior level representation from passenger and freight train operating companies, RDG, DfT, and TfL. The Route Study Programme Board directs the study, reviews the output from the Route Study Working Group and provides a forum to resolve any significant issues which the Working Group wish to remit to the Board for decision.
- Working Group which comprises representatives from the DfT, current and future Train Operating Companies (both passenger and freight) who operate on the Route, RDG, TfL and Network Rail. The Working Group determines how and whether the Conditional Outputs from the Market Studies can be accommodated on the Route. Where Conditional Outputs cannot be accommodated, options and trade-offs are developed for both services and infrastructure, and choices for funders are presented for both CP6 and the longer term to 2043. The Working Group has a mandate to discuss the study on behalf of the rail industry with other stakeholders. The Working Group is supported by a Technical Working Group, led by Network Rail, which evaluates options for technical feasibility, deliverability and cost.
- Regional Working Groups provide location specific oversight as well as an opportunity to collaborate in the production of the Route Study with the rail industry. The Regional Working Group comprises representation from Local Authorities, Local Enterprise Partnerships, DfT, Airports, Ports and Freight stakeholders across the Route. For the Western Route Study, three Regional Working Groups have been established:
  - Thames Valley (incorporating London – Swindon – Basingstoke/Worcester),
  - West of England (Swindon – Somerset including Greater Bristol area), and
  - Peninsula (Somerset, Devon and Cornwall).

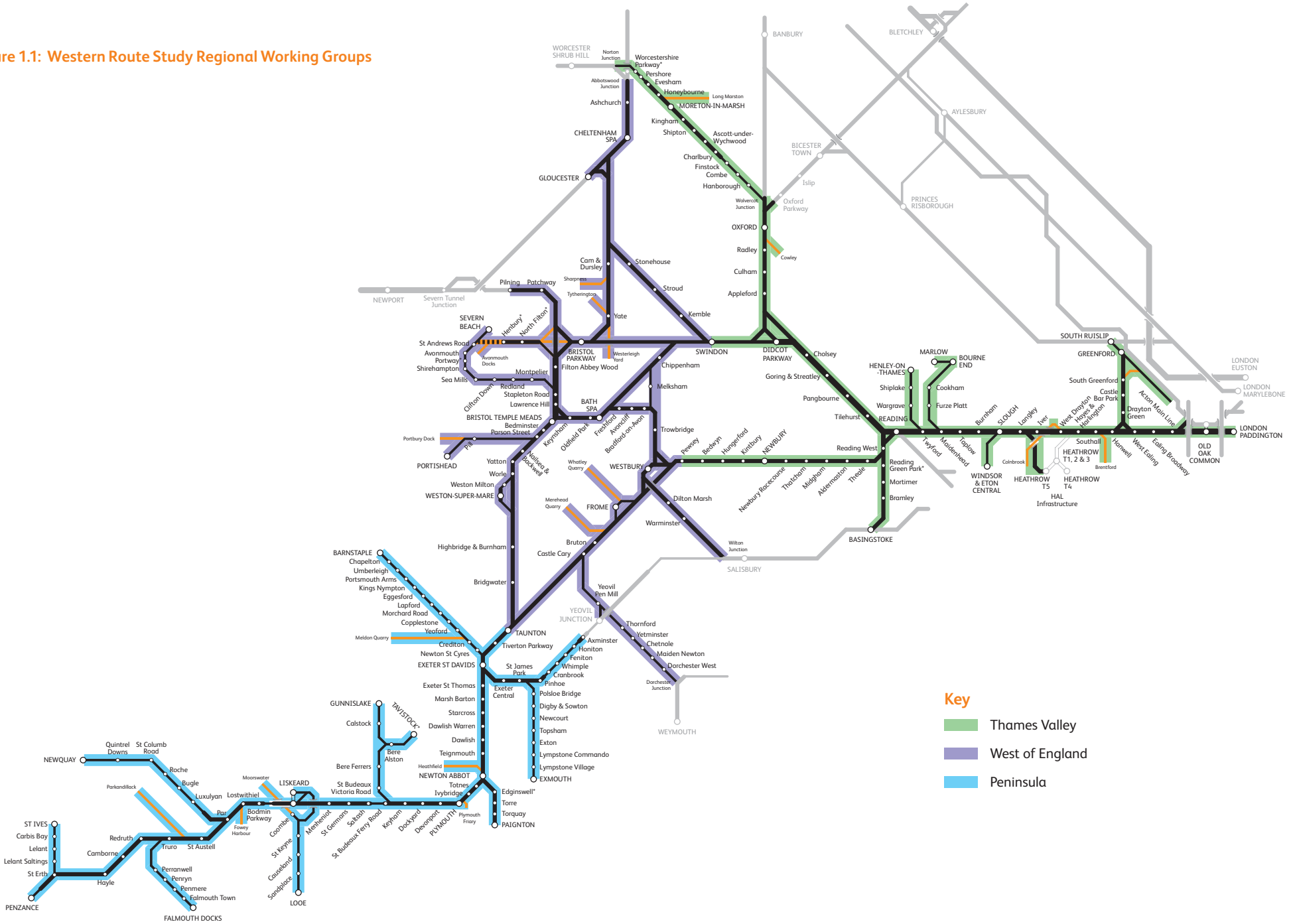
  This division is representative of the differing requirement, markets and geographic areas across the Route. Figure 1.1 illustrates the geographical areas that each Regional Working Group considers. Where an authority's area crosses a boundary between Regional Groups, an invitation is extended to both forums.
- Wider Stakeholder Group has been convened to inform stakeholders on the Western Route Study process and outputs. The Wider Stakeholder Group consists of representatives from District Councils, rail user groups and campaign groups from across the Western Route.

The ORR is included throughout this process as an observer to ensure that due process is followed.

Cross-boundary assumptions for the study have been managed by the Cross-Boundary Working Group. This national group, consisting of representatives of the passenger and freight operators along with funders, meets to consider the implications of cross-boundary services across the country.

Figure 1.2 presents the Western Route Study governance structure.

Figure 1.1: Western Route Study Regional Working Groups



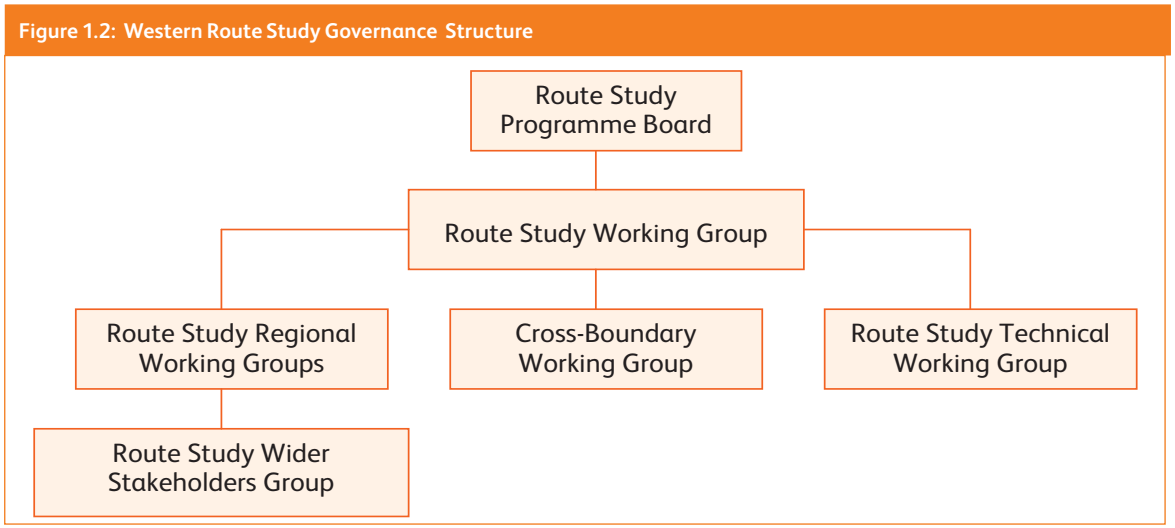
1.9 Document Structure

The remainder of this document is structured as follows:

- Chapter 2: Baseline includes planned changes to infrastructure and services to describe the Western Route Study baseline anticipated in 2019
- Chapter 3: Interpreting the Conditional Outputs for the Route in 2043 identifies the established Conditional Outputs from the Market Studies relevant to the Western Route Study
- Chapter 4: Cross-Boundary Analysis sets out assumptions for passenger and freight flows that cross the Route Study boundary
- Chapter 5: Accommodating the Conditional Outputs – Choices for Funders presents the choices available to accommodate the Conditional Outputs to 2043 and for CP6
- Chapter 6: Control Period 6 – Outline Strategy presents the emerging strategy specifically for the next control period
- Chapter 7: Consultation – explains the consultation process and provides an overview of the consultation responses received and the key themes raised.

This document has been published on behalf of the rail industry exclusively on Network Rail's **website**.

Figure 1.2: Western Route Study Governance Structure



02 Baseline

This chapter details the geographic scope and anticipated 2019 baseline for the Western Route Study. It presents the characteristics of the route envisaged in 2019, at the beginning of Control Period 6 (CP6, 2019 – 2024), including committed schemes planned for implementation during Control Period 5 (CP5, 2014 – 2019) and the anticipated changes to rail service provision on the route (as known in June 2015). Route characteristics in the context of the longer term through to 2043 are also outlined which include High Speed Two (HS2) and the developments at Old Oak Common, resignalling plans, and the proposed introduction of the European Train Control System (ETCS) and European Rail Traffic Management System (ERTMS).

2.1 Geographical Scope

The scope of the Western Route is extensive, the key axis being the Great Western Main Line (GWML) that runs from London Paddington to Bristol and into south Wales, and the Main Line route from Reading to Penzance. Connected to this are routes to Oxford, the Cotswolds, Birmingham and the South Coast. Branch lines in the inner and outer suburban area, around Bristol, to the coasts of Devon and Cornwall and dedicated freight only lines complete the mix of routes. The Western Route has boundaries with London North Western, Anglia, Wessex and Wales Routes. See Figure 2.1.

2.2 Route Characteristics – the Route in Control Period 6

This section outlines the Western Route and its anticipated infrastructure provision at the beginning of Control Period 6 (CP6, 2019 – 2024). This includes major renewal and enhancement schemes proposed for delivery, known as committed schemes. These schemes have been identified in the Government's July 2012 High Level Output Specification (HLOS) or are third party funded. Schemes planned to be implemented after 2019, which have a commitment to development or delivery, such as Western Rail Link to Heathrow Airport (WRLtH) (subject to funding, a satisfactory value for money business case and agreement of acceptable terms with the aviation industry) and HS2 are also included in the Route Study baseline.

The Network Specification for the Western Route (July 2015) describes the geographical context of the Route, its markets, the services and infrastructure provision outlining the present situation and medium- to long-term strategy. The Route Specifications support the Network Specifications and cover specific sections of the Route and describe in greater detail the current and future requirements. These documents can be used to understand the specific details of the infrastructure provision. The **Network and Route Specifications** for the Western Route can be found on Network Rail's website.

2.2.1 Western Route Study Baseline

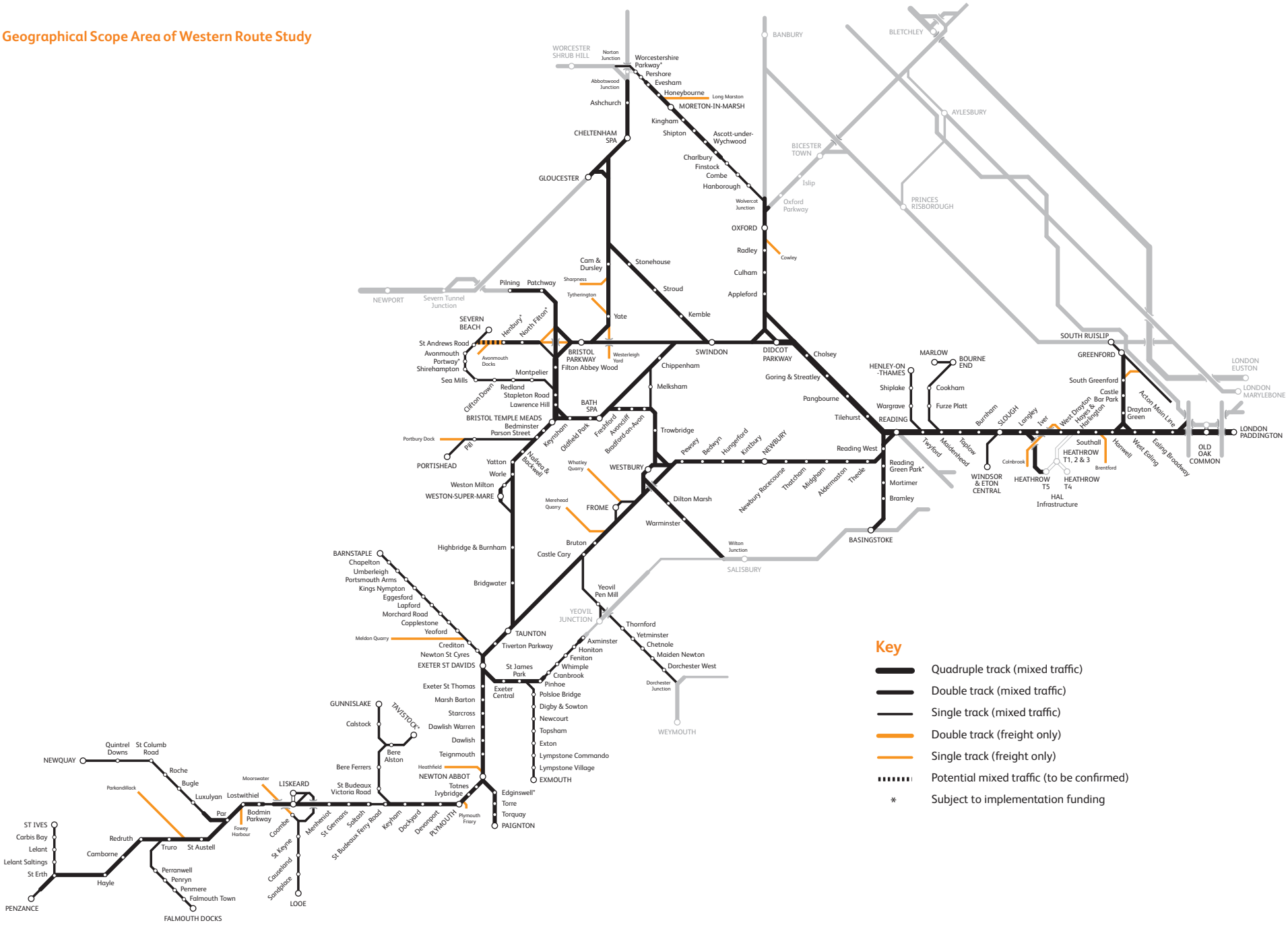
The baseline for the Western Route Study is defined as today's railway plus the anticipated train service changes (subject to contractual agreement) and/or infrastructure to be provided through committed schemes. There are significant infrastructure and service provision changes envisaged on the route in the period up to 2019. Consequently, the baseline for the Western Route Study is defined as December 2019, when the dynamics of the route will fundamentally change following the introduction of the full enhanced service provision.

However, the Indicative Train Service Specification (ITSS) for December 2019 is currently a development timetable that is yet to be finalised by the industry, see section 2.2.4. It is therefore not possible at present to be precise for every aspect of the timetable, so for the purposes of this Route Study a number of planning assumptions have been made.

It is apparent from studies undertaken by Network Rail to date that the Route will be significantly constrained in 2019; the ability to vary individual train paths and calling patterns of Relief Line services between London Paddington and Reading may be limited by the volume and range of service types, particularly following the implementation of Crossrail from 2018. These studies suggest that it may be possible to operate the Main Lines between London Paddington and Reading at a maximum theoretical peak capacity utilisation of 24 trains per hour (tph) subject to a number of assumptions on planned service, pathing of trains, technical capability of the system being valid, and appropriate interventions.

However, using all of the theoretical capacity would not deliver a resilient timetable or provide for service recovery from unplanned delay and perturbation, and is therefore detrimental to train performance without further mitigation. A choice has to be made as the precise level of capacity utilisation will determine the capability to deliver a satisfactory level of performance and reliability on a daily basis. There are options to provide mitigation through interventions to increase flexibility and resilience to support such increased capacity utilisation.

Figure 2.1: Geographical Scope Area of Western Route Study



A high performing railway also requires a consistent and sufficient maintenance and engineering access strategy to achieve necessary maintenance and renewal requirements. This invariably requires for example, a line, or pair of lines, to be taken out of use for inspection or maintenance activity at quieter times of the day or week. On four track sections of railway this typically necessitates a "two track railway operation" which reduces overall network capacity and increases journey times. In these circumstances the ability to cross between lines in order to provide an operational railway and to maximise capacity becomes essential.

Studies into the extent and duration of the maintenance access regime required from 2019 on the Western Route have now commenced. These are considering the safest and most efficient ways of allowing inspection and maintenance activity alongside a busy operational railway, to enable the infrastructure to continue to function at a high level of performance and reliability. Maintenance access may also affect the ability to access train maintenance and overnight stabling locations at the start and end of the day, which could potentially influence the provision of a reliable and timely train service. The maintenance access strategy developed for CP5 will inform the development of a maintenance access strategy for CP6.

The determination of an efficient level of engineering access also needs to consider a strategy for the future renewal of key assets that is consistent with the maintenance access strategy, and interrupts the train service operation only when it is entirely unavoidable. This issue is not just confined to Western Route, but is a challenge for the entire network, and requires a holistic consideration of available technology, manpower skills and safe systems of work.

There are inevitably choices to be made between the level of train service that can be provided at times when such maintenance access can be efficiently organised: this often means that compromises need to be made at certain times which may not always suit the travel patterns of the customer, particularly for the long distance market. The outputs of this maintenance/access study may present additional choices for funders that are currently unknown.

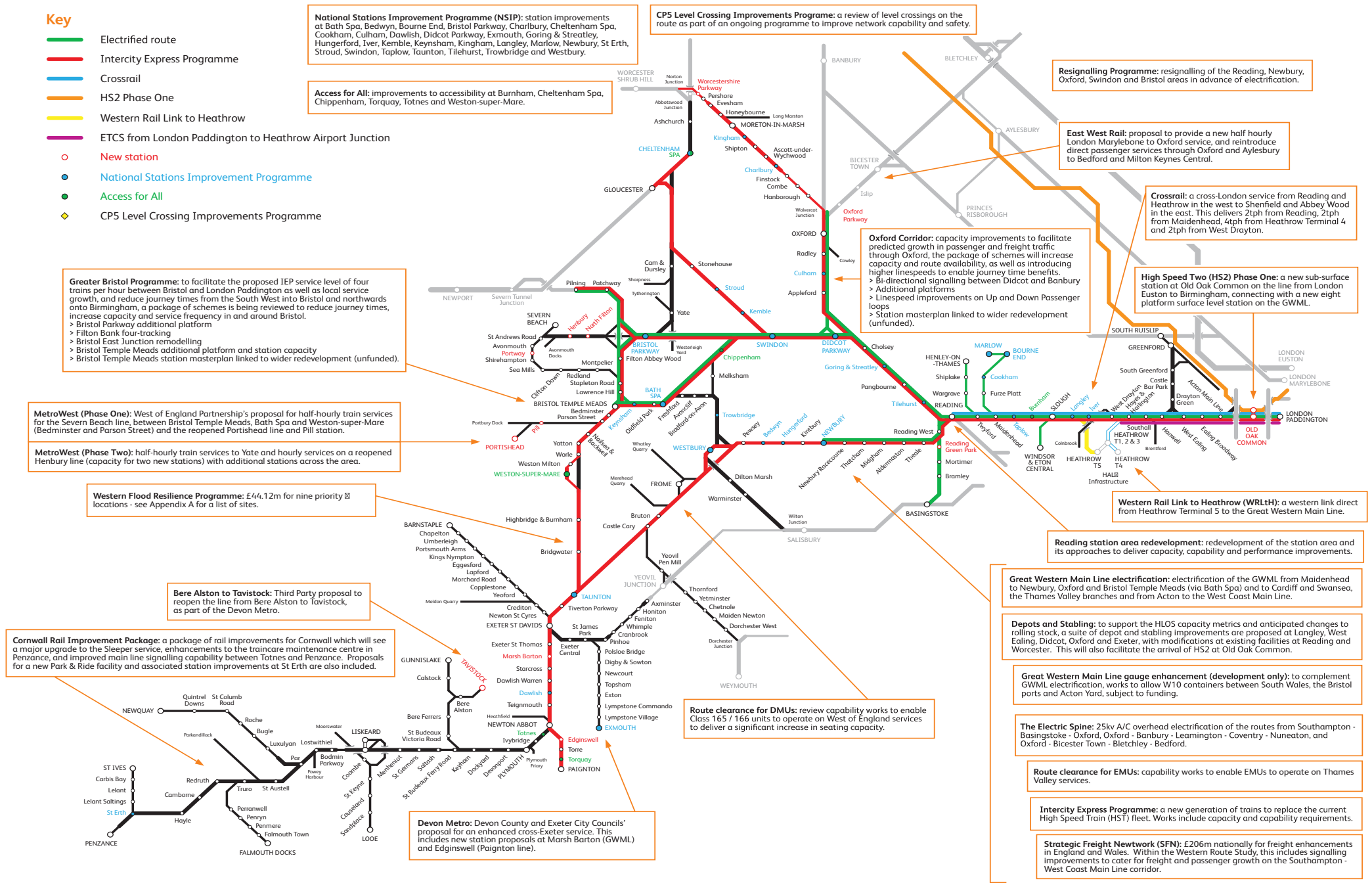
2.2.2 Planned Schemes included in the Baseline

Details of the planned schemes included in the Western Route Study baseline are illustrated in Figure 2.2. Further details can be found in Network Rail's **CP5 Delivery Plan** or in the Western Route Network and Route Specifications

In summary, the planned schemes included in the Western Route Study baseline are:

- Great Western Main Line Electrification
- Electric Spine (development only)
- Great Western Main Line Gauge Enhancement (development only)
- Intercity Express Programme (IEP)
- Route clearance for Electric Multiple Units and Diesel Multiple Units
- Resignalling Programme (Swindon, Oxford, Reading, Newbury, Bristol and Cornwall)
- Crossrail
- High Speed Two (Phase 1) (HS2)
- Western Rail Link to Heathrow Airport (WRLtH)
- Reading Station Area Redevelopment
- East West Rail
- Oxford Corridor Capacity Improvements
- Greater Bristol Programme
- MetroWest Phase 1 and Phase 2
- Devon Metro
- Bere Alston to Tavistock Reinstatement
- Station Improvements (including NSIP, AFA and SCPF)
- New Stations (Old Oak Common, Reading Green Park, Oxford Parkway, Worcestershire Parkway, North Filton, Henbury, Portway, Pill, Portishead, Edginswell, Marsh Barton, Tavistock)
- Level Crossings Programme
- Western Flood Resilience Programme
- Depot and stabling requirements.

Figure 2.2: Planned Schemes included in the Baseline



2.2.3. Other Known Schemes (not included in the Route Study Baseline)

There are a number of proposals that the Western Route Study has taken cognisance of which are currently uncommitted and unfunded in terms of implementation and therefore have not formed part of the Route Study baseline. However, due to the impact they would have on the Western Route they are important and consideration of their effects and benefits has been included, where possible, in our analysis.

HS2 Phase 2

The proposed second phase of HS2 would see the high speed lines extended further north beyond Birmingham to Manchester on the western leg and to Leeds on the eastern leg. The western leg is proposed to serve Manchester Airport and Manchester Piccadilly with the eastern leg proposed to serve stations in the East Midlands, South Yorkshire and Leeds. HS2 Phase 2 could add an additional 211 miles of new railway. HS2 Phase 2 has a projected completion timeframe of 2033 (Source HS2 Ltd website, 2014).

West Coast Main Line – Crossrail Link

The West Coast Main Line – Crossrail Link project would create a link between the Relief Lines on the GWML and the slow lines of the WCML. This would enable a number of Crossrail services, which are currently planned to terminate at Westbourne Park (or Old Oak Common after the implementation of HS2 Phase 1), to be extended to destinations on the WCML. This scheme was considered in the 2011 London & South East Route Utilisation Strategy and recommended for further development including a review of performance implications on the Crossrail network.

The WCML – Crossrail Link would provide WCML passengers with direct trains into east, west and central London reducing the need to interchange at London Euston to continue their journeys. This would provide connectivity benefits to passengers travelling from the WCML to destinations served by Crossrail (which is the case for the higher proportion of WCML Slow Line passengers). It would also reduce the number of trains and passengers arriving at Euston Station, releasing capacity there and on the public transport feeder network. The WCML – Crossrail Link is currently under review.

London Overground Connections at Old Oak Common

The current HS2 proposals do not include a connection to the London Overground services that currently pass through the area in which Old Oak Common Station will be located. Transport for London has led a study on options for linking HS2 to the London Overground network, i.e. the West London Line (WLL) and the North London Line (NLL). Following a public consultation, TfL's current proposals are for two new stations to be built in the Old Oak Common area; one on the WLL ('Hythe Road') and one on the NLL ('Old Oak Common Lane'). These would allow passengers to interchange between HS2, GWML, Crossrail and London Overground services, which would enable the creation of a key strategic interchange point for West London, similar to that in Stratford, East London.

HS2 passengers would be able to connect for onward journeys south towards Clapham Junction and Richmond, or north and east towards Stratford without having to enter central London. The new stations would also allow passengers travelling to Heathrow Airport from south west London the opportunity to change at Old Oak Common for direct Heathrow Airport and/or Crossrail services. Hythe Road station is currently projected to be completed in 2021, with Old Oak Common Lane in 2026.

Chiltern Route Connectivity at Old Oak Common

The Chiltern Main Line is already connected to the Old Oak Common area and it is an aspiration for rail to provide regular services along this corridor to provide a direct link from the key population centres of Buckinghamshire to Crossrail and HS2. This would provide an effective means of improving connectivity to airports, HS2 and Crossrail, as well as improving generalised journey times between several large commuter towns and London's major employment centres.

Colnbrook Branch Freight terminal

Network Rail is currently working with the developer of a substantial warehouse and distribution development on the Colnbrook branch that is currently the subject of a planning application. This could involve substantial numbers of additional freight services on this line.

Cowley Branch Line

The two-mile branch line from Oxford (Kennington Junction) currently serves freight traffic generated by the BMW car plant located at Cowley. Oxfordshire County Council is developing a proposal for the reintroduction of passenger services from Oxford Station along the Cowley branch line with new stations serving Oxford Science Park and Oxford Business Park. Work is progressing to assess the feasibility of upgrading the branch for passenger traffic whilst maintaining alignment with freight requirements and the CP5 Oxford Corridor proposals.

Brentford Branch Line

The three-mile branch line from Southall on the GWML currently connects two principal freight terminals at Brentford serving aggregates and domestic waste markets. The London Borough of Hounslow has a proposal to commence passenger services, having identified continued business development along the A4 Great Western Road corridor that has increased the potential viability of reintroducing passenger services along the line. This would provide direct connectivity with Crossrail at Southall. Network Rail is supporting the London Borough of Hounslow in investigating the feasibility of upgrading the line for passenger traffic and identifying funding streams for this work.

Plymouth Metro

Plymouth Metro is Plymouth City Council's aspiration for enhanced services linking Plymouth with the travel to work area of Liskeard, Gunnislake (including the future reopening of the Tamar Valley line between Bere Alston and Tavistock), Paignton and Exeter. Enhancements could be delivered through increased frequencies and clock face departures from Plymouth. Consideration is also given to a new Park & Ride station at Trerulefoot to target road traffic from South East Cornwall into Plymouth.

Other new stations

A further New Stations Package is proposed by the West of England Partnership for Saltford, Ashton Gate and Corsham (Wiltshire Council scheme) subject to funding and business case work, and further new stations between Taunton and Exeter at Wellington and Cullompton are being reviewed by the local authorities. Whilst due cognisance has been taken of these new station proposals, they do not form part of the Western Route Study baseline. There are further new stations proposed that have not been considered as part of the Western Route Study, although the rail industry continues to work with developers on these proposals.

2.2.4 Service Characteristics

During CP5, the characteristics of a number of train services are anticipated to change significantly. This reflects the programme of investments proposed for CP5 that are likely to provide enhanced infrastructure and rolling stock capacity and capability to operate an improved service offering.

A proposed development timetable has been constructed for 2019 (known as 'Iteration 5') which is based on a number of assumptions for the deployment and operation of the new SETs, EMUs, Crossrail and freight. The characteristics of the existing services will therefore alter with the introduction of new and redeployed rolling stock (electric and diesel) with differing capabilities.

At present, high level principles have been established to enable the development of Iteration 5 to continue. However, as previously noted, there are a number of issues and limitations with Iteration 5 that are currently being assessed and subject to further, more detailed modelling. This includes the future maintenance and engineering strategy for the Route. It is therefore evident that the timetable development currently underway for 2019 will change further. However, the Western Route Study has assumed Iteration 5 in its current form as the Indicative Train Service Specification (ITSS) for the 2019 baseline – noting that Iteration 5 is subject to further changes as the 2019 ITSS is developed into a confirmed, deliverable timetable through the agreed industry process of Industry Planning Group and Event Steering Groups.

Since the publication of the Western Route Study Draft for Consultation in October 2014, the second Direct Award for the Greater Western Franchise (covering the period from September 2015 to March 2019) has been agreed between the Department for Transport and First Great Western. This includes a new December 2018 timetable that draws upon the substantial changes anticipated with rolling stock and infrastructure. The timetable is being reviewed with deliverability assessments and other operators' needs to create a new baseline for 2018 that will be used to inform the 2019 development timetable.

However, the timeframe for completion of this is beyond the programme for the Western Route Study and therefore the decision was made to continue with our current planning assumptions using the 2019 development timetable for the purposes of the Route Study.

The analysis for the Route Study has included a review of the service changes from 2014 to create the 2019 baseline, with these anticipated service changes set out below.

Long Distance High Speed services

The most significant change across the Western Route will follow completion of the electrification of the GWML and enable the introduction of SETs into service. The change in rolling stock will drive changes to the timetable structure, service frequency and journey times across the Western Route Study area, with SETs expected to serve the long distance market from London Paddington to Bristol, Cheltenham and South Wales, and services from London Paddington to Oxford, Worcester and Hereford.

Subject to contractual agreement through standard industry processes, the key timetable changes anticipated are:

- two additional trains per hour between London Paddington and Bristol Temple Meads via Bristol Parkway (with the two existing services via Bath Spa continuing as today)
- an optimisation of calling patterns of trains between London Paddington, Bristol and South Wales providing faster journey times
- an increase in frequency of the London Paddington to Cheltenham Spa service from two-hourly to hourly all day.

The IEP is likely to introduce bi-mode rolling stock for long distance services from London Paddington to Westbury, Exeter and Paignton. Some services to the West Country including destinations such as Exeter, Paignton, Plymouth and Penzance are at present assumed to continue to be served by HSTs although at the time of writing new rolling stock is being considered. Services west of Newbury are anticipated to change with the introduction of electrification along the Berks and Hants route as far as Newbury.

Didcot Parkway and Oxford are assumed to have a broadly similar service pattern to today's timetable. An hourly service will operate between London Paddington and Worcester, with selected services extended beyond to Great Malvern or Hereford.

Thames Valley services

The primary service change for the suburban services in the Thames Valley area is through the introduction of Crossrail services. Crossrail will be a high frequency service serving all stations between Reading and London Paddington and across central London to East London. Crossrail will replace current suburban services and provide improved capacity and connectivity to the West End and the City of London with 24 trains per hour (tph) operating in each direction through the central tunnel. At peak times it is anticipated that ten trains per hour will continue west of London Paddington consisting of: 4tph to Heathrow Airport, 2tph to West Drayton, 2tph to Maidenhead and 2tph to Reading; 14 services will start / terminate at London Paddington.

The service on the Greenford branch will be amended to operate as a shuttle into a new bay platform at West Ealing at today's frequency.

The Henley-on-Thames, Windsor & Eton Central and Marlow/ Bourne End branches remain unchanged at the same service frequency as today and are anticipated to benefit from electrification on the Western Route and be served by electric rolling stock. The 2019 ITSS used in the baseline currently assumes that the morning and evening peak through services between London Paddington and Henley-on-Thames and Bourne End/Marlow will be replaced by connections at Twyford and Maidenhead respectively.

The introduction of EMUs will bring additional on-train capacity and journey time opportunities due to the improved capability of the rolling stock. However there are currently no proposals to change the service pattern further beyond that presently proposed.

West Country

Additional services and service amendments are anticipated to be introduced during 2019 as part of MetroWest and Devon Metro. Phase 1 of MetroWest includes the reinstatement of the Portishead

branch with stations at Pill and Portishead. This would provide a half-hourly service frequency on the Severn Beach branch, a peak half hourly, and off-peak hourly, service on the reinstated Portishead branch line, and an additional hourly service between Bristol Temple Meads and Bath Spa calling at all intermediate stations.

Devon Metro anticipates the continuation of the Interreg-funded scheme for two trains per hour on the Paignton line. Also the current Barnstaple to Exmouth service is anticipated to become a Barnstaple to Honiton/Axminster service to deliver the aspiration for two trains per hour on this corridor east of Exeter, subject to funding and infrastructure requirements. The Paignton services would then extend at 2tph to Exmouth to maintain the service frequency. There will also be new stations open at Cranbrook, Edginswell and Marsh Barton.

Rolling Stock and Depot & Stabling requirements

The introduction of EMUs on the Western Route will replace many of the DMUs that currently operate in the Thames Valley. These in turn would cascade to the west to replace and supplement the existing rolling stock. This would provide opportunities for increased on-train capacity and may provide journey time improvements where line speeds permit. The planning assumptions that have been used for analysis purposes as part of the Western Route Study are that Class 165 and Class 166 DMU rolling stock will be redeployed to the Bristol area facilitating the redeployment of DMUs from there to the Exeter area.

Development work to examine depot and rolling stock stabling requirements to support the introduction, and redeployment, of rolling stock is currently being undertaken by the rail industry and may lead to further requirements to support the rolling stock changes anticipated in CP5. This also considers the ability to operate and facilitate Empty Coaching Stock movements to stabling and maintenance locations across the route, in particular during peak periods between London Paddington and Reading where there are a number of significant changes to depot facilities including new facilities for Crossrail and IEP, and replacement for facilities to be displaced by the proposed HS2 station at Old Oak Common; this includes a proposed new depot for Heathrow Express at Langley.

As part of the Cornwall Rail Improvement Package, a major upgrade to the Sleeper service rolling stock will be completed and enhancements made to the train maintenance depot in Penzance. The depot will have engineering facilities upgraded as well as an increase in capacity to enable the maintenance of the Sleeper service to transfer from Old Oak Common to Penzance.

Freight

Significant volumes of freight are carried over the Western Route with an estimated 11 million tonnes transported per annum. The GWML is the second busiest freight corridor into London after the West Coast Main Line with a mix of freight traffic, and both cross-boundary and inter-regional flows. Across the route there are approximately 45 freight terminals, handling at least twelve different commodities. The major commodities transported are aggregates, coal, containers and steel. In addition to these flows, other freight traffic traverses the area to destinations in South Wales and to the North of England and Scotland. The influence of South Wales on freight traffic is significant on the route due to the many impacts that through traffic has on the area.

The dominant freight flows for the Western Route are summarised as follows:

- aggregates: the Western Route sees the heaviest trains in the UK, with some 4,500 tonnes trailing weight, transporting aggregates for the construction industry from the Mendip quarries to terminals in London and the South East. There are also aggregate flows from South Wales transported across the route
- china clay traffic in the far south west, from a range of loading points around St Austell, is carried locally within Cornwall for export via the Port of Fowey, as well as over longer distances outside the route
- the Heathfield branch has been used from 2011 for timber traffic but is currently being reviewed for aggregate traffic from Teignbridge
- deep sea intermodal traffic between the Port of Southampton and the WCML, (via Basingstoke, Reading, Oxford) for terminals in the Midlands, North West and Scotland

- automotive flows, with manufactured output centred on Oxford Cowley (BMW) and Swindon (Honda). Significant volumes of cars flow for import and export across the route, with imports through Bristol's Portbury terminal and exports through the Eastern Docks at Southampton
- steel products, both finished and semi-finished, originate in South Wales and consist of domestic flows to the Midlands and North, as well as international flows to Tilbury and the Channel Tunnel
- petroleum traffic from the refinery at Milford Haven in South Wales generates up to five trains per week to either Westerleigh or Theale in the Western Route.

The proposal by the Bristol Port Company to construct a new container terminal at Avonmouth will introduce further freight traffic across the area. Network Rail is also working with SITA to develop an energy from waste power station on the Severn Beach branch at the former ICI Severnside site.

Freight that moves across the Western Route, either as a raw material or a finished product, supports a significant portion of UK industry and economic activity contributing significantly to employment and growth.

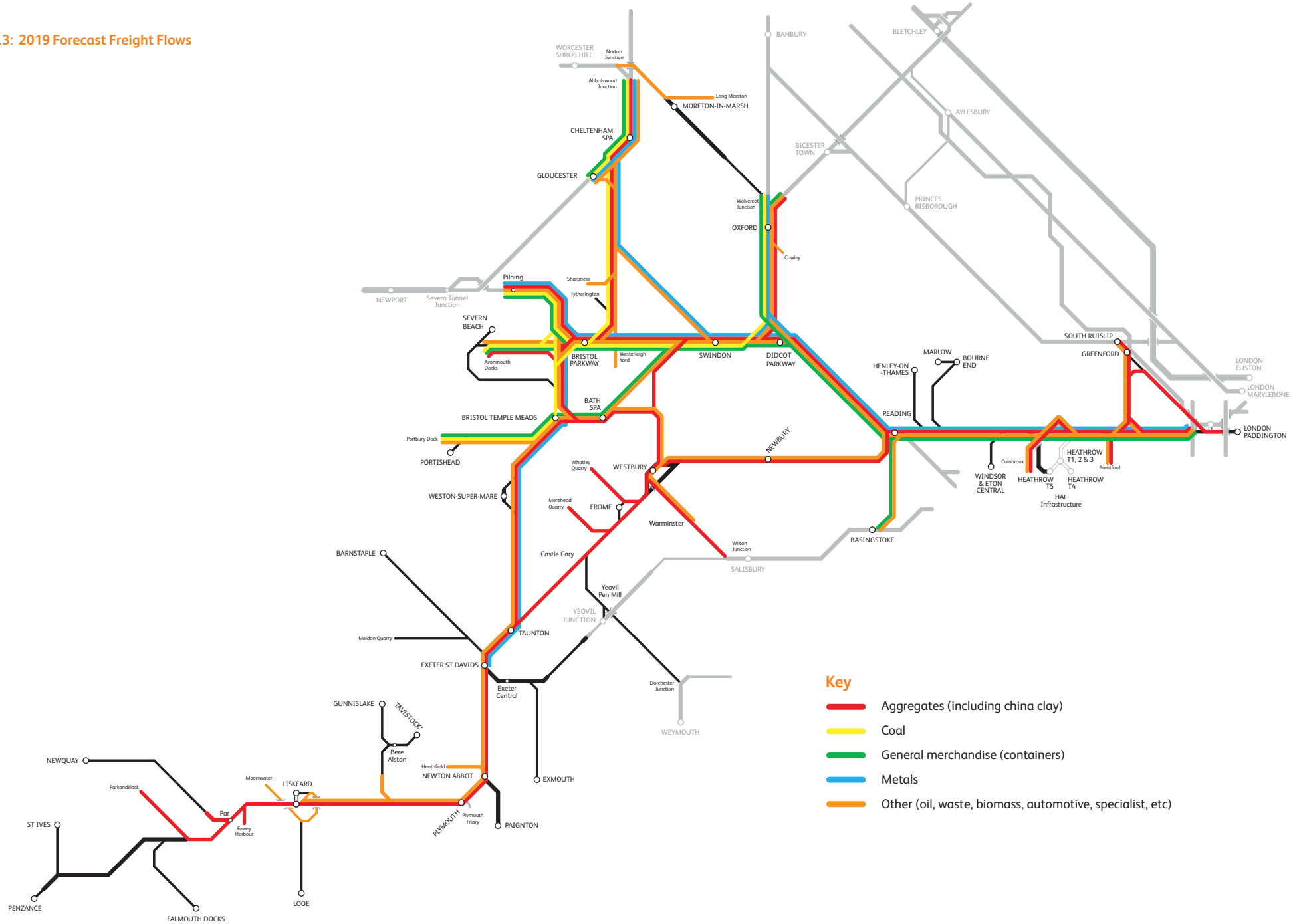
Freight forecasts were developed as part of the **Freight Market Study** (FMS); in summary these show substantial growth in intermodal freight from ports, a gradual decline in coal traffic (as coal forms a smaller part of the UK's power generation mix) and modest growth in other commodities (in particular, aggregates for the construction industry). However, the aggregates market is also currently growing faster than established industry forecasts as a result of government policy and faster than predicted economic growth. This is likely to further increase during the construction of HS2. Figure 2.3 presents the core freight flows across the route.

The **Network RUS: Freight**, due to publish its Draft for Consultation in 2015, has revised the forecasts produced for the FMS. This has primarily affected the growth forecasts for the construction market, which has already shown strong growth compared to the forecasts in the FMS. The **Network RUS: Freight** has revisited the forecasts and updated them according to the recent growth witnessed. Further details are available in Chapter 3.

2.2.5 Rail Passenger Demand in 2019

Analysis has been undertaken to determine the 2019 baseline for rail passenger demand. Chapter 3 presents the level of demand expected into London Paddington, Reading, Bristol and Exeter St Davids as key corridors across the Western Route Study area.

Figure 2.3: 2019 Forecast Freight Flows



2.3 Longer Term Strategy to 2043

Looking through to the longer-term planning horizon of 2043, there are further proposals being developed.

European Rail Traffic Management System

ERTMS (European Rail Traffic Management System) is a signalling and train control system that will replace traditional line side railway signals with a computer display inside every train cab, reducing the costs of operating and maintaining the railway, improving performance and enhancing safety. ERTMS combines European Train Control System (ETCS) and Global System for Mobile communications – Railways (GSM-R). ETCS provides trains with a movement authority and target speed on a screen display located in the driver's cab. The train is identified through a combination of trackside equipment and on-board sensors, while instructions from the control centre are conveyed through the GSM-R signal.

The introduction of the system will be a key enabler in the development of the future railway. It will underpin enhancements to railway operations and support capacity improvements beginning in Control Period 6. ERTMS will become the long-term standard for resignalling schemes and will:

- reduce the cost of signalling renewals (when installed with no line side signals)
- reduce the cost of signalling maintenance (when installed with no line side signals)
- improve safety through continuous automatic train protection
- provide the opportunity for enhanced operational capability and increased capacity (when installed with no line side signals)
- afford regulatory compliance to Railway Interoperability Regulations (2011).

Traffic Management technology forms an integral part of Network Rail's National Operating Strategy, which seeks to consolidate operations into 14 rail operating centres over the next 30 years. Once fully implemented, the traffic management strategy would reduce the cost of Britain's railways, improve industry efficiency, reduce delays and provide more accurate, timely information to staff and passengers.

Figure 2.4 indicates the potential capability requirements of ETCS across the Western Route.

The anticipated programme of signalling renewal across the Western Route is presented in Figure 2.5. This illustrates the resignalling schemes and their anticipated timeframes.

Digital Railway

The Digital Railway is a rail industry-wide programme to accelerate the digital enablement of the railway. The scope is being defined but will transform key areas of the railway such as train operation, capacity allocation, infrastructure and stations. Further details are available in Chapter 1.

Figure 2.4: Anticipated capability requirements of ETCS across Western Route

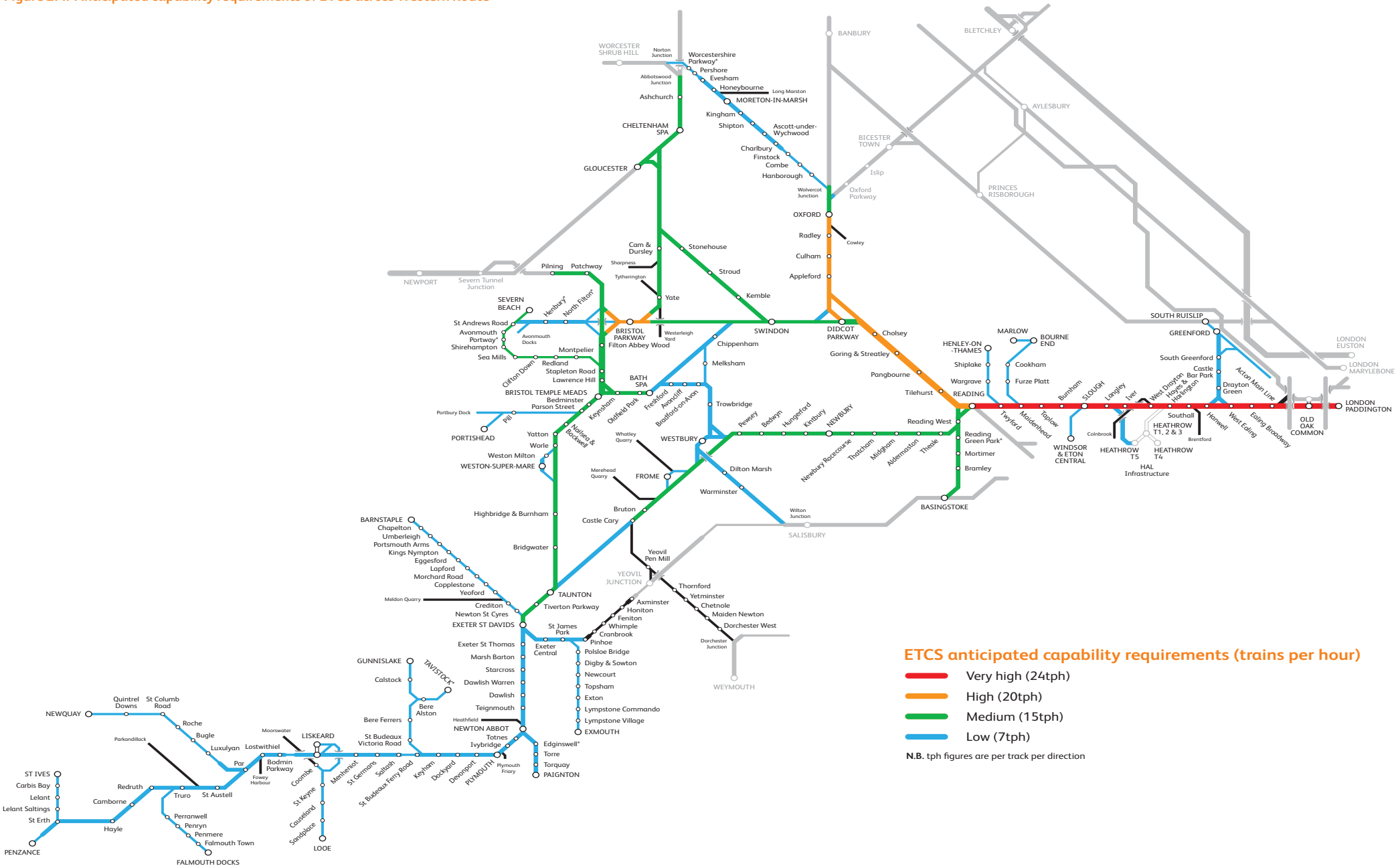
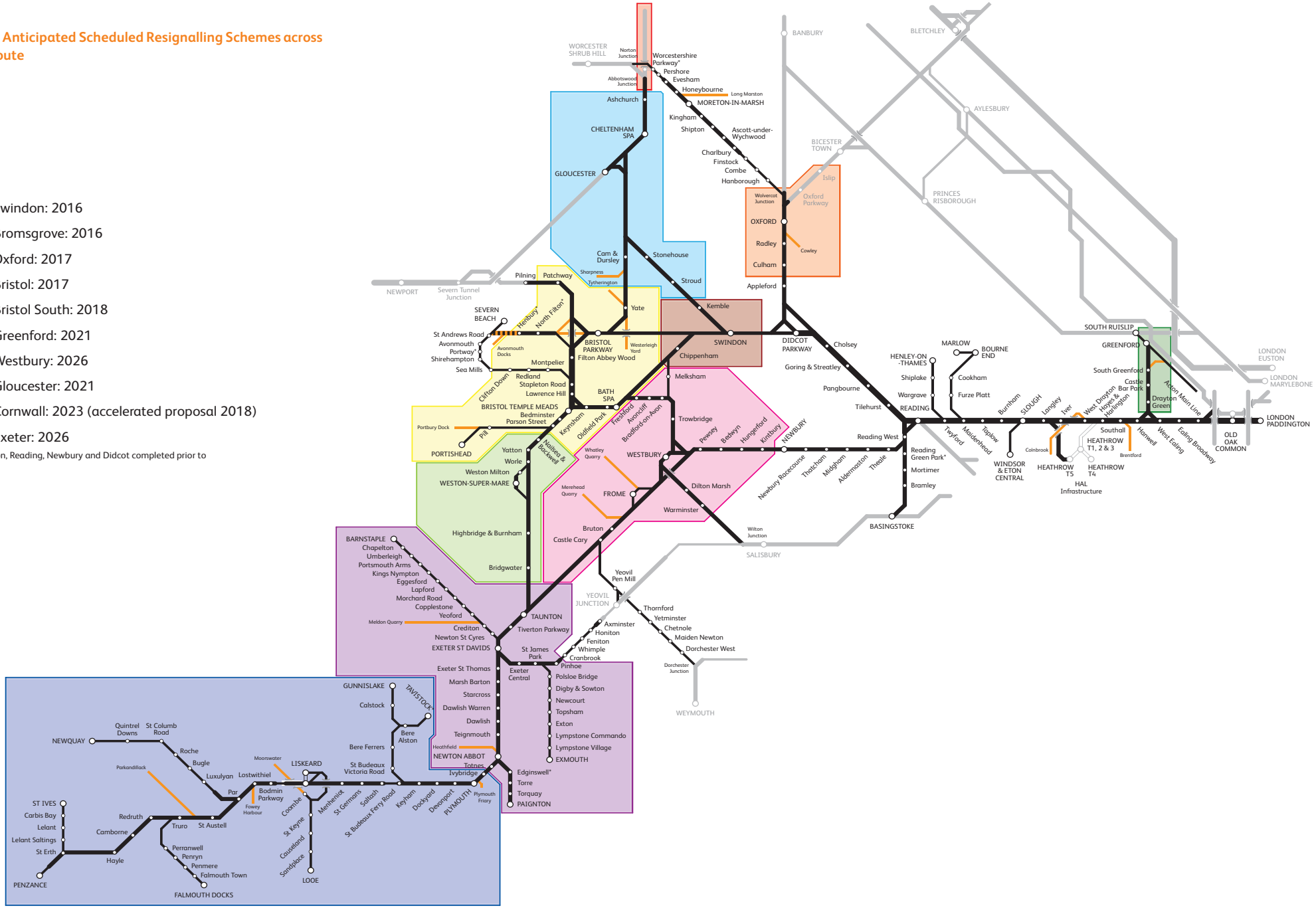


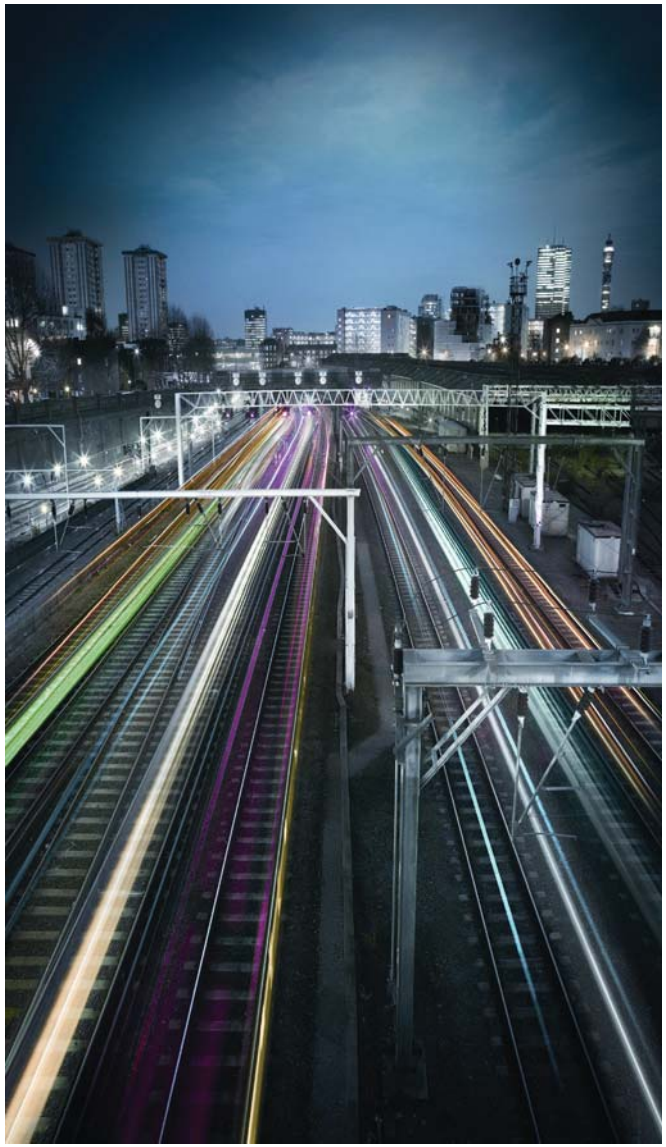
Figure 2.5: Anticipated Scheduled Resignalling Schemes across Western Route

Key

- Swindon: 2016
- Bromsgrove: 2016
- Oxford: 2017
- Bristol: 2017
- Bristol South: 2018
- Greenford: 2021
- Westbury: 2026
- Gloucester: 2021
- Cornwall: 2023 (accelerated proposal 2018)
- Exeter: 2026

Note: Paddington, Reading, Newbury and Didcot completed prior to electrification





Electrification Proposals

In the July 2012 HLOS, the DfT indicated that it wished the industry to develop a 'rolling programme' of electrification to provide capability for electric traction on a significant proportion of the national rail network. Expansion of the electrified network would reduce rail industry costs and cut carbon emissions through the creation of electrified routes to link the core centres of population and economic activity. Electrification could also provide additional benefits including gauge clearance for large containers and better journey times for passenger and freight trains.

Network Rail, on behalf of the rail industry, will publish a 'refreshed' Route Utilisation Strategy for Electrification, to outline potential priorities for future electrification following completion of the programme currently underway. The strategy will prioritise routes for further development based primarily on the density of diesel-operated traffic that could be converted to electric operation through the provision of electrification. It will also consider options that may be worthy of further investigation in light of other factors. These include, for example, whether an option would allow more efficient usage of the existing electrified network by reducing diesel running on electrified sections of the route; providing a diversionary route; identifying synergies with rolling stock replacement; or other enhancement schemes. For the routes selected for further development cost estimates will be produced and full business case appraisals conducted in a manner consistent with funders' guidelines.

The RUS will examine in detail the passenger electrification options most likely to offer the highest value for money following the completion of the current portfolio of schemes. The business cases will be based on current understanding of the services that would be required to meet CP5 growth projections. Over the timescale of the RUS, the strength of the case for further electrification will continue to evolve as the industry progresses through a rolling programme that adapts to technological developments and changes in demand. Similarly, the inclusion of other factors (for example the wider economic benefits considered by the Northern Electrification Task Force) could suggest a different prioritisation than that presented in the RUS.

2.4 Airports Strategy

London is served by several airports, the two largest of which are Heathrow and Gatwick. Heathrow Airport is the UK's hub airport serving 70 million passengers a year. Gatwick Airport serves 34 million passengers a year, the majority of whom are originating or terminating passengers. UK air passenger numbers are expected to grow by between one and three per cent per annum to 2050 as identified in the **London & South East Market Study**.

Airport policy for the UK has recently been reviewed by the Airports Commission, chaired by Sir Howard Davies. Initial findings from this review were published in 2013 with final findings published in July 2015. In particular, it considers the various options for expanding airport capacity in order to maintain the UK's position as Europe's most important aviation hub. The shortlisted options are expansion of either Heathrow or Gatwick Airports. Network Rail has been working with the Airports Commission to enable options for expanding UK aviation capacity to be informed by the opportunities and constraints of viable rail access links.

Summary

This chapter has presented what is currently understood as the 2019 baseline for the Western Route Study. It has outlined anticipated changes between today and 2019 for infrastructure, service specifications and passenger and freight demand and highlighted other proposals that have been taken into account during the analysis. Finally, it presents the longer-term horizon with developments for consideration.

Chapter 3 presents the Market Studies, the Conditional Outputs and the interpretation of these adopted for use in the Western Route Study.

03 Interpreting the Conditional Outputs

This chapter interprets the Conditional Outputs from the Market Studies in the context of the Western Route Study area. It also presents more detailed forecasting work that has been undertaken, and reports the outputs in terms of anticipated levels of crowding. It concludes by creating an Indicative Train Service Specification for 2043 to illustrate a level of off-peak service which the Route Study then uses in subsequent analysis.

3.1 Interpreting the Conditional Outputs

The Market Studies presented in Chapter 1 present growth forecasts and Conditional Outputs developed in consultation with the rail industry, funders, local authorities and other stakeholders. Conditional Outputs are defined as the required service characteristics for passenger and freight (such as capacity, frequency and journey time) which the industry aspires to deliver over the next 30 years to meet the long-term strategic goals, and includes:

- the level of rail capacity required to accommodate demand for passenger journeys and freight
- the level of rail connectivity between large towns and cities across the country (by for example, the frequency of train services, journey times, and the provision of direct journeys which do not require an interchange)
- improvements to intra-regional connectivity.

These Conditional Outputs are aligned to a number of national strategic goals for the transport sector, which include:

- supporting and stimulating sustainable economic growth. For example, the provision of sufficient capacity for people travelling to take part in economically productive activities and improvements in business to business connectivity
- reducing the impact of travel and transport on the environment for example, by reducing the environmental impact of rail
- improving the quality of life for communities and individuals by connecting communities, reducing road congestion and providing access to social infrastructure
- modal shift of freight from road to rail.

The Western Route Study considers strategies to deliver these Conditional Outputs over a 30-year planning horizon to 2043, consistent with the Long Term Planning Process (LTPP). The length of this planning horizon reflects in part the longevity of rail infrastructure assets and investments. It also enables the industry to plan the capacity and capability of the network in the context of major schemes, some of which will take many years to deliver, for example High Speed Two (HS2) (see Chapter 2 Baseline for further details).

The following sections present the established Market Studies growth forecasts and Conditional Outputs followed by an interpretation of these Conditional Outputs into a set specifically for the Western Route Study.

The remainder of this chapter is structured as follows:

3.5 Freight Conditional Outputs (FCO1-FCO6)

3.6 Other Conditional Outputs

- 3.6.1 Better capacity for the leisure market at weekends and weekday evenings
- 3.6.2 Improved local access to the rail network to cater for demand
- 3.6.3 Better connectivity for the leisure market at weekends
- 3.6.4 Improved access to long distance gateways
- 3.6.5 Long distance strategic rail interchanges
- 3.6.6 High speed rail
- 3.6.7 Airports
- 3.6.8 Major ports
- 3.6.9 Connectivity and capacity for tourist attractions outside of the region's urban centres
- 3.6.10 Improved access to higher educational establishments and other social infrastructure
- 3.6.11 Improved passenger satisfaction

Each of the sections is described, in turn, in further detail.

3.2 Market Study Forecasts

3.2.1 Passenger

The Market Studies specified a Conditional Output to accommodate the high growth scenario in rail passenger demand to 2043. This growth includes influences from factors such as projected employment levels, Gross Domestic Product (GDP) and population; known as "background growth". Where specified, the forecasts also include anticipated demand from future rail investments, which have committed funding and are planned for implementation in Control Period 5 (CP5, 2014 – 2019) as described in Chapter 2. The passenger rail demand forecasts established in each of the Market Studies, relevant to the Western Route Study are presented in Figure 3.1.

The analysis is based on the Market Studies' growth forecasts which do not include demand generated by further schemes, i.e. only background growth is included. The additional demand generated by new stations, for example, needs to be considered separately, which is considered further, for example, in Route Section O in Chapter 5.

Figure 3.1: Market Study rail passenger demand forecasts relevant to the Western Route Study (High Growth Scenario)

Market Study	Forecast description	2012-2023	2012-2043
London & South East	Demand growth into London Paddington on Relief Line services including background growth and demand from committed schemes	198%	298%
London & South East	Demand growth into London Paddington on Main Line services including background growth and demand from committed schemes	29%	99%
Regional Urban	Demand growth on services into Bristol, generally journeys of less than 50 miles, background growth only	47%	111%
Long Distance	Demand growth on journeys generally over 50 miles from Bristol, background growth plus committed schemes*	Bristol – London: 47% Bristol – Birmingham: 40% Bristol – Manchester: 43%	Bristol – London: 118% Bristol – Birmingham: 97% Bristol – Manchester: 123%

*For the full list of long distance journey forecasts please see the Long Distance Market Study.

Relief Line services include shorter distance, Inner Suburban stopping services into London Paddington, and Crossrail.

Main Line services include long distance services, Outer Surburban services from towns such as Oxford and Newbury.

Demand growth includes demand from CP4 (2009 – 2014) and CP5 schemes that were committed for funding at the time of publication of the Market Studies.

The high growth scenario represents the "Prospering in Global Stability" UK future scenario. Please refer to the Market Studies for the complete list of scenarios and forecasts developed.

Since publication of the Market Studies, further forecasts have been developed to include expected demand from other committed schemes and to model growth in areas not included in the Market Studies. They have been specified where relevant throughout this chapter.

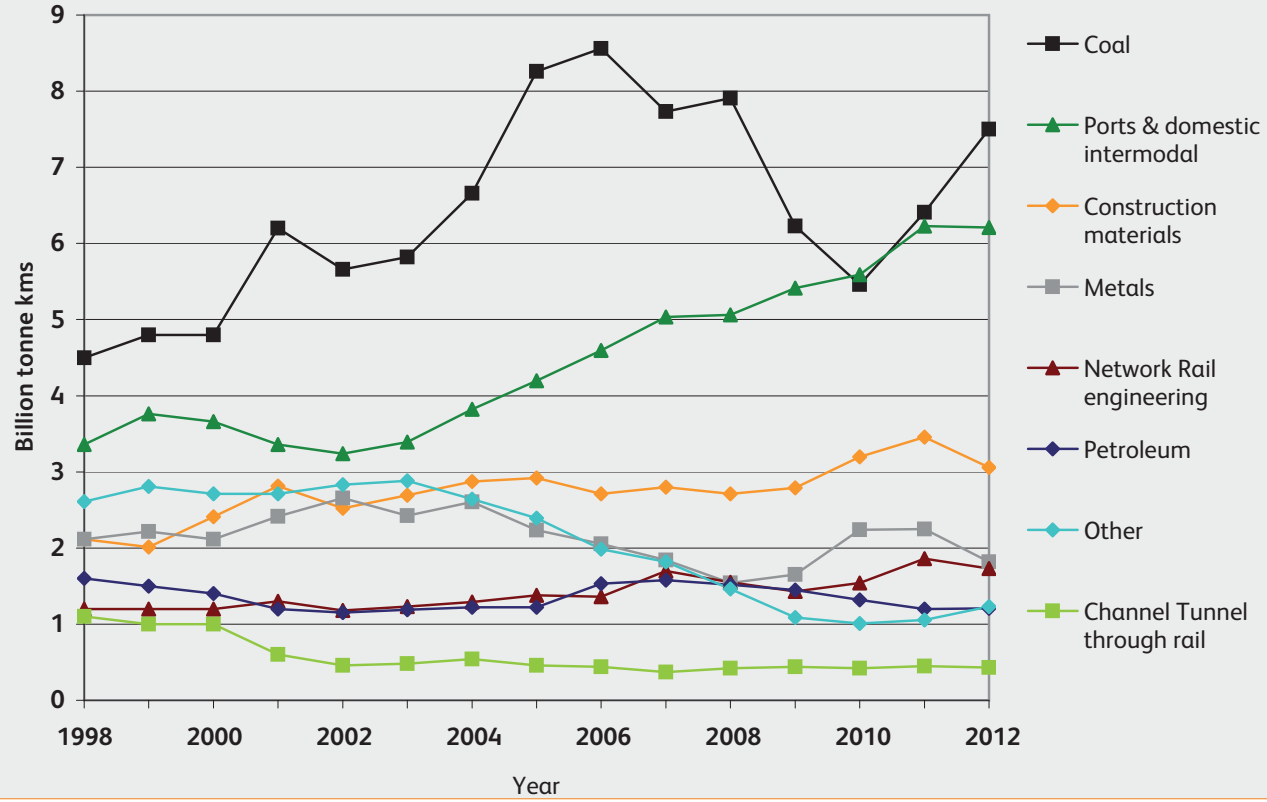
3.2.2 Freight

The **Freight Market Study** (FMS) developed forecasts for future rail freight demand across the UK network which took a strategic view of the potential development of key freight markets. The Conditional Outputs established in the FMS are to accommodate the forecast level of freight demand for 2023 and 2043.

To set forecasts of rail freight demand in context, the FMS reviewed historical rail freight demand to see how it has changed between 1998 and 2012. Figure 3.2 shows that, in terms of tonne kilometres, the largest source of growth within the freight market has been the intermodal sector.

Figure 3.2: National Freight Demand between 1998 – 2012

Figure 3.2: National Freight Demand between 1998 – 2012



The forecasts developed as part of the FMS took a strategic view of the potential development of key freight markets and produced forecasts for 10, 20 and 30 years into the future with scenarios that seek to capture uncertainties in the markets. The forecasts were developed under several key assumptions including;

- an unconstrained network for freight capacity
- UK and global economic growth
- labour and fuel costs rise in line with Department for Transport (DfT) guidance
- no change in rail productivity relative to road productivity.

Freight across the UK, measured in total tonne kilometres, is forecast by the FMS to increase at 2.9 per cent per annum to 2043 compared to the annual growth rate of circa 2.5 per cent per annum since the mid-1990s. In terms of total tonnes lifted, the forecast is two per cent annual growth to 2043, compared with the recent trend of broadly stable tonnage. The forecast growth rate in terms of tonnes is lower than that for tonne kilometres as a result of changes in the composition of traffic, such as the forecast reduction in coal flows and the forecast increase in longer distance intermodal flows.

Any constraints identified to accommodate this forecast demand are addressed as part of the Cross-Boundary Analysis work stream and the Western Route Study (as presented in Chapters 4 and 5 respectively).

3.3 Passenger Capacity Conditional Outputs (CO1-CO6)

The Western Route Study has used the established Market Study forecasts for rail passenger demand as presented in Figure 3.1 to develop specific capacity Conditional Outputs for the Western Route Study area. These determine the forecast level of rail passenger demand to be accommodated over the next 30 years. The capacity Conditional Output is to provide sufficient capacity to accommodate forecast rail passenger demand to 2043. The capacity required has been assessed based on the busiest periods of the day, which is predominantly the peak periods in the morning (07:00 – 09:59) and the evening (16:00 – 18:59) with cognisance taken of all day travel and weekend demand.

For the purposes of long-term capacity planning, the Western Route Study has assumed that the evening peak period is as busy as the morning peak period, and any options identified to provide capacity in the morning peak period should therefore be sufficient to accommodate demand in the evening and at weekends. This is discussed further in Section 3.6.3 'Better capacity for the leisure market at weekends and weekday evenings'.

However, the Western Route Study area experiences significant variations in demand throughout the year due to seasonal influences. This variation is most dominant on journeys on the rural branch lines in Cornwall. These areas have been assessed based on the peak demand during the summer months and is presented further in Section 3.3.6.

Capacity Assumptions

On-train capacity requirements are assessed by the calculation of the load factor which is defined as the ratio of rail passenger demand to capacity provided. The Western Route Study describes train capacity as the total number of standard class seats available plus standing allowance where there is a stop within 20 minutes, as per DfT guidance.

The load factor is used to indicate the level of on-train crowding that would be expected. Where analysis is considering multiple services (e.g. over a specific time period rather than individual services) an average load factor is used to account for variability in loads across individual train services. An average load factor of greater than 85 per cent is assumed to indicate there is likely to be on-train crowding within the specified time period, which is deemed unacceptable and additional capacity is required.

Rolling stock assumptions (type and capacity) are specified using the 2019 ITSS which is based on anticipated future deployment plans, available at the time of publication, noting these are subject to change. These are presented in Appendix B.

The passenger capacity Conditional Outputs for the Western Route Study are shown in Figure 3.3.

The following section describes the capacity assumptions and each capacity Conditional Output in turn highlighting changes in capacity anticipated between 2013 and the 2019 baseline. The expected capacity shortfalls between 2019, 2023 and 2043 passenger demand are also presented. Chapter 5 proposes choices for funders to meet these capacity constraints.

Figure 3.3: Western Route Study Capacity Conditional Outputs

Conditional Output Reference	Western Route Study Capacity Conditional Output
CO1	To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Relief Line services from the Inner Suburban area
CO2	To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel
CO3	To provide sufficient capacity for passengers travelling into Reading, taking into account anticipated growth over the period to 2043
CO4	To provide sufficient capacity for passengers travelling into the Greater Bristol area, taking into account anticipated growth over the period to 2043
CO5	To provide sufficient capacity for passengers travelling into the Exeter Area, taking into account anticipated growth over the period to 2043
CO6	To provide sufficient capacity for passengers travelling into Devon and Cornwall, taking into account anticipated growth over the period to 2043

3.3.1 Passenger Capacity Conditional Output 1 (CO1): provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Relief Line services for the Inner Suburban market

The **London & South Market Study** (LSEMS) defines an inner suburban market within approximately 30-40 minutes travel time of London. Within the Western Route Study the extent of this area differs depending on whether the passenger travels on Main Line or Relief Line services.

For the purpose of analysis, the Inner Suburban area has been defined as between London Paddington and Reading as per the characteristics of the planned rail services for Crossrail and the Thames Valley Branch lines (West Ealing – Greenford; Slough – Windsor & Eton Central; Maidenhead – Marlow/Bourne End and Twyford – Henley-on-Thames). These markets are illustrated in Figure 3.4.

It is noted that passengers travelling in the peak to London Paddington from Reading, Twyford and Maidenhead tend to travel on faster Outer Suburban services that use the Main Lines for some or all of their journey.

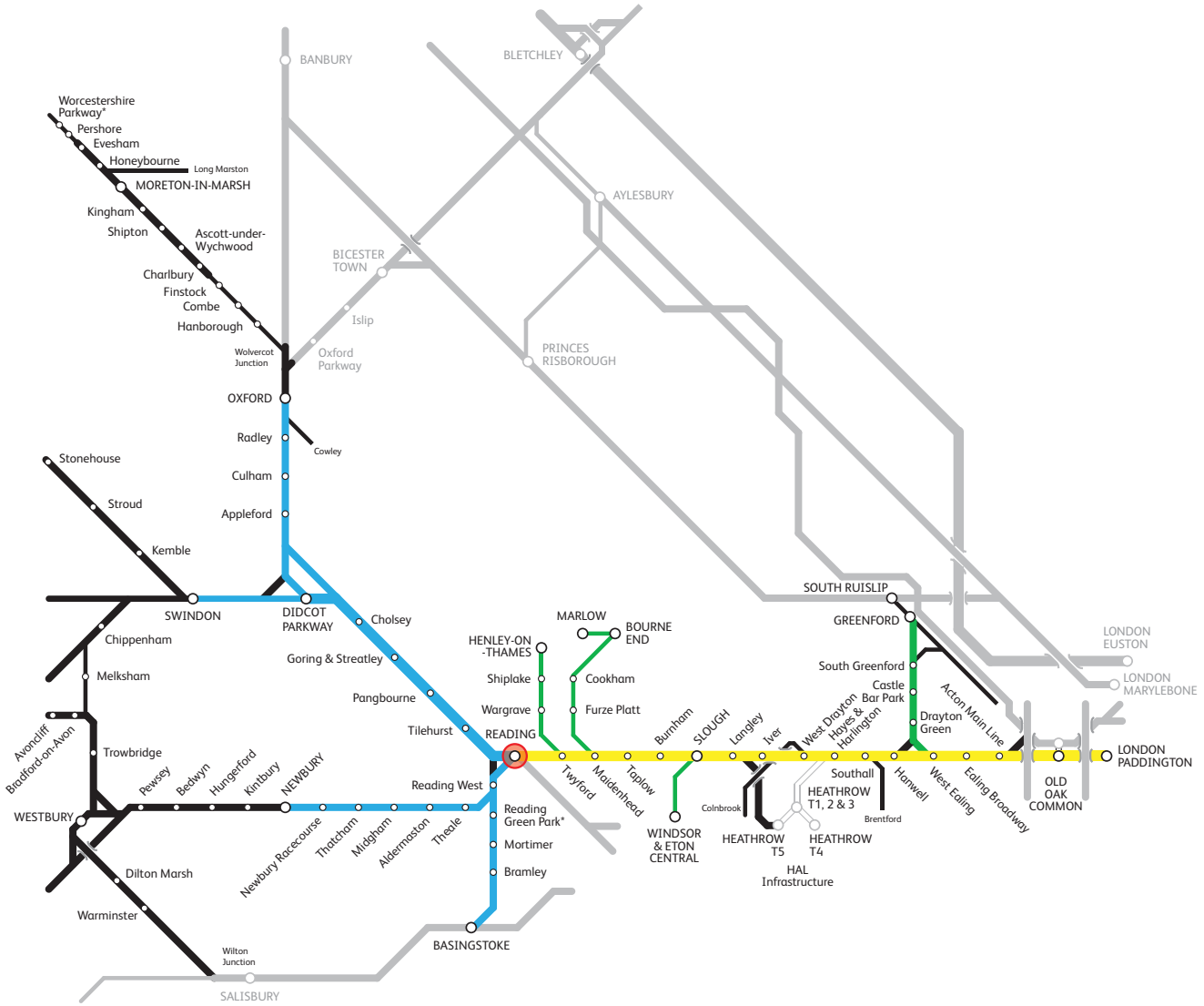
Crossrail

The introduction of Crossrail services between Reading, Heathrow Airport and central London is anticipated to provide a significant step change in the provision of capacity and connectivity to the Western Route Inner Suburban market. The new connections will enable rail passengers to travel directly into central London without interchange, which is expected to stimulate further passenger demand for rail. This significantly increased capacity forms part of the baseline for the Western Route Study.

Transport for London (TfL) have provided forecast demand data for 2026 (following the introduction of the HS2 station at Old Oak Common which is assumed to be served by Crossrail) and for 2041. These forecast years are close to the reference points of 2023 and 2043 used in the LTPP.

Figure 3.5 shows the predicted demand profile in 2026 and Figure 3.6 shows the equivalent predicted profile in 2041, between London Paddington and Maidenhead in the morning high peak hour (08:00 –08:59). Both forecasts suggest that interventions to provide additional capacity on Crossrail services above the 2019 baseline will be required to accommodate predicted peak rail passenger demand beyond 2024.

Figure 3.4: Inner Suburban markets between London Paddington and Reading



Key

- Inner suburban, principally served by Crossrail
- Thames Valley branches, with interchange onto GWML
- Outer suburban, served by dedicated and some long distance services
- Reading: outer suburban commuter market served by a mix of longer distance rail services

Figure 3.5: Anticipated passengers on high peak Crossrail arrivals at London Paddington (08:00 – 08:59) with estimated 2026 demand

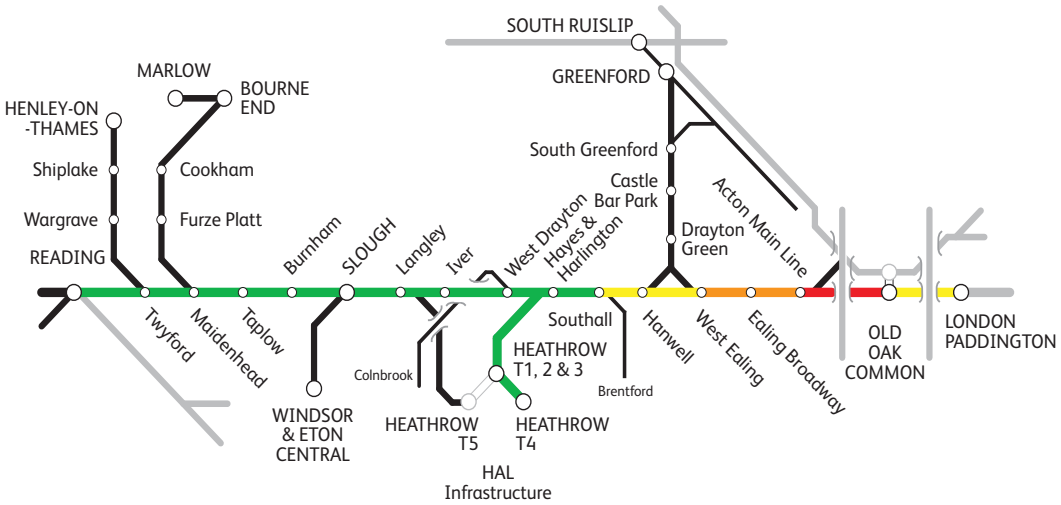
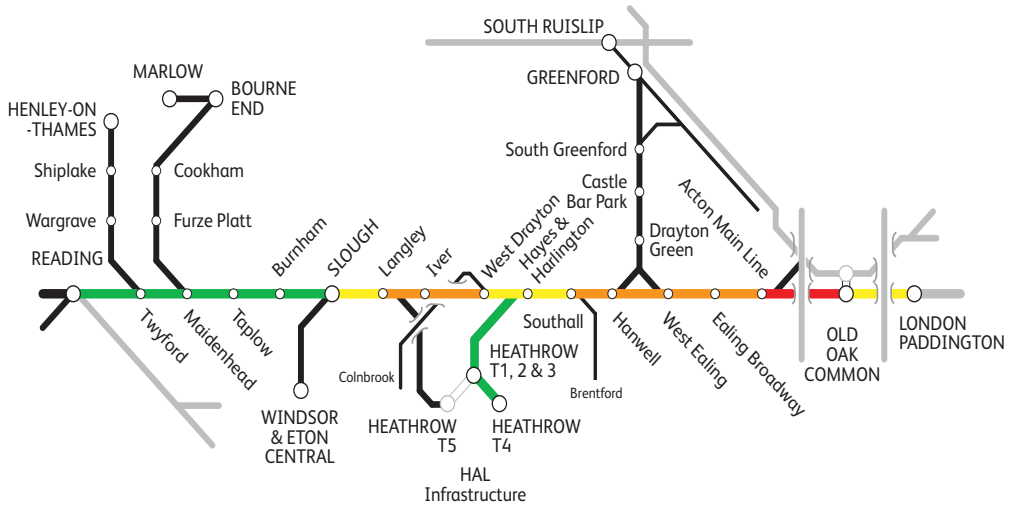


Figure 3.6: Anticipated passengers on high peak Crossrail arrivals at London Paddington (08:00 – 08:59) with estimated 2041 demand



Key

- Less than two passengers per square metre
- Two to three passengers per square metre
- Three to four passengers per square metre
- Four or greater passengers per square metre

Estimated number of passengers per square metre on Crossrail eastbound services in the morning high peak hour

The level of crowding is defined as the typical number of passengers standing per square metre. TfL generally considers crowding to be high when the number of passengers per square metre exceeds three. Figure 3.5 shows that the number of passengers standing per square metre is expected to reach three from Southall and stations to the east of, in 2026. Figure 3.6 shows crowding is forecast to approach four passengers per square metre in 2041.

This analysis includes the impact of HS2 and the new station at Old Oak Common. Anticipated demand for Crossrail services from Reading is not currently available; however rail passenger demand from Reading is unlikely to have a material impact on the level of on-train crowding with the anticipated calling patterns assumed in the 2019 ITSS. Passengers travelling between London Paddington and Reading are more likely to use the long distance services, which are generally non-stop and offer faster journey times.

Figures 3.5 and 3.6 exclude any potential demand impact from the proposed Crossrail to West Coast Main Line link, which would connect Crossrail services to the suburban stations on the West Coast Main Line (e.g. Tring and Hemel Hempstead) via a new connection at Old Oak Common (see Chapter 2, Section 2.2.3).

Thames Valley Branches

The 2019 ITSS assumes that the Windsor, Marlow and Henley-on-Thames branches will be electrified and the introduction of electrically powered rolling stock will provide improved acceleration capabilities and higher capacity. The Greenford Branch remains non-electrified. The 2019 capacity assumptions, for the branch lines are indicated in Figure 3.7.

Demand growth to 2023 and 2043

Peak demand into London Paddington from the Thames Valley Branches is predicted to increase by 29 per cent between 2012 and 2023 and up to 99 per cent between 2012 and 2043. These increases are a function of the background growth expected and align with the forecast growth on Main Line services published in the **London & South East Market Study**. These forecasts have been applied to 2013 rail passenger demand into London Paddington across the morning peak as an indicator for the highest level of demand and compared with the capacity anticipated to be provided in the 2019 ITSS. The expected 2023 and 2043 demand and capacity anticipated to be provided in 2019 for each service is presented in Figure 3.7.

Figure 3.7: Thames Valley Branches 2019 baseline capacity and estimated 2023 and 2043 demand for services expected to provide connections to arrive at London Paddington in the high peak hour (08:00 – 08:59)

Branch Line	2019 Indicative Train Service Specification	Rolling stock assumptions	Total capacity assumed (seats and standing)	2023 expected demand	2043 expected demand
Henley-on-Thames	A 45 minute frequency service	4-car EMU	384	270	420
Marlow	1tph shuttle to Maidenhead	3-car EMU	288	220	330
Windsor & Eton Central	3tph shuttle to Slough	4-car EMU	1,152	650	990
Greenford	2tph shuttle to West Ealing	2-car DMU	390	260	400

Please see Appendix B for rolling stock capacity assumptions.
tph = trains per hour

Capacity required in 2023 and 2043

Analysis identifies the busiest services on the Thames Valley Branches are those which provide connections to arrive into London Paddington in the high peak hour (08:00 – 08:59). With the 2023 and 2043 rail passenger demand forecasts, a capacity intervention would not be required in 2023. However, demand is expected to exceed the high peak capacity before 2043 and Chapter 5 Route Section B, presents choices for funders to accommodate this.

Figures 3.8 and 3.9 highlight the anticipated load factors in the high peak in 2023 and 2043.

3.3.2 Passenger Capacity Conditional Output 2 (CO2): provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel

For the long distance services into London Paddington, electrification and the introduction of new Super Express Trains (SET) (as part of the Intercity Express Programme) will increase the total capacity provided as per the 2019 ITSS.

Demand growth to 2023 and 2043

Peak demand into London Paddington from the Outer Suburban market is predicted to increase by 29 per cent between 2012 and 2023 and up to 99 per cent between 2012 and 2043, as published in the **London & South East Market Study**. These forecasts have been applied to 2013 rail passenger demand into London Paddington across the morning peak as an indicator for the highest level of demand and compared with the anticipated capacity provided in the 2019 ITSS.

The anticipated capacity provided in 2019 for each service group is presented in Figure 3.10 with predicted demand for 2023 and 2043.

Capacity required in 2023 and 2043

Analysis has shown that at London Paddington, the three-hour morning peak period (07:00 – 09:59) and the three-hour evening peak period (16:00 – 18:59) have similar levels of rail passenger demand. Some of the individual long distance services in the evening peak can be more crowded than the morning peak equivalents as they cater for demand for business, commuting and leisure leaving London. This is particularly the case for services to the far West of England (beyond Exeter) in the summer period when leisure demand is highest.

The following figures present average load factors for services into London Paddington using the 2019 ITSS with predicted rail passenger demand in 2023 and 2043.

Figures 3.11 and 3.12 demonstrate that additional capacity will be required to accommodate forecast rail passenger demand and minimise on-train crowding on Main Line arrivals into London Paddington in 2023 and 2043. The forecasts indicate that there will be crowding from Didcot Parkway and Newbury, with standing on the majority of services between London Paddington and Reading. On-train crowding on selected long distance services, particularly between London Paddington and Plymouth/Penzance is predicted in the off peak by 2023. This level of crowding is expected to be more significant during the summer when demand for leisure travel is higher.

Choices to provide sufficient capacity to accommodate rail passenger demand in CP6 and 2043 are presented in Chapter 5 Route Section A: London Paddington to Reading.

Figure 3.8: Average load factor on services between London Paddington and Thames Valley Branches in the high peak hour (08:00 – 08:59) with 2023 estimated demand and 2019 baseline capacity

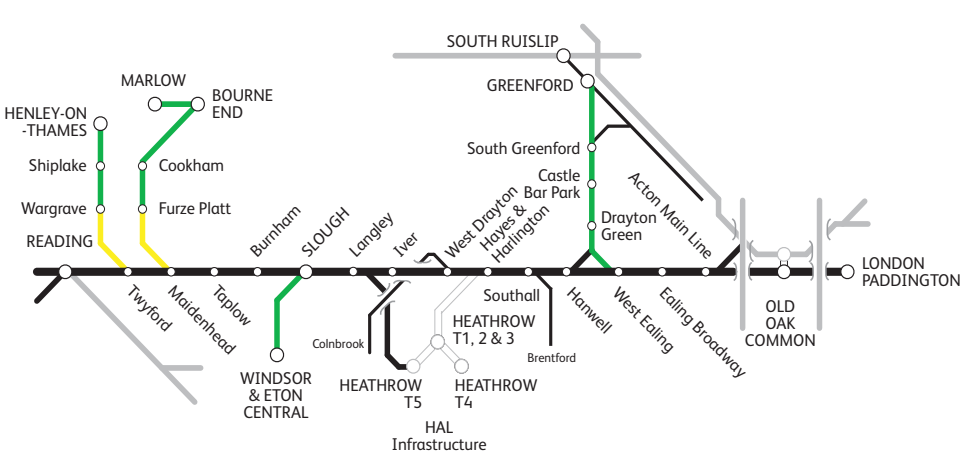
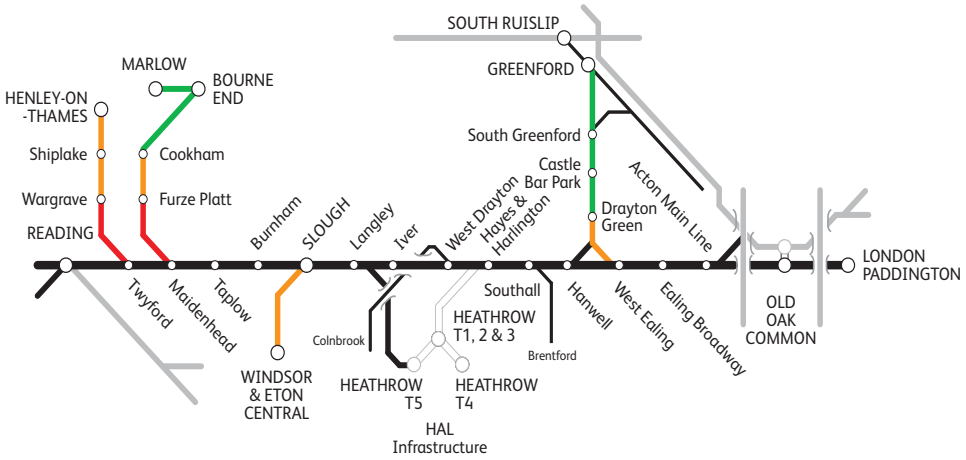


Figure 3.9: Average load factor on services between London Paddington and Thames Valley Branches in the high peak hour (08:00 – 08:59) with 2043 estimated demand and 2019 baseline capacity



Key

- Less than 70 % load factor
- Greater than 70 % and up to and including 85 % load factor
- Greater than 85 % and less than 100 % load factor
- 100 % or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station

Figure 3.10 : Main Line arrivals into London Paddington, 2019 baseline capacity and estimated 2023 and 2043 demand over the three hour peak (07:00 – 09:59)

Service group into London Paddington	2019 Indicative Train Service Specification (trains)	Rolling stock assumption	Total capacity assumed (standard class seats)	2023 expected demand	2043 expected demand
Via Oxford	6 suburban stopping services 6 fast from Oxford 3 from Hereford	8-car EMU 12-car EMU 10-car bi-mode SET	2,880 2,160 1,890	2.000 1,300 1,600	3,000 2,000 2,400
From Newbury (stopping at stations on route to Reading)	3	8-car EMU	1,440	1,300	1,900
Cheltenham via Kemble	3	10-car bi-mode SET	1,890	1,700	2,600
Bristol Temple Meads via Bath Spa	6	9-car electric SET	3,762	4,000	5,300
Bristol Temple Meads via Bristol Parkway	5	10-car bi-mode SET	3,150	2,500	5,000
From Swansea	6	9-car electric SET	3,762	3,900	5,700
West of England (Exeter/Plymouth/ Penzance)	6	8-car HST	2,970	2,600	4,000

The projected demand is allocated according to 2019 ITSS + additional high peak stops assumed at Reading to manage demand across the services for modelling purposes (as per Choice A3 in Chapter 5).
Please see Appendix B for the rolling stock capacity assumptions.

Figure 3.11: Average load factor on Main Line services arriving into London Paddington in the high peak hour (08:00 – 08:59) with 2023 estimated demand and 2019 baseline capacity

Key

- Less than 70% load factor
- Greater than 70% and up to and including 85% load factor
- Greater than 85% and less than 100% load factor
- 100% or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station

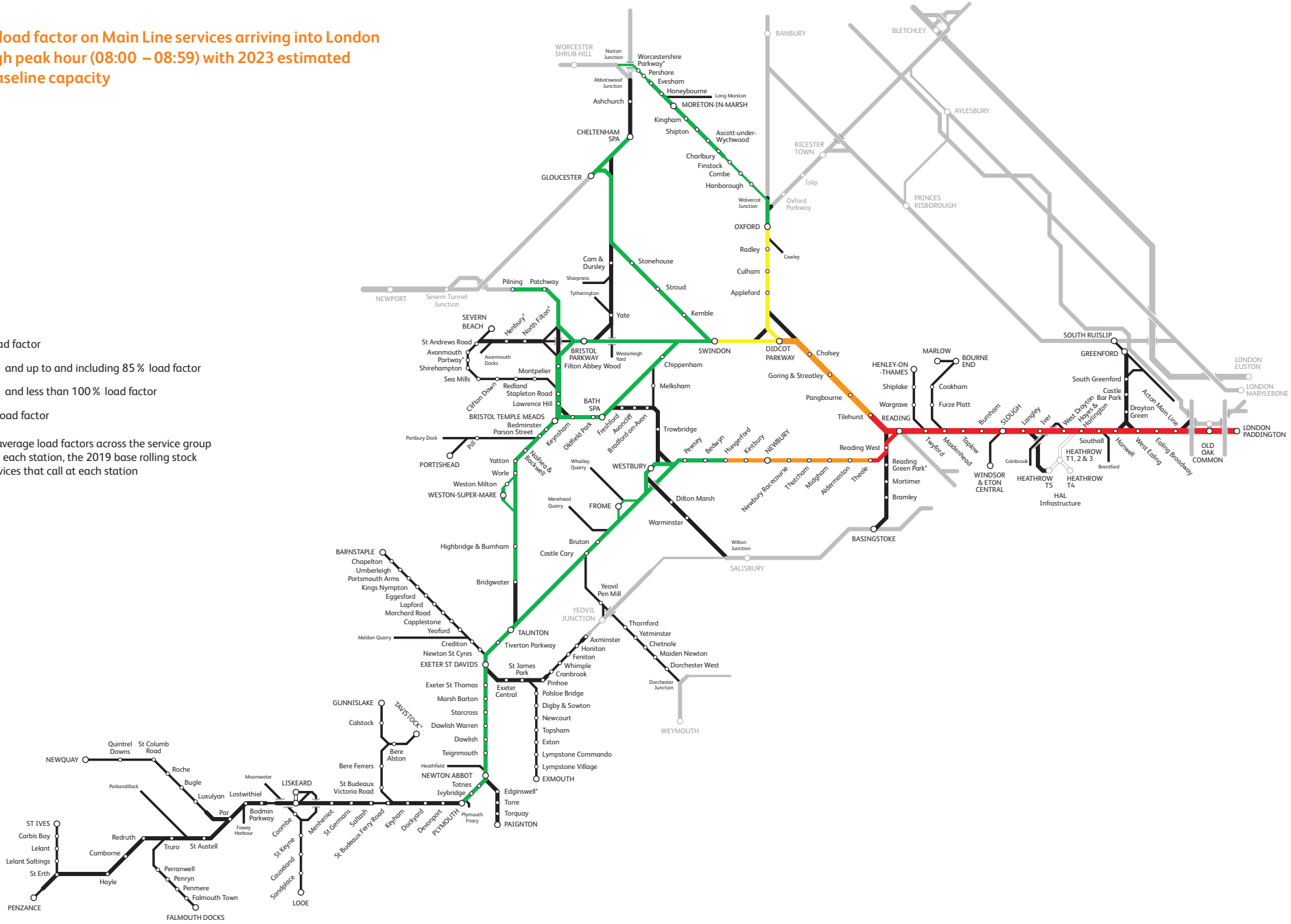
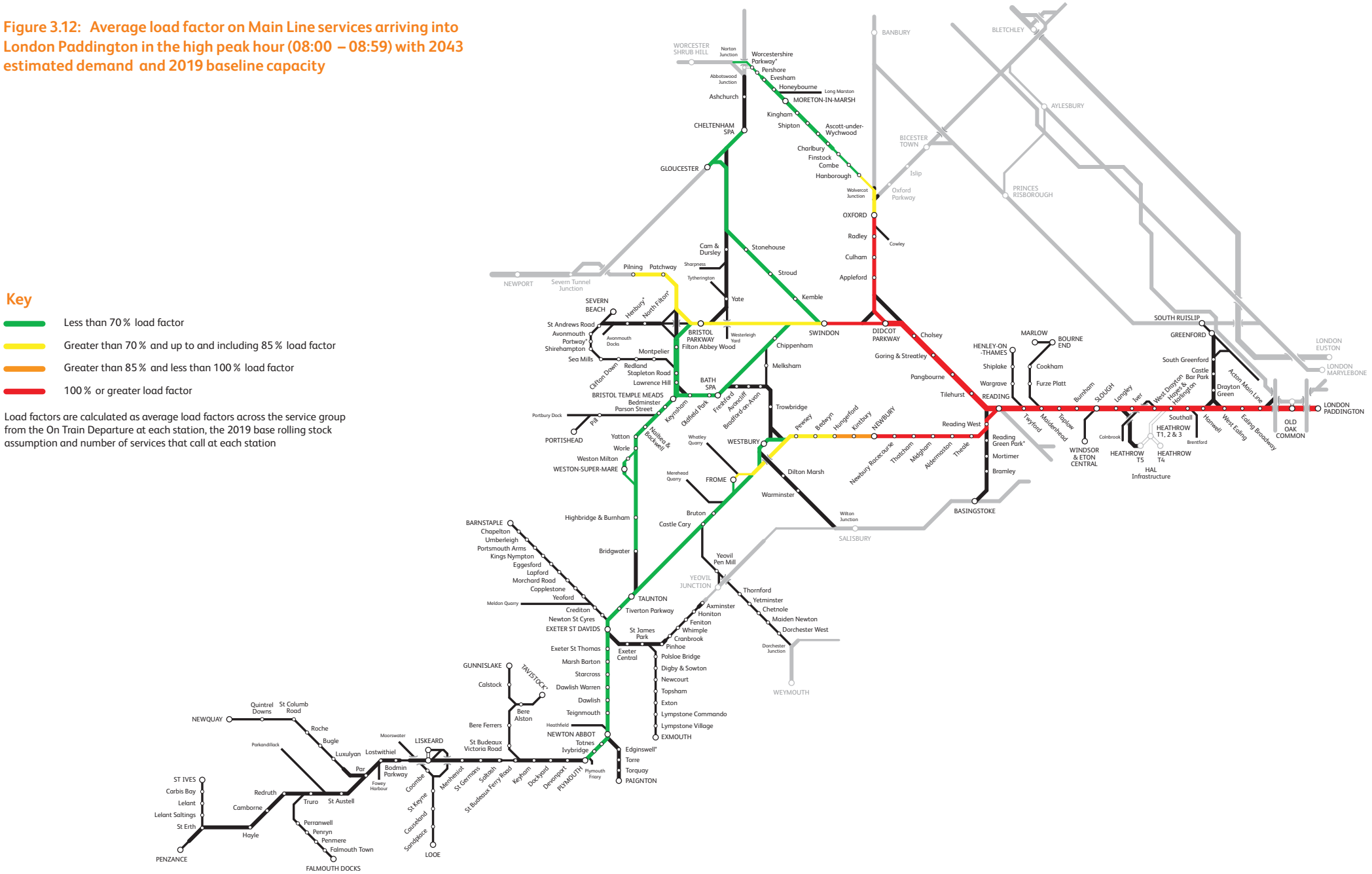


Figure 3.12: Average load factor on Main Line services arriving into London Paddington in the high peak hour (08:00 – 08:59) with 2043 estimated demand and 2019 baseline capacity



3.3.3 Passenger Capacity Conditional Output 3 (CO3): provide sufficient capacity for passengers travelling into Reading, taking into account anticipated growth over the period to 2043

For the long distance services into Reading, electrification and the introduction of new electric Super Express Trains (as part of the Intercity Express Programme) and electric rolling stock on selected stopping services will increase the total capacity provided as per the 2019 ITSS.

Demand growth to 2023 and 2043

Using the **Regional Urban Market Study** forecast methodology, peak rail passenger demand forecasts into Reading have been modelled as 28 per cent between 2013 and 2023 and 86 per cent between 2013 and 2043.

These forecasts have been applied to 2013 rail passenger demand into Reading across the morning peak as an indicator for the highest level of demand and compared with the anticipated capacity assumed to be provided in the 2019 ITSS. Where applicable, induced demand as a result of the 2019 service changes has been included.

The anticipated capacity provided in 2019 for each service over the three hour peak arrivals (07:00 –09:59) is presented in Figure 3.13 with estimated demand for 2023 and 2043.

Capacity required in 2023 and 2043

Figures 3.14 and 3.15 present average load factors for services into Reading on the 2019 ITSS, arriving in the high peak hour (08:00 –08:59) with estimated 2023 and 2043 demand.

Figures 3.14 and 3.15 demonstrate that additional capacity will be required to accommodate demand and minimise on-train crowding on high peak arrivals into Reading in 2023 from the Didcot Parkway and Newbury corridors. The busiest services are those that are due to arrive at London Paddington within the high peak hour.

On-train crowding is also forecast on some long distance services from the North (Oxford) and from the South (Basingstoke) into Reading in 2023. The capacity requirement for the non-London long distance services are discussed in Section 3.3.7. By 2043, the majority of services into Reading will require additional capacity to accommodate forecast increases in rail passenger demand.

Choices to provide sufficient capacity to accommodate rail passenger demand in CP6 and 2043 are presented in Chapter 5 Route Section A: London Paddington to Reading, Route Section C: Reading to Basingstoke and Route Section D: Reading to Gatwick Airport.

Figure 3.13: Three hour peak arrivals (07:00 – 09:59) into Reading, 2019 baseline capacity and estimated 2023 and 2043 rail passenger demand

Corridor into Reading	2019 Indicative Train Service Specification (trains) in three hour peak	Rolling stock assumption	Total capacity assumed 2019	2023 estimated demand	2043 estimated demand
Basingstoke	6x Basingstoke – Reading	3-car DMU	2,430	1,300	1,800
	4x Long distance (e.g. Bournemouth-Manchester/ North)	Mix of 4- and 5-car DEMU	925	700	1,000
Wokingham	6x London Waterloo – Reading	8-car EMU	7,872	2,600	4,000
	6x Gatwick – Redhill – Reading	3-car DMU	2,250	1,600	2,300
Didcot Parkway	6x stopping services from Oxford, calling at stations between Didcot Parkway and Reading	8-car EMU	2,844	2,100	3,100
	3x from Hereford direct from Oxford 3x from Cheltenham direct from Swindon or Didcot Parkway 6x from Bristol direct from Didcot Parkway	10-car bi-mode 10-car bi-mode 9-car electric SET	7,542	8,400	12,800
	4x Long distance from North East and North West	Mix of 4- and 5-car DEMU	773	1,000	1,400
Newbury	3x services from Newbury, stopping at stations between Newbury and Reading 6x services direct from Frome or Newbury	12-car EMU 8-car HST	4,392	3,400	5,200

Please see Appendix B for the rolling stock capacity assumptions.
Provision of sufficient capacity into Reading over the morning peak hours is assumed to provide sufficient capacity out of Reading in the evening. However, the service pattern is driven largely by the need to provide sufficient capacity into London Paddington.

Figure 3.14: Average load factor on services arriving into Reading in the high peak hour (08:00 – 08:59) with 2023 estimated demand and 2019 baseline capacity

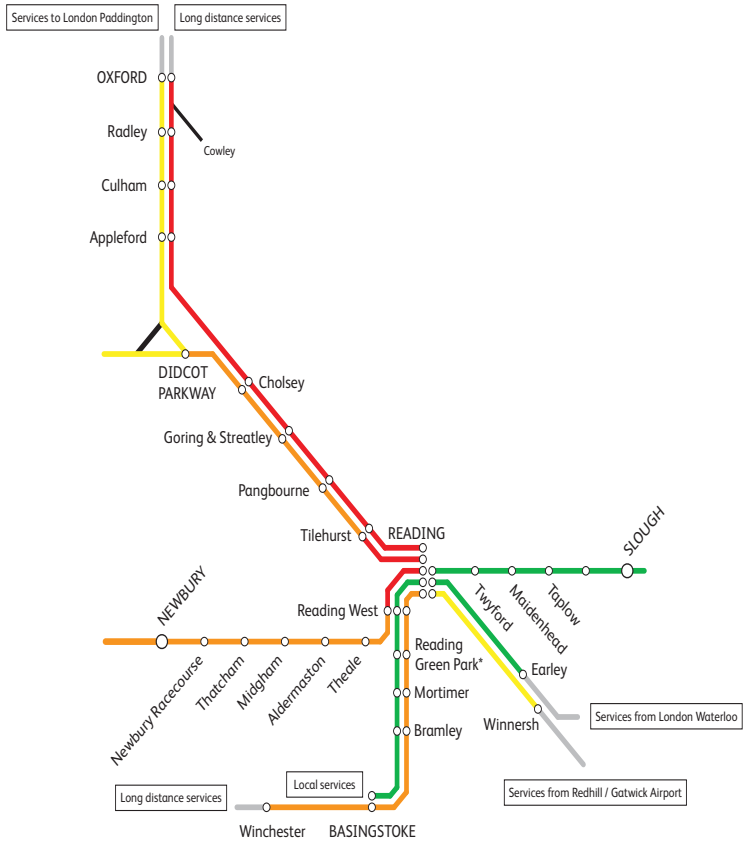
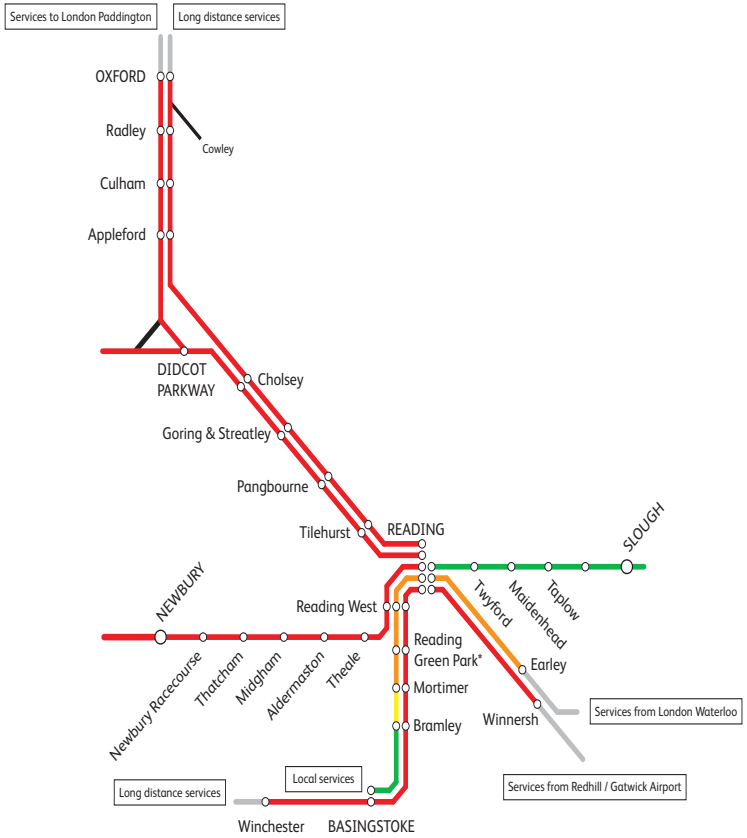


Figure 3.15: Average load factor on services arriving into Reading in the high peak hour (08:00 – 08:59) with 2043 estimated demand and 2019 baseline capacity



Key

- Less than 70 % load factor
- Greater than 70 % and up to and including 85 % load factor
- Greater than 85 % and less than 100 % load factor
- 100 % or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station.
Note: Does not include anticipated demand from Reading Green Park.

3.3.4 Passenger Conditional Output 4 (CO4): provide sufficient capacity for passengers travelling into the Greater Bristol Area, taking into account anticipated growth over the period to 2043

The anticipated 2019 ITSS includes two additional Super Express Trains between London Paddington and Bristol Temple Meads per hour which will increase capacity. The proposed introduction of MetroWest Phase 1 in 2019 also included in the Route Study baseline provides additional capacity to Severn Beach and Bath Spa due to the increased service frequencies offered. The reinstatement of passenger services on the Portishead branch and associated new stations also forms part of MetroWest Phase 1 which would provide additional services with potential improvements in capacity and connectivity at Parson Street and Bedminster.

As part of the rolling stock redeployment programme, the 2019 ITSS anticipates that the Class 16x rolling stock will be cascaded from the Thames Valley into the greater Bristol area replacing the current Class 15x rolling stock which would also contribute to the provision of greater on-train capacity.

Demand growth to 2023 and 2043

The high growth forecasts in the **Regional Urban Market Study** suggest that between 2012 and 2023 rail passenger demand into Bristol will increase by 47 per cent and by up to 111 per cent by 2043. These forecasts describe background growth only. The Western Route Study has reviewed these forecasts and uplifted them to include the impact of those committed schemes anticipated as part of the 2019 baseline. For the greater Bristol area, this includes the introduction of the Super Express Trains and MetroWest Phase 1. The new forecasts are presented in Figure 3.16.

Figure 3.16: Growth forecasts for the Greater Bristol Area

Timeframe	Regional Urban Market Study	Western Route Study
2012 – 2023	47%	54%
2012 – 2043	111%	121%

These forecasts have been applied to 2013 rail passenger demand into Bristol across the morning peak as an indicator for the highest level of demand and compared with the anticipated capacity provided in the 2019 ITSS.

The anticipated capacity provided in 2019 for each service is presented in Figure 3.17 with predicted demand for 2023 and 2043.

Capacity required in 2023 and 2043

Figures 3.18 and 3.19 present the expected average load factors for services within the greater Bristol area in the 2019 ITSS arriving into Bristol Temple Meads in the high peak hour (08:00 – 08:59) with estimated demand in 2023 and 2043.

Figures 3.18 and 3.19 demonstrate that additional capacity is expected to be required to accommodate forecast rail passenger demand and minimise on-train crowding on some of the long distance arrivals into Bristol Temple Meads in 2023 from Birmingham and the North. The non-London long distance services are discussed in section 3.3.7. By 2043 the majority of services are expected to require additional capacity to accommodate high peak rail passenger demand forecasts. Choices to provide sufficient capacity to accommodate rail passenger demand in CP6 and 2043 are presented in Chapter 5 Route Section M: Greater Bristol Area.

Figure 3.17: Three hour peak arrivals (07:00 – 09:59) into Bristol Temple Meads , 2019 baseline capacity and estimated 2023 and 2043 rail passenger demand

Corridor into Bristol Temple Meads	2019 Indicative Train Service Specification (trains) in three hour peak	Rolling stock assumption	Total capacity assumed	2023 expected demand	2043 expected demand
Severn Beach	6	3-car DMU	2,250	1,400	1,900
Cardiff Central	6	3- and 5-car DMU, long distance: 4-car	2,795	1,400	2,000
Westbury/Bath Spa	10	3- and 5-car DEMU	4,430	2,700	3,900
Chippenham	6	9-car electric SET	4,514	2,000	2,800
Gloucester/Bristol Parkway	17	3-car DMU, long distance: 4- car DEMU and 10-car bi-mode SET	5,203	1,900	2,700
Taunton/Weston-super-Mare	13	3-car DMU. long distance: 10 car bi-mode SET and 4-car DEMU	5,198	3,400	4,800
Portishead	6	3-car DMU	2,250	Forecasts not available	

Please see Appendix B for the rolling stock capacity assumptions.
*The 2023 and 2043 expected demand is forecast growth on the highest on-train passenger count on arrival at a station on route to Bristol Temple Meads; and generally reflects the busiest part of the journey.

Figure 3.18: Average load factor on services arriving into Bristol Temple Meads in the high peak hour (08:00 – 08:59) with 2023 estimated demand and 2019 baseline capacity

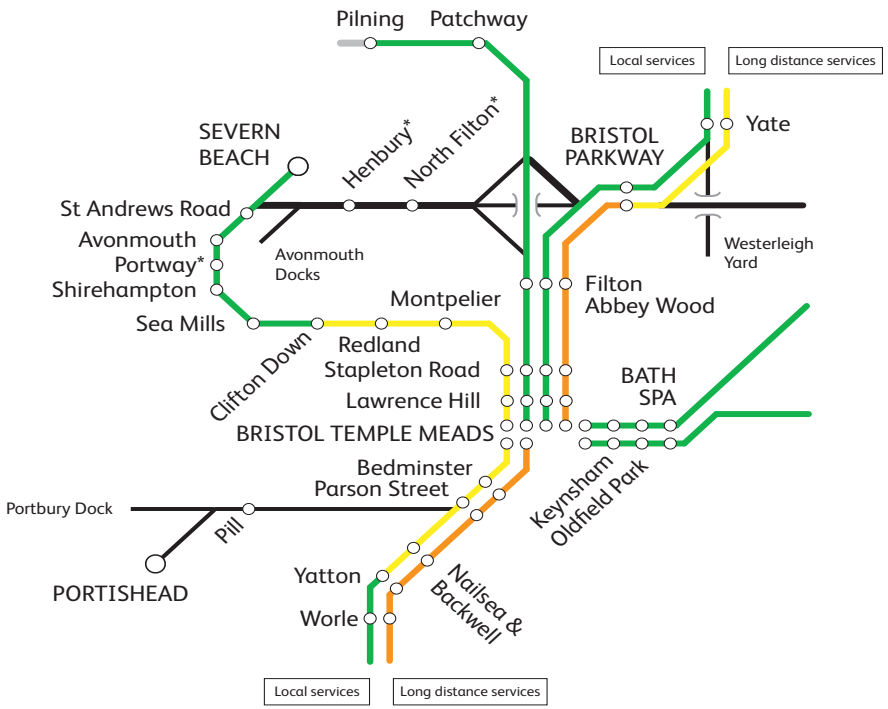
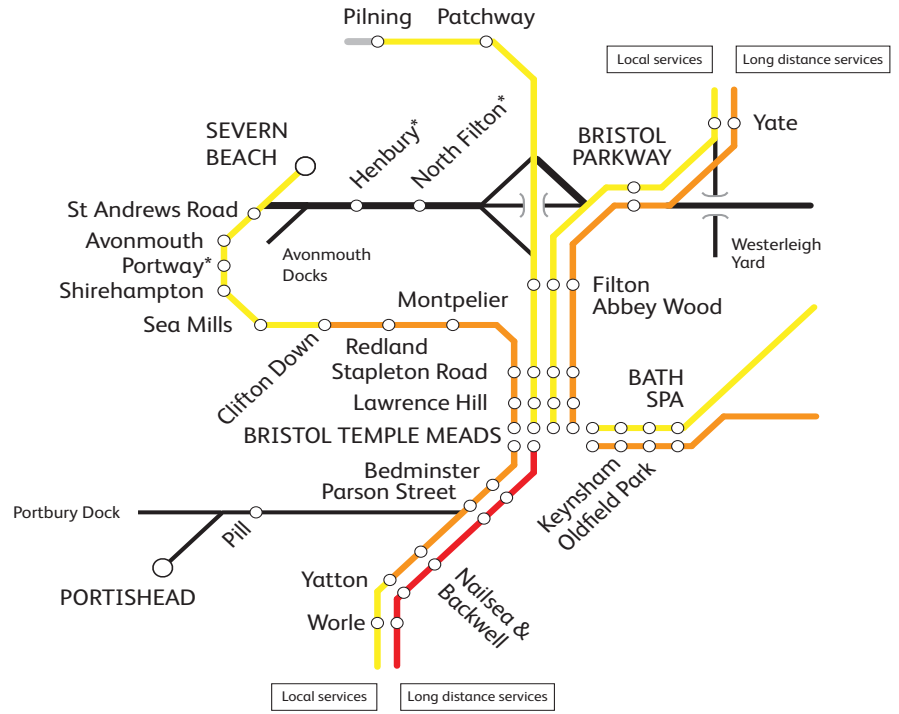


Figure 3.19: Average load factor on services arriving into Bristol Temple Meads in the high peak hour (08:00 – 08:59) with 2043 Load factors are calculated as average load factors across the service group



Key

- Less than 70 % load factor
- Greater than 70 % and up to and including 85 % load factor
- Greater than 85 % and less than 100 % load factor
- 100 % or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station.
Note: Does not include anticipated demand from Portishead and Henbury lines.

3.3.5 Conditional Output 5 (CO5): provide sufficient capacity for passengers travelling into the Exeter Area, taking into account anticipated growth over the period to 2043

Demand by rail to Exeter has increased substantially in the last decade. Recent growth to Exeter (and other key economic centres in Devon such as Plymouth) is consistent with the growth trends observed in other core cities in the Route Study area such as Bristol. The strong growth, especially for commuters in the morning peak, is a combination of external factors, rail industry interventions and government policy including:

- economic and socio-demographic trends, in particular towards a service-led, knowledge-based economy, with increasing concentration of economic activity and population in major cities and urban centres;
- increasing costs of car use, and increasing road congestion especially in the morning and evening peak; and
- improvements in rail services to both accommodate and stimulate growth, initially using spare capacity on the network, but increasingly supported by infrastructure investment.

It is expected that these demand drivers will continue to affect the market size and share of rail and rail demand is likely to continue to grow.

Demand growth to 2023 and 2043

Suburban demand to Exeter is predicted to increase by 47 per cent to 2023 and 111 per cent to 2043. These growth rates represent the growth in shorter distance journeys (generally less than 50 miles) to Exeter, predominately journeys made by commuters in the peak.

The Route Study has used the Bristol Regional Urban growth rate because analysis of historic growth has suggested that the external demand drivers and their impact on rail market are similar to Exeter with economic growth, employment projection and population projected to grow at similar rates. It should be noted that these forecasts include the impact of external factors only, and do not include impact of any committed schemes or potential rail interventions. Further rail interventions are likely to drive growth higher than the forecasts presented here.

A case study of recent demand growth in Exeter has shown that once the impact of rail interventions (including timetable changes and rolling stock) has been taken into account, suburban demand to Exeter grew at similar rates to that observed on key commuter corridors into Bristol. Appendix C summarises the results of the case study which considered a number of corridors in Devon and Cornwall.

It is recognised that Bristol currently has a larger rail market share than some suburban corridors in Devon. Therefore the scope for demand growth into Exeter could be higher than some corridors into Bristol. When undertaking assessments to define capacity that is required to accommodate demand, sensitivity tests on demand growth are recommended to ensure that any gap between capacity and future demand is identified and subsequently options are developed to address these gaps. For example, evidence suggests that historic growth on the Exeter – Exmouth line has been higher than in the Bristol area, even after taking into account the impact of rail interventions and variations in economic factors. The Route Study recommends applying a sensitivity test of a higher demand growth of 1 per cent to 2 per cent per annum to 2023.

The forecasts have been applied to 2013 rail passenger demand into Exeter St Davids across the morning peak and are compared with the anticipated capacity provided in the 2019 ITSS. This is presented in Figure 3.20 with estimated 2023 and 2043 demand.

Figure 3.20: Three hour peak arrivals (07:00 – 09:59) into Exeter St Davids, 2019 baseline capacity and estimated 2023 and 2043 expected rail passenger demand

Corridor into Exeter St Davids	2019 Indicative Train Service Specification (trains) in three hour peak	Rolling stock assumption	Total capacity assumed	2023 estimated demand	2043 estimated demand
Paignton/Plymouth	4 x Paignton to Exmouth	4-car DMU	1,838	1,000	1,500
	1 x Bristol/Cardiff - Penzance stopping	2-car DMU			
	4 x to London Paddington	8-car HST	2,028	1,800	2,800
	4 x Long distance Plymouth/Penzance to Manchester/North	4- and 5-car DEMU	1,112	700	1,000
Barnstaple	2 Barnstaple – Exmouth/St James Park	3-car DMU high peak 2-car DMU shoulder peak	465	400	600
Taunton	1 x Bristol/Cardiff - Penzance stopping	2-car DMU	214	100	200
	1 x from London Paddington	8-car HST	465	70	100
	3 x Long distance Bristol/ North to Plymouth/ Penzance	4- and 5-car DEMU	834	300	400
Axminster	3 x Salisbury/Yeovil Junction – Exeter St Davids	3-car DMU 6-car DMU (high peak)	1,048	900	1,300
Exmouth	3 x Paignton to Exmouth	4-car DMU	2,292	1,500	2,200
	2 x Barnstaple – Exmouth/ St James Park	3-car DMU high peak 2-car DMU shoulder peak			

Some services have been grouped due to similarities in the passenger demand they serve.
*The critical point is the highest on-train passenger count on arrival at a station on route to Exeter St Davids and generally reflects the busiest part of the journey.
The data in the table includes anticipated demand from new stations at Marsh Barton, Cranbrook and Edginswell.
Please see Appendix B for the rolling stock capacity assumptions.

Capacity required 2023 and 2043

Figures 3.21 and 3.22 present the expected average load factors for services in the 2019 ITSS arriving into Exeter St Davids in the high peak hour (08:00 – 08:59) with estimated 2023 and 2043 demand. Figure 3.21 demonstrates that expected demand will exceed capacity on the peak arrivals into Exeter St Davids on the Exmouth corridor in 2023. Demand is also expected to exceed capacity on the London Waterloo to Exeter St Davids service in 2023 from Pinhoe, with standing expected from Whimple on the high-peak service.

The Barnstaple line shows standing on arrival into Exeter St Davids in 2023 from Yeoford, however demand is expected to remain within the total assumed capacity.

Figure 3.22 demonstrates that by 2043, services from Axminster and Exmouth are expected to have significant on-train crowding, given 2019 baseline assumptions and estimated 2043 demand. Additional capacity is also expected to be required on services from Barnstaple to avoid crowded conditions from as far as Umberleigh. The analysis has included the anticipation of increased capacity by 2019 through the redeployment of higher capacity rolling stock on selected local services into Exeter St Davids as part of the proposed rolling stock cascade.

3.3.6 Conditional Output 6 (CO6): provide sufficient capacity for passengers travelling into and within Devon and Cornwall, taking into account anticipated growth over the period to 2043

Rail in Devon and Cornwall helps to connect large and small communities to key economic and commercial centres including Exeter, Plymouth and Truro, as well as many popular tourist destinations such as Looe, Newquay, St Ives and Penzance. Therefore rail provision and its characteristics vary across the region to serve different markets and journey purposes. As discussed in Section 3.3.5, commuting flows are significant in parts of Devon such as those on the Exeter to Exmouth and Exeter to Paignton corridors. While in Cornwall, the Truro to Falmouth Docks line is well used by commuters and university students throughout the year, as well as demand from tourists in the summer months. Rail demand can fluctuate significantly in other parts of Devon and Cornwall, such as St Ives to St Erth where demand is particularly high in the summer and is predominately driven by leisure and tourism. In some areas there is also demand for leisure trips on weekends throughout the year.

Given the geography of Devon and Cornwall and varying markets in the regions, the following sections discuss demand to/from and within Devon and Cornwall in two segments:

- Commuter demand
- Leisure demand

Commuter demand

Exeter, Plymouth and Truro are the key urban centres in Devon and Cornwall providing employment and economic activities to communities across the areas. Commuter demand, as seen in Section 3.3.5 to Exeter is high throughout the year. Key flows and corridors where demand for commuter flows is significant include:

- Exmouth – Exeter
- Barnstaple – Exeter
- Paignton – Exeter
- Truro – Falmouth
- Gunnislake – Plymouth
- Plymouth – Penzance

Rail corridors to Exeter are covered in Section 3.3.5. The following sections address rail demand to Plymouth and Truro along with flows to/from and within Devon and Cornwall.

Commuting demand growth to 2023 and 2043

Demand to Plymouth and Truro has been increasing in the last decade. Similar to the Exeter markets, economic and socio-demographic trends, increased cost of car use and rail interventions have helped to drive demand for rail. The Route Study has undertaken analysis to show that once the impact of timetable changes have been included, the external demand drivers and growth in commuter demand to Plymouth and Truro is similar to Bristol. For the purpose of identifying and defining the capacity gap, the demand growth of Bristol has been assumed for Plymouth and Truro. A detailed case study of the Truro – Falmouth line is presented in Appendix C as an example to assess this.

Commuting demand to Plymouth and Truro is predicted to increase by 47 per cent to 2023 and 111 per cent to 2043. These growth rates are similar to the background demand growth into Bristol and Exeter and represent the growth in shorter distance journeys (generally less than 50 miles), predominately journeys made by commuters in the peak. Forecasts applicable to the leisure market are described in Section 3.3.6.1.

Figure 3.21: Average load factor on services arriving into Exeter St Davids in the high peak hour (08:00 – 08:59) with 2023 estimated demand and 2019 baseline capacity

Key

- Less than 70 % load factor
- Greater than 70 % and up to and including 85 % load factor
- Greater than 85 % and less than 100 % load factor
- 100 % or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station

Note: Includes anticipated new station demand from Marsh Barton, Cranbrook and Edginswell.

Figure 3.22: Average load factor on services arriving into Exeter St Davids in the high peak hour (08:00 – 08:59) with 2043 estimated demand and 2019 baseline capacity

Key

- Less than 70 % load factor
- Greater than 70 % and up to and including 85 % load factor
- Greater than 85 % and less than 100 % load factor
- 100 % or greater load factor

Load factors are calculated as average load factors across the service group from the On Train Departure at each station, the 2019 base rolling stock assumption and number of services that call at each station

Note: Includes anticipated new station demand from Marsh Barton, Cranbrook and Edginswell.

Capacity required in 2023 and 2043: weekday commuting demand

2013 rail passenger count data indicates that the largest commuter flow in Cornwall is on the branch line between Truro and Falmouth Docks. The Gunnislake branch and services along the Cornish Main Line are also used by commuters. Figure 3.23 presents the capacity assumptions on the Cornish Main Line and branches and Figure 3.24 demonstrates anticipated 2019 peak capacity and estimated commuter demand in 2023 and 2043 along key commuter routes in Cornwall.

Figure 3.25 illustrates that in 2023, analysis indicates that the Truro to Falmouth Docks line is likely to require additional capacity to avoid on-train crowding on arrival into Truro during the high peak hour (08.00-08.59), options to accommodate this is discussed in Chapter 5 Route Section P: Newton Abbot – Plymouth.

The Gunnislake branch line is likely to see a significant increase in demand if the line is connected to Tavistock, and sufficient capacity needs to be considered in the plans.

Figure 3.23: 2019 Capacity assumptions on the Cornish Main Line and branches

Route	Peak Weekday services (07:00 – 09:59)	Rolling stock assumption 2019	Changes to the summer timetable
From Gunnislake branch	1 arrival across the three hour peak Gunnislake – Plymouth	2-car DMU	
Looe – Liskeard	2 arrivals across the three hour peak Looe – Liskeard	2-car DMU	Looe trains have Sunday services (not provided in Winter)
Newquay – Par	0*	2-car DMU	On Summer Saturdays Newquay is served by through trains from London, Plymouth, Exeter, Bristol, Birmingham and the North
Falmouth Docks – Truro	2tph Falmouth Docks – Truro	2-car DMU	
St Ives – St Erth	2 arrivals St Ives – St Erth	2-car DMU	Some services extended to Penzance
Cornish Main Line, on arrival to Plymouth over three peak hours	1 Plymouth – Cardiff 1 Long distance to the North, and 3 London Paddington	2-car DMU 5-car DEMU 8-car HST	Additional services, running to Newquay as above.

*1tph starting from ~10am
See Appendix B for rolling stock capacity assumptions.
tph = trains per hour

Figure 3.24: Rail passenger demand forecasts for journeys across Cornwall

Journey	Journey type	2013 – 2023	2023 – 2043	Methodology
London Paddington – Cornwall	Long distance, all day, business and leisure journeys	40%	158%	Long Distance Market Study
Cornwall – Exeter	Long distance, all day, business and leisure journeys	23%	79%	Long Distance Market Study
Branch Lines -Main Line; e.g. Falmouth Docks – Truro	Regional Urban, peak commuting	47%	111%	Using Regional Urban Market study background growth into Bristol

The long distance rail passenger demand forecast is applied to journeys of more than 50 miles, capturing background growth plus any demand from committed schemes.
The Regional Urban rail passenger demand growth is background growth for shorter distance journeys, usually for commuting purposes. The growth forecast for Bristol background growth has been used as background growth for commuting journeys across Cornwall, due to regional similarities in forecast changes to factors that influence this type of rail passenger demand.

Figure 3.25: Weekday high peak arrivals (08:00 – 08:59) capacity and demand analysis on commuter routes in Cornwall

Route	High peak arrivals 2019 (08:00-09:00)	High peak capacity assumption, 2019	2023 estimated demand over high peak	2023 average Load factor	2043 estimated demand over high peak	2043 average Load factor
Falmouth Docks – Truro	2x 2-car DMU	406	260	64% on arrival to Truro	350	86% on arrival to Truro
Gunnislake – Plymouth	1x 2-car DMU	203	150*	74% on arrival to Plymouth	220*	108% on arrival to Plymouth
Cornish mainline, Plymouth peak arrivals	1x 8-car HST 1x 2-car DMU 1x 4-car DEMU	900^	610	67% on arrival to Plymouth	900	100% on arrival to Plymouth

Based on Summer 2013 count data where available to represent busier services
*No morning peak count data available, count based on one evening peak count
^Includes standing allowance for 2-car DMU and seats only for longer distance services
See Appendix B for rolling stock capacity assumptions

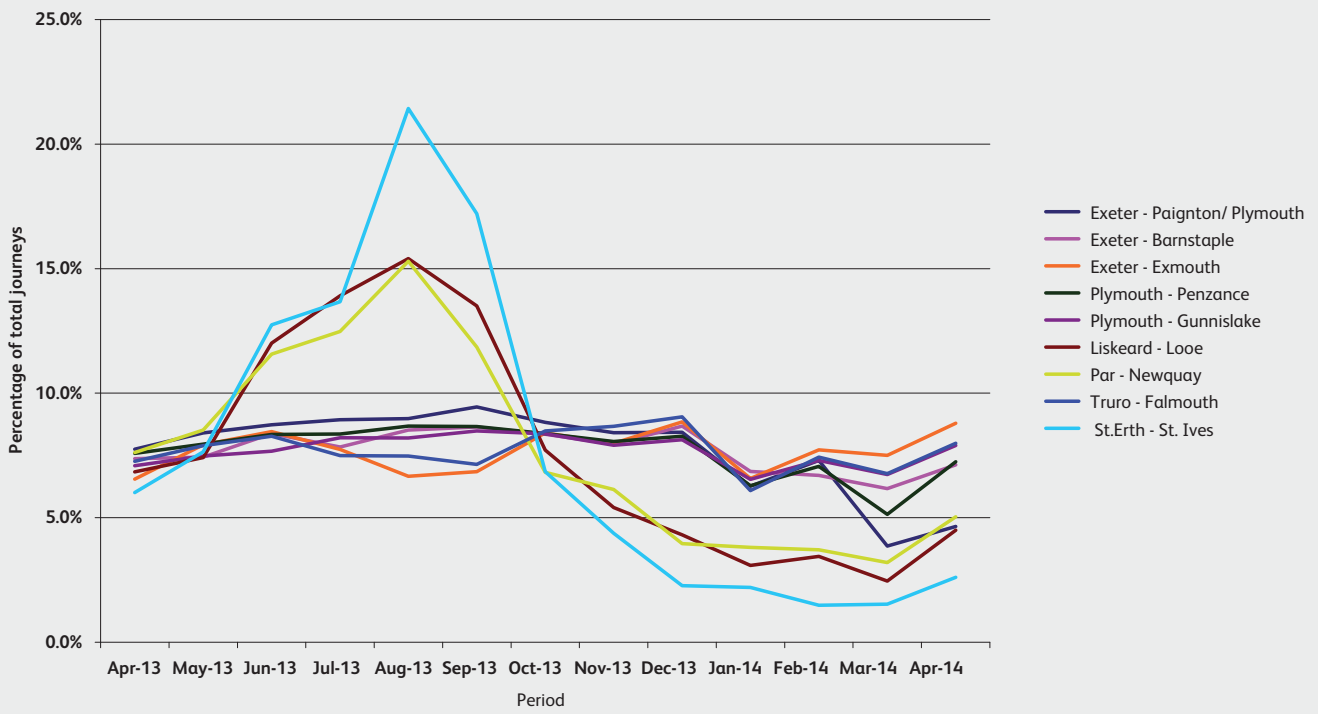
3.3.6.1 Better capacity for the leisure market at weekends and weekday evenings

Accommodating, and avoiding suppression of, demand for the leisure market is a particularly important consideration for the Western Route, where leisure and tourism can be significant drivers of demand across a large majority of the network. Accommodating such demand supports the local economy and meets the transport industry's strategic goals.

It is important to distinguish between the two types of leisure demand; all-year leisure demand at weekends and weekday evenings and seasonal leisure demand. The focus of this section is on the seasonal demand, where demand for travel is significantly higher in the summer months, usually both at weekends and weekdays due to holiday traffic. All-year leisure demand on weekends and weekday evenings is discussed in Section 3.6.1.

Figure 3.26 illustrates the percentage of journeys made each month across 2013/2014 for journeys across Devon and Cornwall. This demonstrates the seasonal variation across the area; in particular on journeys between St Erth – St Ives, Liskeard – Looe and Par – Newquay. These journeys show the most variation throughout the year, with over 20 per cent of journeys made in the peak summer months between July and September.

Figure 3.26: 2013/2014 journeys across Devon and Cornwall



Leisure demand growth to 2023 and 2043

Figure 3.24 presents the long distance forecasts that were developed as part of the LDMS that are relevant to Devon and Cornwall. The forecast for journeys between London Paddington and Cornwall (158 per cent to 2043), equates to approximately 3 per cent growth per year. The historic growth of journeys during the summer months for the seasonal branch lines identified (St Erth – St Ives, Liskeard – Looe and Par – Newquay), indicate an average growth rate of close to 3 per cent per year, in line with the highest LDMS forecast for journeys between London Paddington and Cornwall. For modelling purposes, this growth rate has been applied as the high growth scenario for summer demand. The historic growth of seasonal demand and a discussion on the long distance forecasts is presented in Appendix C.

Capacity required to 2023 and 2043: summer leisure demand

This section discusses what the available data is indicating for crowding levels, and patterns of crowding on the seasonal branch lines in Cornwall (St Erth – St Ives, Liskeard – Looe and Par – Newquay). The varied quality of data for each of the branch lines means that a different approach has been applied, in comparison with other capacity analysis in this section. Also, the demand itself has different characteristics compared with the commuter demand previously assessed; passengers are generally less time constrained, and peaks can vary throughout the day. The level of demand can also be weather dependent.

Where possible, both summer and weekday demand has been used, and if multiple counts are available, the mean count is compared to the maximum count to try and gain a better understanding of how often the peak loads occur. This section discusses the forecasts and demand patterns on each of the branch lines identified. The data available is presented in Appendix C.

Liskeard to Looe

Appendix C Section 4(a) presents the forecasts of demand for rail services between Liskeard and Looe, using all counts made available to the Western Route Study. The data demonstrates a pattern of preference for arrival time into Looe, indicating the peak period between 10.00 and 12.00. The return journey data demonstrates a preference for trains that depart between 16.00 and 18.00. Growing demand to 2023 does not indicate that additional capacity will be required above that anticipated in the 2019 ITSS. However, on-train crowding will be expected on selected services. Within the data available, there is significant variability which is expected to relate to weather conditions (trains being busier when the weather is good). More data is required to understand how often significantly higher train loads occur, and how dependent these loads are on conditions outside of rail industry control, such as the weather.

If demand continues as per the 2043 forecasts, additional capacity will be required on the peak services in the longer-term.

St Erth – St Ives

Appendix C Section 4(b) presents loadings on services over one hour time periods corresponding to the busiest train counts available to the Western Route Study; insufficient counts were available to generate average loadings, and no Saturday counts were available. It is recognised that, during the summer months, peak services can be very busy. The data indicates there is a peak hour for leisure demand, between 11.00 and 12.00. This might indicate not only a preferred time of travel, but also the timing of popular connections with longer distance rail services.

The journey time between St Erth and St Ives is less than 20 minutes, therefore the total capacity of the train is relevant, and analysis demonstrates there is sufficient capacity in 2023. This is based on the assumption that this count data represents a typical summer load.

However, given the limitations in the dataset available it is recommended that the loading levels of these services are reviewed at the first available opportunity.

Par – Newquay

Analysis shows that demand is significantly lower during the week than at the weekends. This could be partly driven by the longer distance services directly serving Newquay at the weekends; generating a spike in demand on arrival and departure of these services. The weekday and Saturday data shows that there is significant capacity to accommodate 2023 forecasts on individual services to/from Newquay. This is shown in Appendix C.

Data for the Sunday departures from Newquay, however, indicates that there is insufficient capacity on two services, assuming 2-car capacity in 2019. In the longer term, to 2043, the forecasts indicate that the majority of services will require additional capacity.

3.3.7 Non-London long distance analysis

The Western Route Study area is currently served by a number of non-London long distance services as follows:

- Plymouth – Edinburgh/Glasgow
- Southampton/Reading-Newcastle via Birmingham and Derby
- Bournemouth – Manchester
- Exeter St Davids – Manchester.

All of these services start or end outside the Western Route Study area and many encounter high load factors outside the Route Study area. In order to assess the capacity requirements for these services it is necessary to consider the load factors throughout the whole of the train's journey.

The analysis, shown in Appendix C, shows load factors across the individual services on this route in 2023, and where available, 2043. A summary by route corridor is provided below:

South West and South to North East and Scotland routes

On these routes, the heaviest loadings are widely spread both between services and across the route. Crowding on these services is not exclusively within the peaks, and several non-peak services are at risk of on-train crowding. By 2023, the forecast growth would present significant on-train crowding on both the Plymouth to Edinburgh/Glasgow and Southampton/Reading to Newcastle services. The anticipated implementation of HS2 Phase 2 in 2033 alters the picture in 2043 where load factors are reduced in the East Midlands section of the route. Within the Western Route Study area, however, there would continue to be on-train crowding. Train lengthening options are presented Appendix D.

South West and South to North West

Crowding on these services is not exclusively within the peak periods, with several non-peak services at risk of on-train crowding. The forecast growth presents significant on-train crowding in 2023 with baseline capacity on the majority of services from Bournemouth, and in particular the service from Penzance shows high levels of crowding for the majority of the service; the crowding expected on individual services is presented in Appendix C, train lengthening options are also presented in Appendix D.

3.4 Western Route Study Passenger Connectivity Conditional Outputs

In addition to the capacity Conditional Outputs previously described, the established Market Studies also generated a number of Conditional Outputs relating to the level of connectivity to be provided by passenger rail services. Connectivity covers aspects of the passenger timetable and can be measured by Generalised Journey Time (GJT) which incorporates:

- train service frequency between stations
- timetabled journey times
- interchange penalties where a direct service is not provided.

In general, the level of connectivity recommended in the Market Studies has been an improvement to the GJT. The GJT between two stations can be improved by operating a more frequent service, reducing the timetabled journey time or eliminating interchange - or by doing a combination of the three. The Western Route Study has determined which method of improving the GJT is most appropriate, in terms of feasibility, affordability and value for money.

The connectivity Conditional Outputs can overlap; for example providing additional services to a key city with the service stopping at other stations on route could help to meet the connectivity Conditional Output of these intermediate stations.

However, there are also challenges in meeting all of the connectivity Conditional Outputs, and trade-offs are required. For example, a faster journey time could be achieved by stopping at fewer stations however this would then reduce connectivity at intermediate stations. There is a further trade-off between on-train capacity and connectivity; for example the capacity Conditional Output could be achieved by stopping additional services at the intermediate stations; however this could increase the in-vehicle journey time for passengers.

The Western Route Study considers choices for delivering the connectivity Conditional Outputs during the off-peak period. Where appropriate, they are considered as a choice to provide additional capacity if required in 2023, where increasing train lengths would require infrastructure interventions and train lengthening may not be the best value for money.

Sections 3.4.1 to 3.4.5 interpret the connectivity Conditional Outputs from the Market Studies into a set of connectivity Conditional Outputs specific to the Western Route Study. In some cases, there may be more than one way to meet the connectivity outputs and what is presented should be seen as an example. Where a range of GJT improvements has been recommended by the Market Studies, the Western Route Study has interpreted the service frequency to be provided to best meet the GJT target. Where there are options, these have been highlighted in the 2043 ITSS presented in Section 3.4.6. As a general rule, the Western Route Study's interpretation has been the highest level of GJT improvement required. Outputs from the Cross-Boundary Analysis (as presented in Chapter 4) have also been incorporated as part of the process of interpretation.

There is a general Conditional Output to at least maintain the same level of service as today. Therefore, the 2043 ITSS would normally maintain a direct service where one already exists.

The Western Route Study connectivity Conditional Outputs have been grouped into the following markets; each of which are addressed further:

- 3.4.1 Suburban commuting journeys to London Paddington
- 3.4.2 Long distance journeys to London Paddington
- 3.4.3 Journeys between key cities and urban centres in the Western Route Study area to large cities outside the area
- 3.4.4 Journeys between key urban centres to other key urban centres within Western
- 3.4.5 Regional-urban (shorter distance) journeys within the Western Route Study.

3.4.1 Suburban commuting journeys to London Paddington (CO7-CO15)

The LSEMS established a Conditional Output to provide a minimum of three or four trains per hour in the off-peak period, to and from central London from stations which are broadly within a 30 – 40 minute journey time to central London. For the Western Route Study, this Inner Suburban area incorporates all stations inclusive between London Paddington, Heathrow Airport and Taplow. The scope to improve connectivity through journey time improvements is limited, as services need to stop at stations close to each other. The primary objective is therefore to provide sufficiently frequent opportunities to travel such that time spent waiting for a train does not pose a barrier to travel.

The Outer Suburban market includes all stations between London Paddington and Twyford, Oxford, Newbury and Swindon (inclusive). The LSEMS defines the connectivity Conditional Output between these areas as a total Generalised Journey Time of as close to 40 minutes as possible, providing this is an improvement on journey times assumed in the 2019 ITSS. The Conditional Outputs for non-London journeys in the area are the same as for London journeys, i.e. to provide a total GJT of significantly less than 100 minutes to and from central London and as close to 40 minutes as possible, provided that this is an improvement on the 2019 ITSS.

If achieving a GJT close to 40 minutes is not feasible, or does not offer sufficient value for money, then incremental improvements to journey time should be sought instead.

Figure 3.27 summarises the relevant flows within the suburban commuter passenger market to London Paddington, connectivity Conditional Outputs from the Market Studies and the Western Route Study interpretation.

Figure 3.27: Western Route Study Interpretation of the suburban commuter market to London Paddington connectivity Conditional Outputs from the Market Studies

Reference	Flow	Market Study connectivity Conditional Output	Western Route Study interpretation
CO7	Taplow/Heathrow Airport – London Paddington inclusive	3-4tph to and from central London	4tph
CO8	Greenford Branch		2tph to connect to Crossrail at West Ealing
CO9	Windsor & Eton Central Branch	To provide a total journey time (GJT) to London (including waiting time) of as close to 40 minutes as possible, provided this is an improvement from today.	3tph to connect at Slough
CO10	Marlow Branch		2tph to connect at Maidenhead
CO11	Henley-on-Thames Branch		2tph to connect at Twyford
CO12	Reading		17tph on Main Line
CO13	Stations from Tilehurst up to and excluding Oxford		2tph to Reading (either connection or direct to London).
CO14	Didcot Parkway and Swindon		4tph
CO15	Stations from Theale up to and including Bedwyn		2 or 3tph (3 from Newbury)

tph = trains per hour

3.4.2 Long distance journeys to London Paddington

The LDMS describes long distance journeys as rail travel over distances of greater than 50 miles, excluding journeys that are predominantly for commuting purposes. The Market Study articulates the connectivity Conditional Outputs for a number of key cities to London at an average journey speed of 160mph. The Market Study implies that markets between London Paddington and Bristol/Cardiff require the highest level of connectivity of three or four trains per hour at an average speed of 160mph. The Western Route Study has identified that it is not operationally feasible or value for money to operate such a speed on the classic rail network. Therefore the Conditional Output has been interpreted as providing rail services which are as fast as possible on the classic rail network, subject to operational feasibility (including infrastructure and rolling stock capability).

Figure 3.28 presents the relevant flows in the Western Route Study for the long distance market into London Paddington, the connectivity Conditional Output recommended by the Market Studies and the Western Route Study interpretation.

Figure 3.28: Western Route Study Interpretation of the long distance market to London Paddington connectivity Conditional Outputs from the Market Studies			
Reference	**Flow**	**Market Study connectivity Conditional Output**	**Western Route Study interpretation**
CO16	London Paddington – Bristol	Average journey speed of 160mph and/or 3 to 4tph	4tph (fast)
CO17	London Paddington – Bath	Average journey speed of 100mph, 2-3tph	2tph (fast)
CO18	London Paddington – Cardiff	Average journey speed of 160mph and/or 3 to 4tph	4tph (fast)
CO19	London Paddington – Swansea	Average journey speed of 100mph, 2-3tph	2tph
CO20	London Paddington – Gloucester	Average journey speed of 100mph, 2-3tph	1tph (and 1tph London – Cheltenham)
CO21	London Paddington – Exeter	Average journey speed of 100mph, 2-3tph	3tph
CO22	London Paddington – Plymouth	Average journey speed of 100mph, 2-3tph	2tph
CO23	London Paddington – Truro	Average journey speed of 80mph, 1-2tph	1tph
The Gloucester zone in the **Long Distance Market Study** also includes Cheltenham. tph = trains per hour			

3.4.3 Journeys between key cities and urban centres in the Western Route Study area to large cities outside Western (non-London)

The LDMS describes the largest functioning economic areas in Great Britain as the 13 principal regional centres of: Birmingham, Bristol, Cardiff, Edinburgh, Glasgow, Leeds, Leicester, Liverpool, London, Manchester, Newcastle, Nottingham, and Sheffield. This section describes the connectivity Conditional Outputs for flows between these key cities and urban centres in the Western Route Study area and principal regional centres outside the study area (not including London).

Figure 3.29 presents the connectivity Conditional Output recommended by the Market Studies and the Western Route Study interpretation of this.

Figure 3.29: Western Route Study Interpretation of the connectivity Conditional Outputs recommended by the Market Studies

Reference	Station to London Paddington	Market Study connectivity Conditional Output	Western Route Study interpretation
CO24	Bristol – Cardiff	Average speed of 60mph, 3 or 4tph	4tph
CO25	Bristol – Swansea	60mph, 1 or 2tph	2tph
CO26	Bristol – Birmingham	100mph, 2 or 3tph	2tph direct (4tph direct from Bristol Parkway)
CO27	Bristol – Leeds	100mph, 2 or 3tph	2tph
CO28	Bristol – Manchester	100mph, 2 or 3tph	2tph
CO29	Bristol – Sheffield	80mph, 1 or 2tph	2tph
CO30	Bristol – Brighton	80mph, 1 or 2tph	1tph
CO31	Bath – Birmingham	80mph, 1 or 2tph	2tph (including a change at Bristol)
CO32	Swindon – Birmingham	80mph, 1 or 2tph	1tph direct
CO33	Swindon – Liverpool	80mph, 1 or 2tph	1tph
CO34	Swindon – Manchester	80mph, 1 or 2tph	1tph to Birmingham for connectivity options
CO35	Swindon – Nottingham	80mph, 1 or 2tph	1tph
CO36	Reading – Birmingham	80mph, 1 or 2tph	2tph
CO37	Reading – Leeds	80mph, 1 or 2tph	2tph direct to Birmingham for connectivity options in addition to connectivity via Old Oak Common for HS2
CO38	Reading – Leicester	80mph, 1 or 2tph	2tph to Birmingham for connectivity options, 1tph direct
CO39	Reading – Manchester	80mph, 1 or 2tph	1tph direct in addition to connectivity via Old Oak Common for HS2
CO40	Reading – Nottingham	80mph, 1 or 2tph	3tph to Birmingham for connectivity options in addition to connectivity via Old Oak Common for HS2, 1tph direct
CO41	Cardiff – Birmingham	80mph, 1 or 2tph	3tph*
CO42	Gloucester – Birmingham	100mph, 2 or 3tph	2tph
CO43	Gloucester – Cardiff	80mph, 1 or 2tph	2tph
CO44	Gloucester – Manchester	80mph, 1 or 2tph	2tph to Birmingham for connectivity options
CO45	Gloucester – Sheffield	80mph, 1 or 2tph	2tph to Birmingham for connectivity options, 1tph direct
CO46	Oxford – Leeds	80mph, 1 or 2tph	2tph to Birmingham for connectivity options
CO47	Oxford – Manchester	80mph, 1 or 2tph	1tph direct
CO48	Oxford – Nottingham	80mph, 1 or 2tph	1tph direct
CO49	Bristol – Peterborough	80mph, 1 or 2tph	As current (no direct services)
CO50	Bristol – Southampton	80mph, 1 or 2tph	2tph

*The Cardiff to Birmnigham connectivity Conditional Output is 3tph because separate connectivity is required between Cardiff and three separate markets beyond Birmingham. This results in 3tph between Cardiff and Birmingham because Birmingham is the nodal point.

3.4.4 Journeys between key urban centres to other urban centres in the Western Route Study area (CO51-CO58)

Figure 3.30 describes the Western Route Study's interpretation of the connectivity Conditional Output for rail journeys between key urban centres.

Figure 3.30: Western Route Study interpretation of connectivity Conditional Outputs from the Market Studies between key urban centres

Reference	Flow	Market Study connectivity Conditional Output	Western Route Study interpretation
CO51	Bath – Oxford	80mph, 1 – 2tph	1tph direct
CO52	Swindon – Bristol	60mph, 3 – 4tph	4tph (2tph direct to Temple Meads and 2tph to Parkway)
CO53	Swindon – Oxford	Total journey time (including waiting) of as close to 40 minutes as possible	1tph
CO54	Swindon – Reading	Total journey time (including waiting) of as close to 40 minutes as possible	4tph
CO55	Plymouth – Truro	80mph, 1 – 2tph	2tph
CO56	Reading – Oxford	Total journey times (including waiting) of as close to 40 minutes as possible	6tph semi-fast
CO57	Bristol – Swindon	60mph, 3 – 4tph	4tph
CO58	Bristol – Exeter	80mph, 1 – 2tph	3tph

3.4.5 Regional urban (shorter distance) journeys (CO5-CO74)

The **Regional Urban Market Study** defines this market as an area of less than 50 miles from a regional centre where people travel in large numbers primarily for the purpose of commuting or leisure. Figure 3.31 describes the connectivity Conditional Outputs for key regional urban rail journeys within the Western Route Study area.

3.4.6 2043 Indicative Train Service Specification

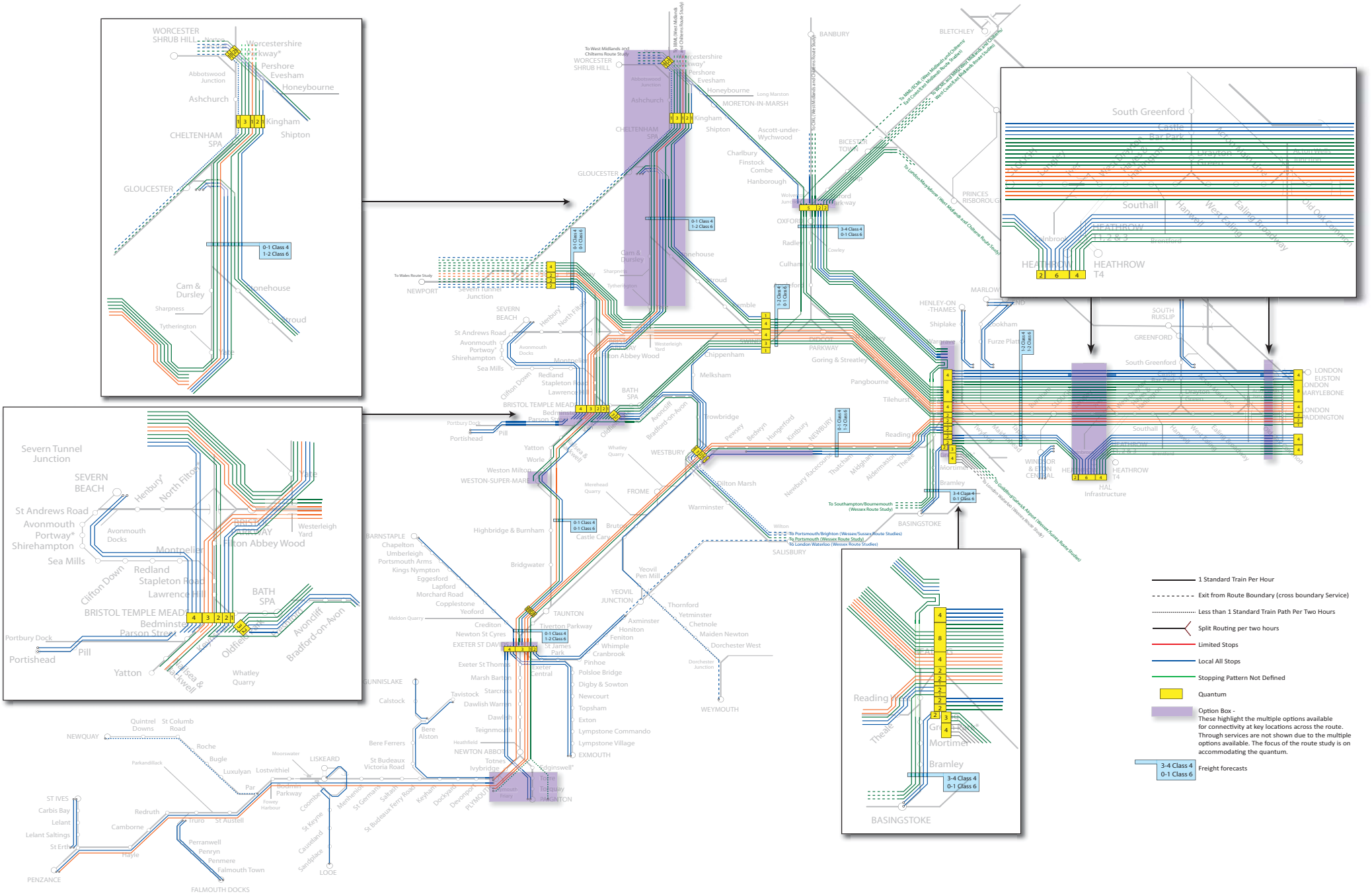
Figure 3.32 illustrates the 2043 connectivity Conditional Outputs interpreted from the Market Studies for the Western Route Study into an Indicative Train Service Specification (ITSS). The ITSS is an all-day off-peak scenario and is unconstrained by network capacity or rolling stock considerations. The Conditional Outputs are expressed as 'journey opportunities' per hour. Specific calling patterns have not been identified as part of this high-level analysis.

Figure 3.31: Connectivity Conditional Outputs for key regional urban rail journeys within the Western Route Study area

Reference	Flow	Market Study connectivity Conditional Output	Western Route Study interpretation
CO58	Bristol – Severn Beach	2tph to all stations and better cross-Bristol connectivity	2tph
CO59	Bristol – Cheltenham/Gloucester	2tph on Gloucester stopping services, peak 2tph service to Yate, better connectivity to Bath Spa	2tph Gloucester stopping services, 2tph at Yate
CO60	Bristol – Bath/Warminster/Chippenham	Oldfield Park off-peak frequency to match peak	Improved connectivity to Bath Spa (achieved by MetroWest Phase 1)
CO61	Bath – Filton Abbey Wood/Bristol Temple Meads	Better cross-Bristol connectivity to Filton Abbey Wood	3tph standard hour service frequency
CO62	Swindon – Bath/Chippenham/Melksham	Increase service from Trowbridge and Melksham and improve GJT at these stations	1tph direct and improved connectivity
CO63	Exeter St Davids – Plymouth	80 or 45mph, 1 – 2tph	1tph Swindon – Westbury via Chippenham, Melksham and Trowbridge
CO64	Exeter St Davids – Plymouth/Paignton/ Newton Abbot	Reduce journey time	3 – 4tph
CO65	Exeter St Davids – Barnstaple	Improve end to end journey time	2 – 3tph Exeter to Paignton, 3 – 4tph Exeter to Plymouth, 6tph Exeter to Newton Abbot
CO66	Exeter St Davids – Exmouth	Reduce journey time	1tph
CO67	Exeter St Davids – Taunton	Reduce journey time and improve connectivity with Exeter Central	2tph
CO68	Exeter St Davids – Truro	80mph, 1 – 2tph	2 – 3tph Exeter to Taunton, 4tph Exeter St Davids to Exeter Central
CO69	Plymouth – Exeter	80mph, 1 – 2tph	2tph
CO70	Plymouth – Exeter/Paignton/Newton Abbot	Improve connectivity between Plymouth and Torbay	3 – 4tph
CO71	Plymouth – Penzance	Reduce journey time	3 – 4tph Plymouth to Exeter, 3tph Plymouth to Newton Abbot, improved connectivity at Newton Abbot for Plymouth to Torbay
CO72	Truro – Exeter	80mph, 1 – 2tph	2tph
CO73	Truro – Plymouth	80mph, 1 – 2tph	2tph

*Note: options to reduce journey times form part of the Western Route Journey Time Improvement programme (see Chapter 5).

Figure 3.32: Western Route Study 2043 ITSS



3.5 Freight Conditional Outputs

The Conditional Outputs established in the FMS are to accommodate the forecast level of freight demand for 2023 and 2043. These have been interpreted for the Western Route Study into the following Conditional Outputs presented in Figure 3.33.

Figure 3.33: Western Route Study Freight Conditional Outputs

Reference	Conditional Output
FC01	To provide capacity to accommodate intermodal (ports, domestic and Channel Tunnel) forecast freight growth in Western Route Study area in 2023
FC02	To provide capacity to accommodate construction materials forecast freight growth in Western Route Study area in 2023
FC03	To provide capacity to accommodate metals forecast freight growth in Western Route Study area in 2023
FC04	To provide capacity to accommodate intermodal (ports, domestic and Channel Tunnel) forecast freight growth in Western Route Study area in 2043
FC05	To provide capacity to accommodate construction materials forecast freight growth in Western Route Study area in 2043
FC06	To provide capacity to accommodate metals forecast freight growth in Western Route Study area in 2043

The Western Route part of the national freight network currently carries eight per cent of national tonne kilometres which is forecast to rise to nine per cent by 2043. The forecast annual growth rate in tonne kilometres for all commodities for the Western Route Study area to 2043 is 3.2 per cent which is consistent with the national average.

Figure 3.34 presents a breakdown of the tonne kilometres carried by commodity across the Western Route study area for 2011/12 and for the forecast years of 2023, 2033 and 2043.

Figure 3.35 presents the key routeing assumptions and the annual growth rate of the four main commodities for freight across the Western Route Study area. This indicates the priority corridors to accommodate future rail freight growth.

Each of the key commodities of Intermodal (Domestic and Ports), Construction and Electricity Supply Industry (ESI) are discussed in turn and presented as an overview of the national freight market, how it is expected to change up to 2043 and the specific impact to the Western Route Study area.

Figure 3.34: Freight Tonnage – 2011/12 and to 2043

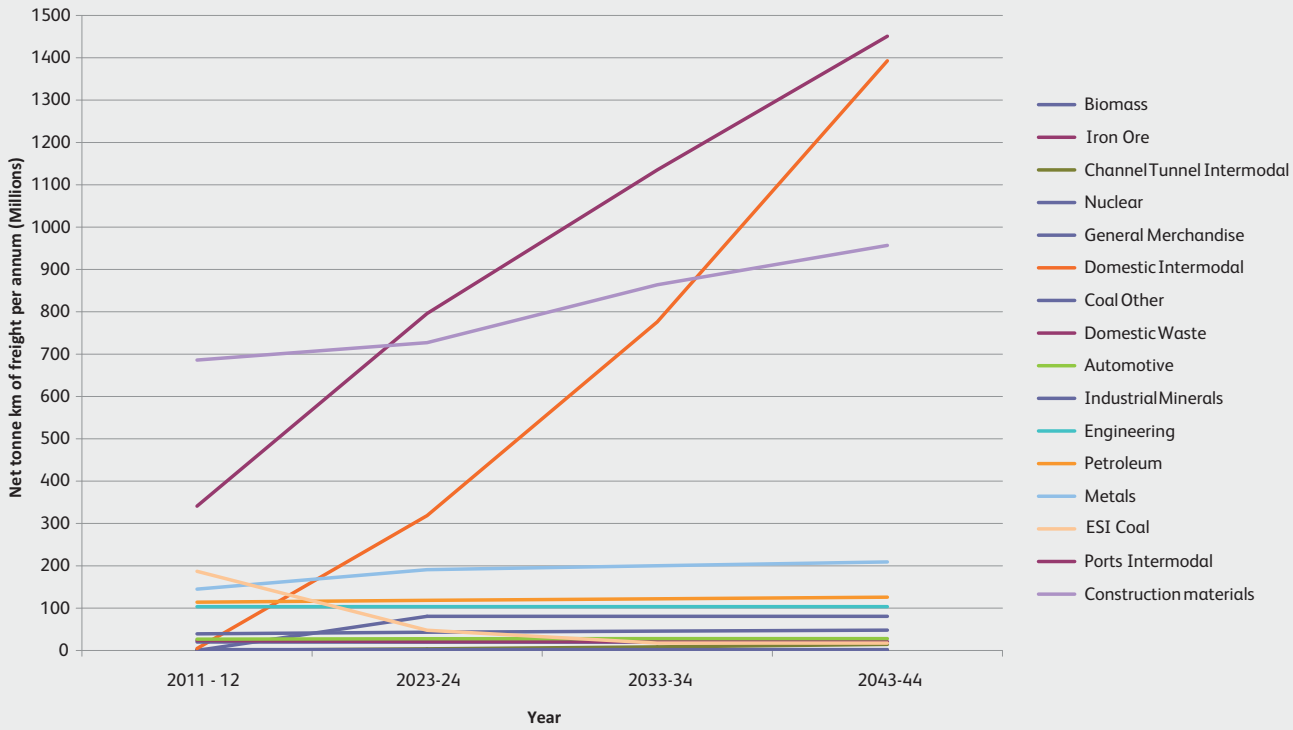


Figure 3.35: Growth per annum of key rail freight commodities across the Western Route Study area		
Commodity	**Net tonne km growth per annum 2012 to 2043***	**Main route corridors**
Intermodal (Ports)	4.5%	Southampton to/from Reading, Didcot/Oxford and West Coast Main Line Wales and Bristol to/from Greater London, Southampton and Haven Ports
Intermodal (Domestic)	20%	Bristol, Wales and Exeter to/from West Midlands, Greater London, East Midlands, and Southampton
Construction	1%	Mendip Quarries to London via Newbury and Reading
Electricity Supply Industry (Coal)	-7%	Bristol Ports to Gloucester and the West Midlands – flows to Didcot Power station ceased in 2013
*compound annual growth rate		

Intermodal

Intermodal covers three sub-sectors, containerised traffic to/ from Ports (intermodal (Ports)), traffic between inland terminals (intermodal (domestic)) and traffic through the Channel Tunnel . Strong growth is forecast for this sector particularly for Domestic Intermodal. The growth in the Western Route Study area is predominantly on the key corridor within the Strategic Freight Network between the Port of Southampton and the West Midlands. This corridor crosses Route Study boundaries (Wessex and West Midland and Chilterns), with the Western Route Study scope area between Basingstoke and Reading and Didcot and Oxford.

Construction

Nationally, the forecasts for the construction materials sector indicate less change than intermodal, coal and biomass sectors. For construction materials, growth of approximately one per cent per annum to 2043 in tonne kilometres is forecast. This reflects growth in the total (road and rail) market for construction materials and an improvement in the competitiveness of the rail industry.

Construction materials are a very important sector within the Western Route Study area, currently comprising around 40 per cent of total tonne kilometres on the route compared with 16 per cent measured on a national basis. The forecast growth rate for the Western Route Study area is similar to the national rate at around one per cent per annum.

The FMS assumptions are now considered to be conservative for construction materials given rail's recent strong performance in this market and as such, the forecasts have been reviewed as part of the Network RUS: Freight which is due to publish in early 2016.

The revised forecast reflects rail's improved market share. Using the revised forecasts increases the train path requirements as shown in Figure 3.36 below.

Figure 3.36: Illustration of impact of revised construction traffic forecasts (assuming no improvement in path utilisation, traction or trailing load)		
	Between Theale and Southcote Jn	Between West Drayton and Acton Yard
2023 Previous Forecast (from FMS)	<1tph Class 6/7	3tph Class 6/7
2023 Revised forecast	1tph	4tph
2043 Previous Forecast (from FMS)	1-2tph Class 6/7	3-4tph Class 6/7
2043 Revised forecast	1-2tph	5tph

The traction and trailing load assumptions used in the Western Route Study are as follows:

- Class 4 = 1,400 tonnes hauled by Class 66
- Class 6 = 2,000 tonnes hauled by Class 66
- Class 7 = 4,200 tonnes hauled by Class 59.

The uplift in paths in 2023 is anticipated to be accommodated in the 2019 ITSS through improvements in the utilisation of existing train paths, whilst maintaining one freight path per hour between Theale and Southcote Junction, and four freight paths per hour between West Drayton and Acton Yard.

The Western Route Study is not seeking to fully accommodate the revised long term forecasts for 2043 as these will be addressed and adjusted within future planning cycles.

Electricity Supply Industry Coal and Biomass

The Electricity Supply Industry (ESI) coal sector covers coal used by power stations. The forecasts in the FMS are based on the Department of Energy and Climate Change projections of energy use (October 2012). They show a projected decline in coal and a rise in gas, renewables and nuclear between 2011 and 2030. The projected fall in coal, relative to a 2011 base, is 74 per cent by 2023 and 90 per cent by 2030. The forecasts for rail traffic related to ESI coal reflect these projections.

The biomass sector also covers fuel used by power stations. This sector has only emerged as being potentially significant for rail over the last four years. Biomass has enormous potential to grow as a rail market and major investment is already taking place in rail based supply chains. However, there is considerable uncertainty around the volume of biomass likely to move on rail to fuel power stations and a number of generators are still developing their strategy for this sector. Working assumptions for the forecasts are based on electricity industry announcements to date and an assessment of Government policy. A national estimate of 14 million tonnes or 2.3 billion tonne kilometres is presented for 2023, as a working assumption. To reflect uncertainties, higher and lower scenarios for 2023 were also presented in the FMS. The 2023 forecasts are assumed to apply to 2033 and 2043.

Since publication of the FMS, further work within the industry has indicated a change in forecast trends. While the decline in coal is still expected to occur, it may be delayed, and the growth in biomass is looking more uncertain. These scenarios will be reviewed as part of the Network RUS: Freight in order to refine planning assumptions. However for the purposes of this Route Study the demand forecasts from the FMS have been used for biomass and coal.

Within the Western Route Study area the volume of ESI Coal has already declined substantially from the base forecast of 2011/12 with the closure of Didcot Power Station in 2013. The remaining coal flows are therefore principally from the Bristol Ports to power stations in the Midlands. The FMS anticipated that these flows will have substantially declined by 2023. In the Western Route Study area, there is currently a biomass flow from Portbury to Ironbridge Power Station in the West Midlands. This flow is assumed to end with the planned closure of Ironbridge Power Station in 2015.

Other Market Sectors

The main commodities include metals, petroleum, industrial minerals and automotive. The forecasts indicate much less change than the other sectors, with growth of up to one per cent per annum to 2043 in tonne kilometres. This reflects improvements in the competitiveness of rail. No change in the total market is forecast for these sectors.

Within the Western Route Study area the other commodities which comprise the largest proportion of the current rail freight traffic are metals at nine per cent, petroleum at seven per cent and industrial minerals at two per cent of tonne kilometres within the route.

The bulk of the metals traffic is from South Wales destined for locations in Greater London or the continent of Europe. Forecast growth is around one per cent per annum in net tonne kilometres. Petroleum traffic is destined for a number of terminals in the Western Route Study area including aviation fuel to Colnbrook for Heathrow Airport. Industrial minerals is a small percentage overall but is significant in Cornwall with china clay transported by rail to the Port of Fowey. There are also smaller flows of china clay from Cornwall to Stoke-on-Trent.

Automotive trains are a significant flow from the West Midlands and North West to the Port of Southampton and from Cowley to either Southampton or Essex Thameside. However, as the weight of finished vehicles per train is low in comparison with bulk commodities they only account for less than two per cent of net tonne kilometres in the Route Study area.

Further details on each of these market sectors is set out in the FMS which includes commentary on the characteristics of each Market Sector, significant recent changes and expected change in future years.

Freight path forecasts

As part of the analysis undertaken by the FMS, the tonnes forecast described above were converted into an assumed number of freight paths per hour between an origin and destination based on commodity specific assumptions, such as:

- tonnes per trains
- path utilisation
- operating days per week
- conversion of paths per day into paths per off-peak hour.

Figures 3.37 and 3.38 illustrate the Western Route Study Class 4 and Class 6 freight paths for 2043 respectively.

Figure 3.37: Western Route Study Class 4 Freight Paths 2043

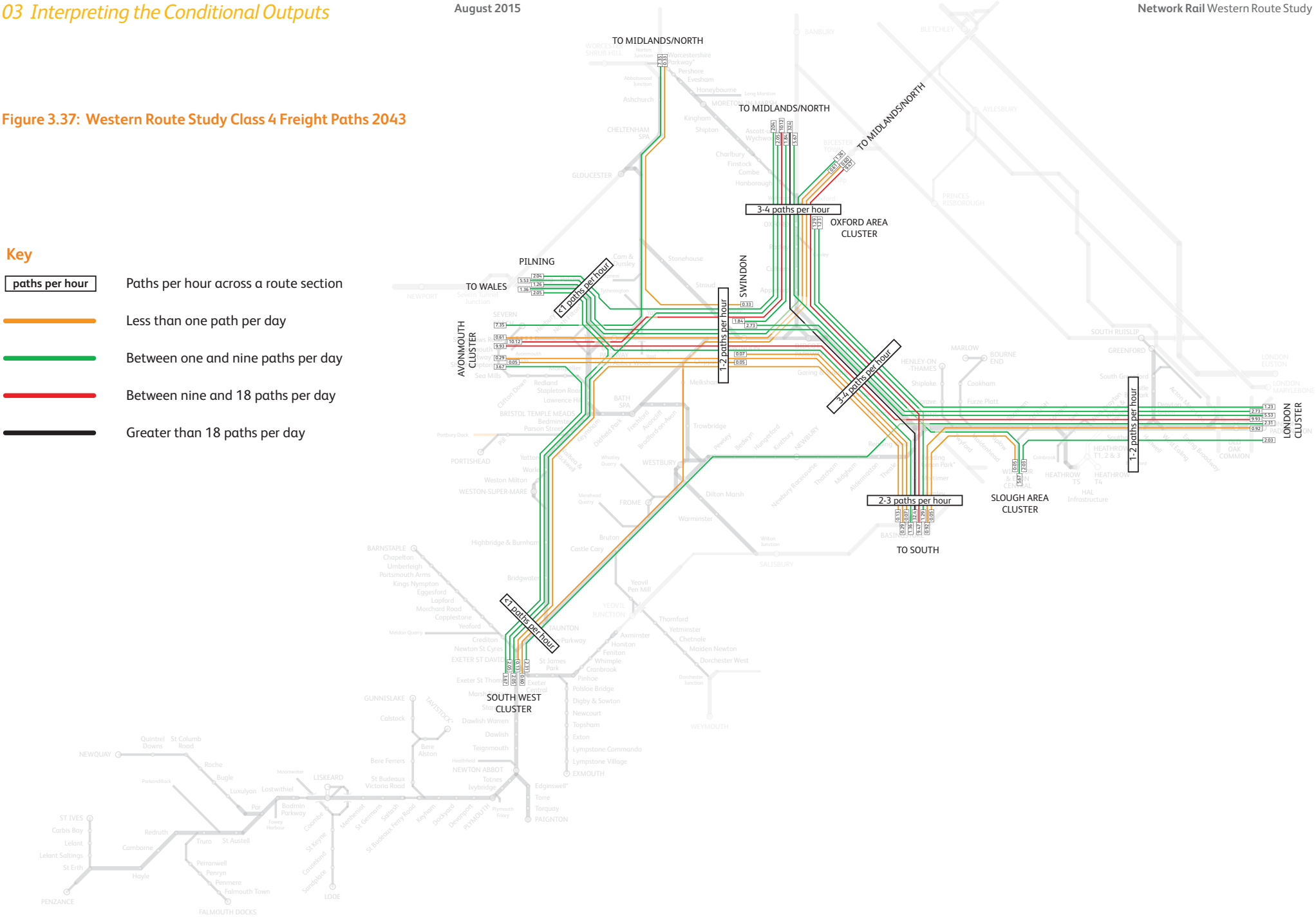
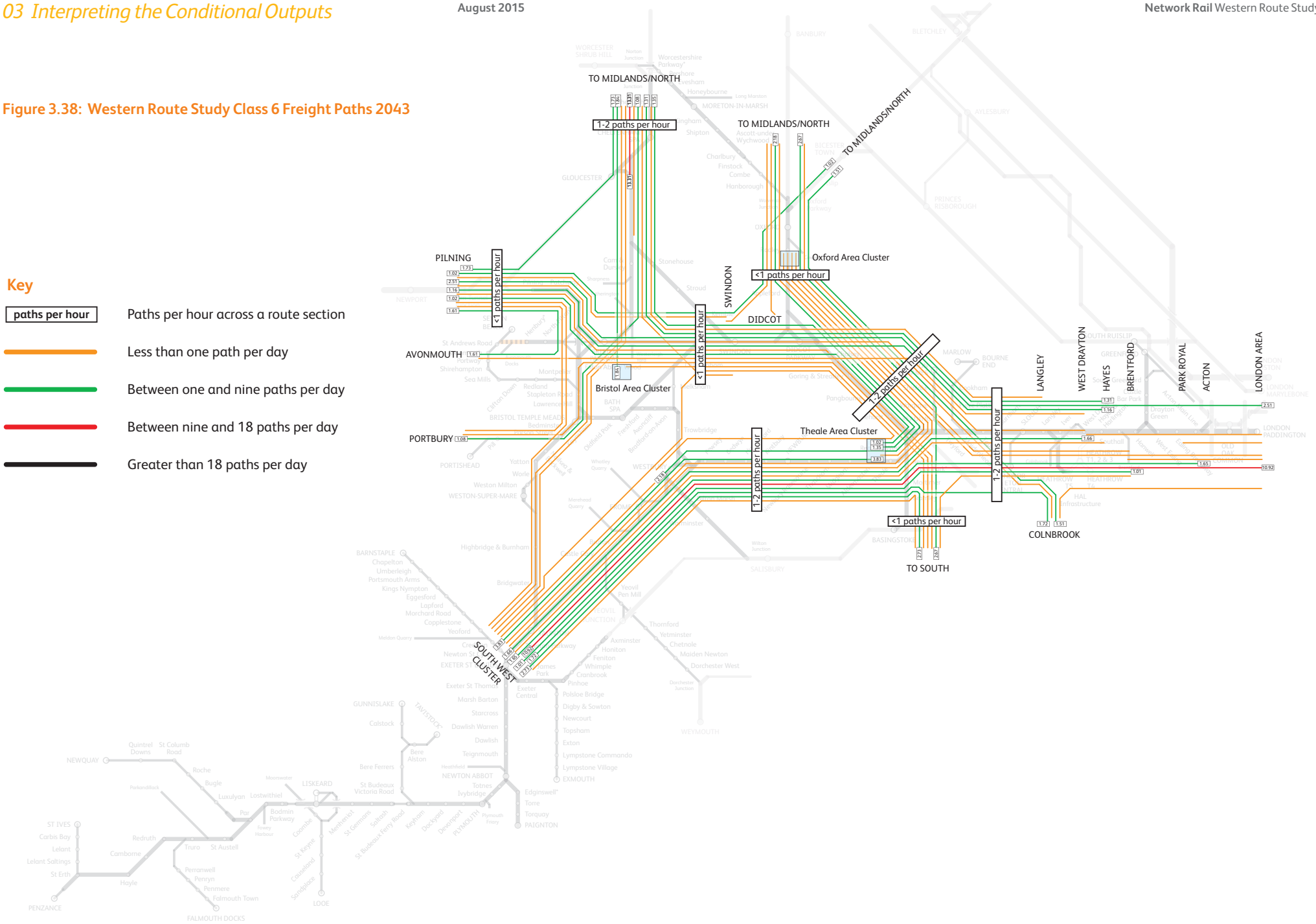


Figure 3.38: Western Route Study Class 6 Freight Paths 2043



3.6 Other Conditional Outputs

Not all of the Market Studies' Conditional Outputs have been quantified as they either do not directly relate to connectivity or are too bespoke for numerical analysis to be undertaken. However, these outputs still require articulation as they are likely to contribute to a successful outcome of the strategic goals and may enable the positive impact of the connectivity and capacity based Conditional Outputs that have been detailed in this chapter. The other Conditional Outputs are:

- better capacity for the leisure market at weekends and weekday evenings
- improved local access to the rail network to cater for demand
- better connectivity for the leisure market at weekends
- improved access to long distance gateways (HS2 and Airports)
- connectivity and capacity for tourist attractions outside of the regions urban centres
- improved access to higher educational establishments and social infrastructure
- improved passenger satisfaction.

Each of these are described in further detail:

3.6.1 Better capacity for the leisure market at weekends and weekday evenings.

The busiest times for travel to and from urban retail and tourism centres are often at weekends and during weekday evenings. This is in contrast to the typical weekday peak for commuting and business travel, when the highest current levels of train service frequency and capacity are provided. The increase in leisure use of rail in recent years is improving the financial case of rail lines which previously served predominantly commuter flows, as it allows better utilisation of resources that are required to deliver the peak timetable. The evolving leisure market is important to the local economy and therefore the Conditional Output is to provide sufficient capacity to avoid suppression of demand and to reduce potential on-train crowding. This involves the consideration of the potential trade-offs resulting from alternative engineering regimes, including an assessment of the value for money and affordability implications.

The implications of seasonal peaks on demand is an issue very relevant to the Western Route Study and cognisance has been taken of the seasonal variations in travel patterns to destinations specifically in the west such as Devon and Cornwall where demand for travel is significantly higher in the summer months. Leisure and tourism can be significant drivers of demand particularly on some rural corridors, in the evenings and at weekends. The analysis of the seasonal demand is discussed in Section 3.3.6.

3.6.2 Improved local access to the rail network to cater for demand.

In many cases, improving access to the rail network is the equivalent of improvements to rail journey times. Good connectivity and accessibility of rail stations are important in attracting passengers to travel by rail. Rail stations and rolling stock accessible to less mobile passengers plays a significant role in improving quality of life by enabling access to a wider range of employment and leisure opportunities. More generally, continuing improvement in the facilities and general ambience at stations can be expected to play an important role in retaining and developing the use of rail, taking into account rising consumer expectations.

Car parking provision at or close to stations will need to keep pace with growing rail demand, as will highway access to stations. Good integration and co-ordination with local transport such as London Underground, bus and tram services and facilities for pedestrians and cyclists are equally important if rail travel is to achieve its maximum potential.

Improvement to station environments is achieved through existing industry programmes such as Access for All (AfA) which improves accessibility to stations and the National Stations Improvements Programme (NSIP) which improves the service environment including passenger facilities, security and overall visual quality. Third party funding provides a significant contribution to station improvements, including station facilities, interchange improvements and additional car parking.

In some cases, new stations and new lines can have a significant impact on the ability of people to access the rail network. However, aspirations for new stations and new lines have not been formalised into Conditional Outputs for the Long Term Planning Process. Sponsorship of new stations and new lines to improve access to the rail network is the responsibility of the scheme promoter in each instance.

3.6.3 Better connectivity for the leisure market at weekends.

The busiest time for leisure travel is often at weekends, which coincides with significant railway engineering activities timed to minimise disruption to commuting and business passengers. Given the growing leisure market and the importance of this market to the strategic goals, the Conditional Output is to provide the connectivity during the weekends as detailed in the LDMS. Providing sufficient capacity to accommodate demand at the weekend is important to avoid suppression of demand and to reduce on-train crowding. This involves the consideration of the potential trade-offs resulting from alternative engineering regimes, including an assessment of the value for money and affordability implications.

3.6.4 Improved access to long distance gateways

Three types of long distance travel gateway have been considered, namely; long distance strategic rail interchanges, major and large airports and major ports.

3.6.5 Long distance strategic rail interchanges

The Conditional Output is to provide improved access to and from the long distance network where this could significantly strengthen the competitive position of rail versus car and/or air.

3.6.6 High Speed Rail

Ease of interchange between the local rail system and the emerging high speed network will become an increasingly significant part of the total rail travel offer. Substantial interchange already takes place with High Speed One (HS1) at London St Pancras International. With the advent of High Speed Two (HS2), such interchange will form a vital part of the attractiveness of travel opportunities providing connectivity between the Western Route, London and South East, the Midlands and the North and is described in more detail in Chapter 2.

3.6.7 Airports

Good rail connectivity to airports is important in supporting economic growth, productivity and social mobility. It can play a key role in providing better access to markets, national and international destinations, business and leisure opportunities, and to jobs. New and improved rail services and their integration with other transport modes at major airports is key to providing more sustainable travel opportunities and improving overall connectivity, acting as a transport hub both for air passengers and for other rail users. Rail is a vital ingredient in improving the travel experience and offering for air passengers, employees and freight and in helping airports meet current and future travel demand.

Rail service provision should be able to meet the growing demand for access to airports by rail. Fast, convenient and reliable rail access to central London is a priority for London's airports but direct access to non-London core economic centres is increasingly important.

Airport passenger and employee travel demand is different to commuting and leisure flows with peak travel demand occurring at different periods of the day and night. Earlier morning and later evening rail services should be considered, subject to value for money and affordability. As with other services in this study, key metrics are capacity, frequency, journey time and ease of transfer.

Figure 3.39 illustrates the connectivity Conditional Outputs for Airport services taken from the LSEMS.

Figure 3.39: Conditional Outputs for services to Airports			
Opportunities to travel, per hour	To/from London (tph)	To/from key airport catchments within London & SE (tph)	To/from key airport catchments beyond London & SE
Large Airport (>30m passengers, >20m surface access)	6	4	Direct service, minimal interchange
Medium Airport (5-30m passengers)	4	2	Direct service, minimal interchange

As a guide, the minimum long term service level aspiration for rail connectivity to airports is:

1) Frequent opportunities to travel.

2) Sufficient capacity for the needs of passengers (including non-air passengers that use the airport as a transport hub).

3) A minimum frequency of two trains per hour during airport peak operation (which may be at different times from the general commuting peaks).

4) High levels of reliability and punctuality.

5) Journey speed (including waiting time) of c. 50–60mph.

6) Direct services (i.e. minimal interchange).

7) A total journey time of less than 60 minutes to/from key airport catchments within London and the South East.

8) A total journey time of less than 100 minutes to/from key airport catchments within long distance airport catchments beyond London and South East.

3.6.8 Major Ports

Rail access to ports is primarily driven by freight requirements. However, ports are also large employers. Rail is not usually an attractive mode of access for port workers as the sheer scale of the sites often requires vehicular access within them. A number of ports, such as Southampton, have thriving cruise operations, with passenger volumes of approximately 1.5 million per annum. Capacity and connectivity for rail passenger traffic to ports is considered on a case by case basis in the relevant Route Study.

3.6.9 Connectivity and capacity for tourist attractions outside of the region's urban centres

The potential for rail to provide good connectivity between large numbers of people and tourist attractions is more limited where these locations are outside of the Region's urban centres. This is because these attractions tend to exhibit a number of the following characteristics:

- they are a significant distance from a rail line
- they are geographically dispersed such that rail can only serve a limited proportion of the attraction
- the nearby population catchments are geographically dispersed, limiting the number of people with easy access to the rail line(s) which serve the relevant attraction.

There are circumstances, however, where rail can play a significant role in connecting people with tourist attractions of this nature, in particular where a large tourist attraction is connected to a large centre of population by rail. Discussions with representatives of the tourism industry and other stakeholders suggest that the key to maintaining and improving the attractiveness of these locations as rail destinations, is to provide a frequent regular service interval throughout the week and at weekends, as well as services which operate sufficiently early and late in the day to enable a full day trip to a location.

These requirements are similar to those for travel to urban tourism locations, albeit with more limited circumstances where rail can be an attractive mode of access. The Conditional Output is therefore to provide an attractive frequency of services to out of town tourist attractions, where the characteristics of these attractions, their visitor catchment areas, and the existing rail network enable a level of service of this nature. This frequency should be provided at the busiest times for tourism travel.

3.6.10 Improved access to higher educational establishments and other social infrastructure

Improving accessibility to higher education establishments and social infrastructure improves the quality of life for communities and individuals; helping to achieve one of the industry's strategic goals. The Western Route Study considers where such establishments have a significant impact on rail demand and affects the level of service provision that is required to meet that demand. Demand scenarios in the LDMS show that an increase in demand in long distance travel is predicted in some circumstances due to an increase in students' willingness to travel for longer distances to gain access for education. Rail is increasingly becoming the mode of choice for students.

Key rail connections to educational establishments within the Western Route Study area includes Reading, Oxford, Bath, Bristol, Exeter, Plymouth, Truro and Falmouth, with connections to London, Birmingham and South Wales equally significant. Improving connectivity to and between these centres is an important way of connecting communities, improving accessibility to services and improving quality of life for many. The Conditional Output for this market is to improve connectivity to these centres.

The Western Route Study 2019 baseline as described in Chapter 2 anticipates the following improvements in connectivity:

- East West Rail – this will provide new rail links between Oxford and Milton Keynes / Bedford
- MetroWest Phase 1 introduces additional local services which would improve connectivity between Bristol Temple Meads and Bath Spa, as well across the greater Bristol area
- the proposed redeployment of rolling stock will provide additional on-train capacity for services across the Thames Valley region, Greater Bristol Area and on local services in Devon and Cornwall.

3.6.11 Improved Passenger Satisfaction

Passenger travel experiences are important and can affect mode choice and demand for rail. The Conditional Output is to seek improvements to station environments, the quality, capacity and consistency of rolling stock, the availability of information to passengers and, where appropriate, train punctuality. Rolling stock needs to meet the requirements and expectations of passengers and to enable an efficient provision of rail services.

3.7 Summary

This chapter has outlined the Conditional Outputs and growth forecasts articulated in the established Market Studies. It has presented the Western Route Study's interpretation of these forecasts for capacity and connectivity Conditional Outputs which have then been used to inform further analysis. The output of this analysis and the potential choices for funders that have been identified in order to accommodate the range of Conditional Outputs for the Western Route Study area are presented in Chapter 5.

The following chapter 'Cross-Boundary Analysis' details how the connectivity Conditional Outputs identified in the Market Studies have been developed for both passenger and freight services, which span multiple Route Study scope areas.

04 Cross-Boundary Analysis

This chapter outlines the approach to passenger and freight services which operate both in and out of the Western Route Study area. It details those services that are anticipated to operate in the 2019 baseline, before describing the process for developing those cross-boundary services which meet the Conditional Outputs for the longer term, and the assumptions that have been made. Finally, it provides a number of examples of how the Conditional Outputs relevant to these aspired services have been interpreted to assist in developing the Western Route Study 2043 Indicative Train Service Specification (ITSS).

4.1 The Cross-Boundary Approach

By necessity, for the purposes of undertaking the Long Term Planning Process (LTPP), the Network Rail geography is divided into Route Study Areas; this is to make the process manageable across the whole of the rail network, which covers Great Britain. For this reason, the Route Studies are not produced in parallel, but are phased over the available time period within the five-year planning cycle of Control Period 5 (CP5, 2014 – 2019).

The Route Study boundaries broadly follow those of the Network Rail devolved Routes. There are some exceptions to this, for analysis purposes: to divide the work into smaller, more manageable areas (from a Route Study perspective); to reduce the number of interfaces between Route Studies or to align with markets. Due to this division of the rail network geography, it is necessary to co-ordinate the treatment of passenger and freight trains that cross Route Study boundaries, hence the cross-boundary approach.

For the purposes of the LTPP, passenger and freight services that operate across more than one study area are referred to as cross-boundary services.

4.2 The Route Study Boundaries and anticipated services that operate across them in 2019

The Western Route Study has boundaries with other Routes at the following locations, with the current (or anticipated baseline) traffic:

- Greenford West Junction
  - limited passenger and freight traffic
- Acton Wells Junction
  - no booked passenger traffic
  - significant freight traffic of all types from the Western and Wales Routes to East Midlands, North East and Anglia
- Portobello Junction (boundary with Crossrail)
  - Crossrail passenger trains
- Airport Junction (boundary with Heathrow Airport Limited managed infrastructure)
  - Airport services from London Paddington and Crossrail trains from central London (and beyond) to Heathrow Airport
- Reading Southern Junction
  - passenger trains from Gatwick Airport and London Waterloo to Reading
- Basingstoke Junction
  - long distance passenger trains from the South Coast to Manchester and Newcastle
  - local passenger trains between Basingstoke and Reading
  - freight traffic particularly intermodal and automotive from the South Coast to the East Midlands (where this is the shortest route), Midlands and North West
- Oxford North Junction (towards Bicester)
  - regional passenger trains from Oxford to Bedford and Milton Keynes (and potentially destinations north and east thereof in the future)
  - passenger trains between London Marylebone and Oxford
  - freight traffic particularly intermodal and automotive from the South Coast to the East Midlands (where this is the shortest route), Midlands and North West
- Wolvercot Junction
  - long distance passenger trains from the South Coast and Reading to Manchester and Newcastle
  - Oxford to Banbury passenger trains
  - significant freight traffic particularly intermodal and automotive between Southampton and the West Mindlands, North West and South Yorkshire
- Gloucester West
  - regional passenger trains between Cardiff, Cheltenham Spa, Birmingham and Nottingham

  - freight traffic particularly metals, liquid fuels and intermodal between South Wales and the West Midlands and the North East
- Abbotswood Junction
  - long distance passenger trains between the West Country, Bristol, Manchester and Scotland
  - regional passenger trains between Cardiff, Cheltenham Spa, Birmingham and Nottingham
  - freight traffic particularly coal, metals and liquid fuels between Bristol and South Wales
- Norton Junction
  - long distance passenger trains from London Paddington to Worcester, Malvern and Hereford
- Pilning
  - long distance passenger trains from London Paddington to South Wales
  - regional passenger trains from Portsmouth Harbour and Taunton to Cardiff
  - freight traffic, particularly coal between Bristol and South Wales
- Wilton Junction
  - regional passenger trains from the South Coast to South Wales and Gloucester/Worcester/Malvern via Bristol
  - limited freight traffic, primarily aggregates between the Mendips and the South Coast
- Yeovil Junction
  - passenger trains between Yeovil Pen Mill and London Waterloo (anticipated to commence from December 2015 subject to regulatory processes); the line is also used for planned and unplanned diversions
  - limited freight traffic
- Dorchester Junction
  - passenger trains from Bristol to Weymouth
  - no booked freight traffic
- Axminster
  - passenger trains between London Waterloo and Exeter St Davids
  - the line is also used for planned and unplanned diversions
  - limited freight traffic.

These boundaries are detailed in the Western Route Study Scope Map presented in Chapter 2, Figure 2.1.

4.3 Conditional Outputs

Not all Conditional Outputs are contained within Route Study boundaries as passenger and freight movements are not constrained to Route Study geographical areas, and the cross-boundary process has been designed to ensure that these are reflected in the analysis within the Route Studies.

4.4 Development of the Process

The cross-boundary process has been developed by a working group consisting of representatives from Network Rail, passenger and freight train operating owning companies, Transport for London and the Department for Transport.

The group has developed a Cross-Boundary ITSS for passenger services that cross Route Study boundaries. This specification is an interpretation of how the connectivity Conditional Outputs articulated in the established Market Studies could be delivered. There are many ways in which the Conditional Outputs could be expressed and the Cross-Boundary ITSS has, as a starting point, sought to minimise the number of train movements over any given corridor by linking Conditional Outputs together and, where possible, delivering several Conditional Outputs by the same train service. The Cross-Boundary ITSS is unconstrained; given that the Conditional Outputs are conditional on a value for money business case being found, it could be that the Cross-Boundary ITSS may need to change in the future.

There are also a number of planning cycles to be undertaken between the time of writing and 2043 that may lead to changed priorities. However, it is necessary to develop a set of service level assumptions to test the capability and capacity of infrastructure based on the professional judgement of industry stakeholders. Using this approach allows a consistent methodology to be applied to ensure that opportunities can be identified and tested.

Further details of the cross-boundary service assumptions and how services pertinent to the Western Route Study area have been developed are shown in Section 4.6 and 4.7.

The services contained in the Cross-Boundary ITSS have been included within the Western Route Study ITSS detailed in Chapter 3.

For freight services, the Western Route Study has used the **Freight Market Study,** which includes preferred routeing of services, These routeings have been disaggregated within the Western Route Study area.

As with passenger trains, there are a wide range of origins and destinations for freight traffic. However, freight trains operate to a varied timetable according to the needs of industry and are often irregular or operate on specific days of the week. The information has been assessed on corridors within the Route Study area to the nearest whole number of trains per hour (or per day), but remains the precise figure at the Route Study boundary area. This ensures that adjacent Route Studies do not incrementally round up, and result in over provision of timetable slots for freight traffic.

All freight flows in the Western Route Study area have been included in this approach to ensure they are incorporated in the Western Route 2043 ITSS.

The Cross-Boundary Working Group continues to meet to receive and approve proposals from the Route Studies to amend the cross-boundary specification (for either passenger or freight services), and to advise on resolving capacity issues affecting more than one Route Study. An example of this process is included in Chapter 5, Route Section N.

As the Route Studies do not run in parallel, the cross-boundary process is continuous throughout the LTPP period.

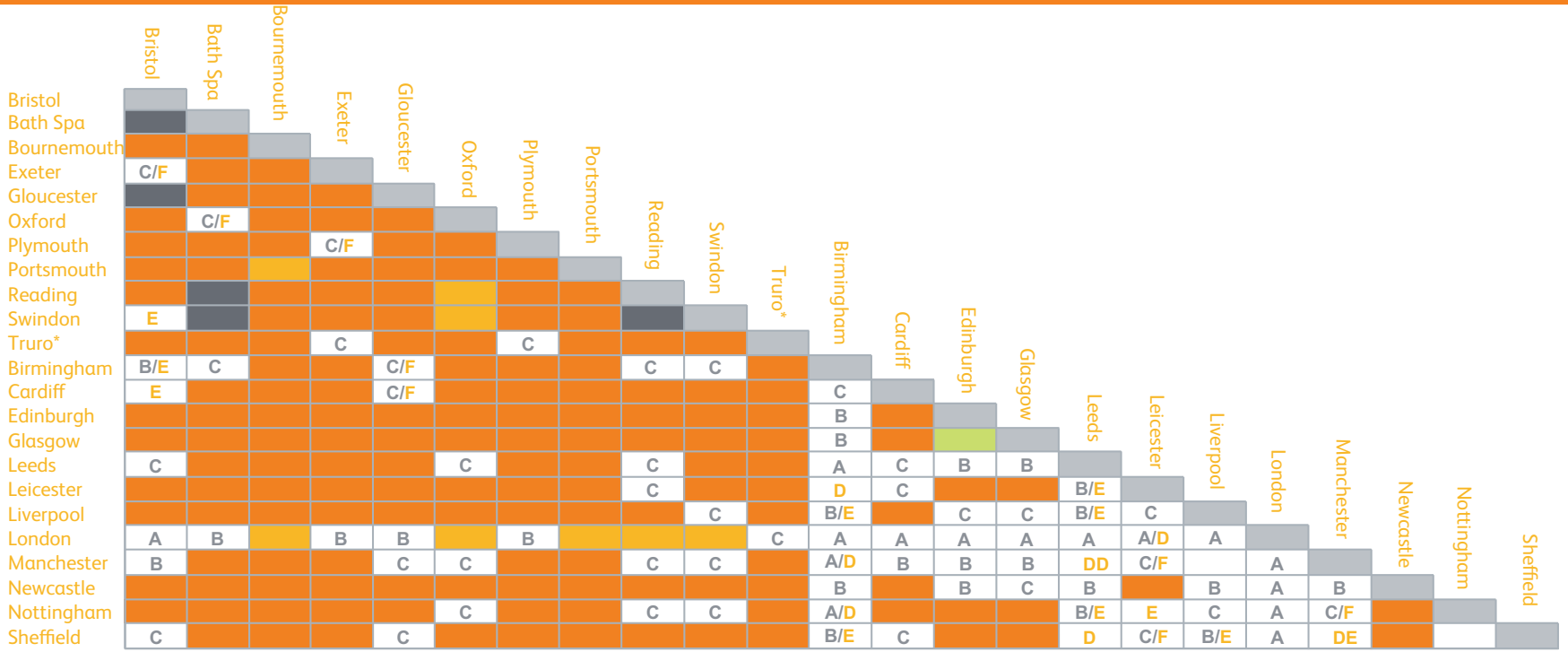
4.5 Cross-boundary service assumptions for the longer term for the Western Route Study Area

To produce the Cross-Boundary ITSS requires the Conditional Outputs from the established Market Studies (those that cross the Route Study boundary and those that do not) to be interpreted. Of most relevance are the passenger connectivity Conditional Outputs, as in Figure 4.1, and the freight demand Conditional Outputs.

Any passenger Conditional Output crossing a Route Study boundary will require a train to 'carry' it. However, one train may address several Conditional Outputs. Therefore, a long distance train travelling across the country from Plymouth to Glasgow may 'carry' Conditional Outputs between, for example, Birmingham and many other places en-route, and from Derby to many other places en-route. It will also be seen that Conditional Outputs work in both directions, e.g. Plymouth to Bristol, and Bristol to Plymouth. One train may also 'carry' passengers in more than one market, for example Long Distance and Regional Urban, or Long Distance and London & South East.

The connectivity Conditional Outputs are expressed as 'journey opportunities' per hour. This recognises the fact that it is impractical to provide direct trains between all origin/destination pairs due to the number of train services this would require, even taking into account the possibility of trains joining and dividing en-route.

Figure 4.1: Long Distance Market Study Conditional Outputs



	Bristol	Bath Spa	Bournemouth	Exeter	Gloucester	Oxford	Plymouth	Portsmouth	Reading	Swindon	Truro*	Birmingham	Cardiff	Edinburgh	Glasgow	Leeds	Leicester	Liverpool	London	Manchester	Newcastle	Nottingham	Sheffield
Bristol																							
Bath Spa																							
Bournemouth																							
Exeter	C/F																						
Gloucester																							
Oxford		C/F																					
Plymouth				C/F																			
Portsmouth																							
Reading																							
Swindon	E																						
Truro*				C			C																
Birmingham	B/E	C			C/F				C	C													
Cardiff	E				C/F							C											
Edinburgh												B											
Glasgow												B											
Leeds	C					C			C			A	C	B	B								
Leicester									C			D	C			B/E							
Liverpool										C		B/E		C	C	B/E	C						
London	A	B		B	B		B				C	A	A	A	A	A	A/D	A					
Manchester	B				C	C			C	C		A/D	B	B	B	DD	C/F		A				
Newcastle												B		B	C	B		B	A	B			
Nottingham						C			C	C		A/D				B/E	E	C	A	C/F			
Sheffield	C				C							B/E	C			D	C/F	B/E	A	DE			

* Truro has been used as a proxy for Cornwall on the basis that it is a single functioning economic area and therefore analogous to city-region

Key					
	Distance	Aspiration	Description	Illustrative service characteristics	
				End to end journey speed	Opportunities to travel
A	> 100 miles	Best possible future	Very fast	160 mph	3 or 4 per hour
B	> 100 miles	Best current	Intercity	100 mph	2 or 3 per hour
C	> 100 miles	Good current	Interurban	80 mph	1 or 2 per hour
D	< 50 miles	Best possible future	High frequency interurban	At least 60 mph	5 or 6 per hour
E	< 50 miles	Best current	Medium frequency interurban	60 mph	3 or 4 per hour
F	< 50 miles	Good current	New interurban connection	45 mph	1 or 2 per hour
A/D	Between 50 and 100 miles	Best possible future	Route Study to determine whether to use outputs related to under 50 miles or over 100 miles		
B/E	Between 50 and 100 miles	Best current			
C/F	Between 50 and 100 miles	Good current			
	Any	Maintain existing level of service			
	Short distance and/or a high proportion of commuters, considered in the Regional Urban Passenger Market Study				
	Short distance and/or a high proportion of commuters, considered in the London and South East Passenger Market Study				
	Outside the scope of this Market Study, will be considered in the Scotland Route Study				

The above outputs are a guide for the rest of the Long Term Planning Process and should be taken to mean "as fast and frequent as operationally feasible given value for money and affordability.

However, there is a general Conditional Output to at least maintain the same level of service as anticipated in the 2019 baseline. Therefore, the ITSS would normally maintain a direct service where one already exists. The major exceptions to this are flows affected by High Speed Two (HS2). HS2 Phase 1 is taken as a committed scheme for the purposes of the LTPP. There are many flows where HS2 will provide a faster and/or more frequent link than currently; this includes locations off the HS2 infrastructure which are proposed to be served by classic-compatible trains. For example, HS2 trains between Birmingham and York may replace such trains on the classic network.

As well as describing connectivity Conditional Outputs between major towns and cities of Great Britain, the passenger Market Studies also describe connectivity to and from international gateways such as medium/large Airports and HS2 stations. In practical terms, cross-boundary services to large airports most pertinent to the Western Route Study are for journeys to and from Heathrow Airport and Gatwick Airport.

It should be noted that both the Cross-Boundary ITSS and the Western Route Study ITSS are not constrained by, for example, network capacity or considerations of rolling stock.

Splitting and joining of trains has been minimised due to the implications on journey time and performance. However where required, it is considered acceptable towards either end of a train's journey rather than mid-route.

It should be noted that demand in the longer term is subject to a degree of uncertainty and intermodal freight demand in particular is predicated on a number of terminals being provided. Due to this uncertainty, and for the purposes of the analysis, freight terminals have been aggregated into clusters so as not to prejudge which freight terminals might be developed.

In addition, the growth in intermodal traffic is likely to continue the trend towards just-in-time deliveries, constraining the times at which such trains operate and reducing some of the flexibility which currently exists to retime trains. Hence, more freight train paths and more daytime freight train movements may be required to carry this kind of traffic than traditional bulk freight.

4.6 Cross-boundary services within and across the Western Route Study Area for the longer term to 2043

The Western Route Study area is served by a number of 'cross-boundary' services, all of which are included within the Western 2043 ITSS. At the end of this section a number of worked examples are provided to show how the Conditional Outputs have been interpreted in practice and how the subsequent train services shown in the 2043 ITSS to accommodate them have been derived.

Anticipated changes in cross-boundary train services at each boundary of the Western Route Study area is as follows:

- Greenford West Junction
  - possible passenger traffic from the **West Midlands and Chilterns Route Study** area to Old Oak Common (HS2)
- Acton Wells Junction
  - increase in intermodal freight traffic
- Portobello Junction (boundary with Crossrail)
  - increase in Crossrail passenger trains on opening of Old Oak Common station (HS2)
- Airport Junction (boundary with Heathrow Airport Limited)
  - changes to passenger services as a result of the opening of the Western Rail Link to Heathrow (anticipated in CP6, subject to funding, a value for money assessment and the agreement with the aviation industry)
- new boundary assumed to be to the west of Heathrow Airport Terminal 5 on the Western Rail Link to Heathrow infrastructure
  - changes to services as a result of the opening of the Western Rail Link to Heathrow (anticipated in CP6, subject to confirmation of funding, a value for money assessment and the agreement of the aviation industry)
- Reading Southern Junction
  - more passenger trains from Gatwick Airport and London Waterloo to Reading

- Basingstoke Junction
  - more long distance passenger trains to Manchester and Newcastle
  - increase in freight traffic, in particular intermodal and automotive from the south coast to the Midlands and North West
- Oxford North Junction (towards Bicester)
  - more regional passenger trains from Oxford to destinations further north and east via East West Rail
  - growth in freight traffic particularly intermodal from the south coast to the East Midlands and beyond, particularly where this is the shortest route or less congested than the alternatives
- Wolvercot Junction (towards Banbury)
  - increase in freight particularly intermodal
- Gloucester West
  - more regional passenger trains between Cardiff, Cheltenham Spa, Birmingham and Nottingham
- Abbotswood Junction
  - passenger trains from South Wales and Swindon to Worcester and beyond
  - more passenger trains from South Wales to the West Midlands and beyond via Birmingham
  - reduction in coal traffic and increase in intermodal freight traffic
- Norton Junction
  - more passenger trains between Oxford and Worcester
- Pilning
  - more long distance passenger trains from London Paddington to South Wales
  - more regional passenger trains from the South Coast and South West England to South Wales
  - reduction in coal traffic and increase in intermodal freight
- Wilton Junction
  - more regional passenger trains from the South Coast to South Wales via Bristol
- Yeovil Junction
  - more passenger trains to Yeovil Pen Mill
- Axminster
  - increase in local passenger trains between Axminster and Exeter St Davids

Freight services are included within the Western Route Study 2043 ITSS and are expressed in the number of Class 4, Class 6 and Class 7 train paths per hour required to meet the forecast growth in demand for movement of freight by rail.

4.7 Worked Examples

4.7.1 Bristol – Birmingham

Even taking into account the simplifications which connections (rather than direct trains) allow, it would still be necessary to include more trains than today to fully meet the Conditional Outputs. For example between Bristol and Birmingham the Long Distance Conditional Output is categorised as a 'B/E' defined as 2 – 3 trains per hour (tph) with an average speed of 100mph, or 3 – 4tph at 60mph. The Freight Conditional Output is defined as a maximum of 3tph.

The anticipated 2019 ITSS is 2tph with an average generalised speed (i.e. including waiting time) of 61mph. To fully meet the Conditional Output requires at least one more train to be added (and/or a significant improvement in average speed on a curvaceous route).

Note that the Conditional Outputs are a guide to the overall Generalised Journey Time (GJT) desired. Thus GJT may be improved by combinations of faster trains, more trains or better connections. For more information regarding GJT please refer to Chapter 3.

It is also necessary to make further assumptions in order to keep the number of trains in the specification manageable. Further examples will illustrate this.

4.7.2 Cardiff/Bristol – Birmingham

Alongside the Bristol – Birmingham connectivity Conditional Output of B/E, the Cardiff – Birmingham connectivity Conditional Output is 'C' (which equates to 1 – 2tph at 80mph), but there is only one train per hour in the anticipated 2019 ITSS (which continues to Nottingham). This implies one additional Cardiff – Birmingham train is required each hour. Taken alongside the Bristol - Birmingham Conditional Output as presented above, this implies up to three additional trains between Bristol/Cardiff and Birmingham, a doubling of the current number of trains. The Freight Conditional Output is defined as a maximum of 2tph from Wales, increasing 3tph from north of Bristol Parkway to meet the 2043 Conditional Outputs.

By routeing 2tph Cardiff – Birmingham via Bristol Parkway (which is in the Bristol demand zone), in addition to the existing 2tph Bristol - Birmingham and 1tph Cardiff – Birmingham, would allow the quantum aspect of the 2043 Conditional Outputs to be met by adding two trains rather than three, providing 3tph Cardiff – Birmingham and 4tph Bristol – Birmingham (note, however, that this would be constrained by available capacity).

This may seem like overprovision, but there are other connectivity Conditional Outputs to take into account such as:

- Cardiff – Leeds (C = 1 – 2tph at 80mph)
- Cardiff – Manchester (B = 2 – 3tph at 100mph)
- Bristol – Leeds (C = 1 – 2tph at 80mph)
- Bristol – Manchester (B = 2 – 3tph at 100mph).

There could also be Conditional Outputs driven by capacity requirements in order to accommodate predicted demand which may drive additional peak services. These are not incorporated in the cross-boundary ITSS as this is for the off-peak period.

4.7.3 Cardiff/Bristol – Birmingham – Manchester/Leeds

Assuming that Leeds and Manchester cannot be served by the same train from Cardiff (or Bristol) due to the extended journey time implied, then 3 – 5tph from Cardiff and 3 – 5tph from Bristol are implied to serve Leeds and Manchester. If run as separate trains, this equates to 6 – 10tph from Cardiff/Bristol to Birmingham and beyond (before allowing for any other places such as Swindon to generate a requirement for additional trains). The extra 3 – 7tph would be impractical and uneconomic from a service provision perspective, even before network capacity constraints are taken into account.

Routeing of the additional 2tph Cardiff – Birmingham via Bristol Parkway allows these diverse market needs to be met at a net cost of two extra trains, i.e.:

- 1tph Cardiff – Bristol Parkway – Leeds
- 1tph Cardiff – Bristol Parkway – Manchester
- 1tph Bristol – Leeds (as 2014)
- 1tph Bristol – Manchester (as 2014)
- 1tph Cardiff – Birmingham – East Midlands (as 2014)
- 1tph Cardiff – Manchester via Welsh Marches (as 2014).

Therefore, combining the Conditional Outputs onto a number of services allows the diverse markets to be met by a lower net number of trains. This is summarised in Figure 4.2, below, for this corridor.

Figure 4.2: Summary of how the Western Route Study 2043 ITSS meets the Conditional Outputs in the example		
Flow	**Long Distance Market Study Conditional Output**	**Western Route Study 2043 Indicative Train Service Specification**
Cardiff – Leeds	C = 1-2tph at 80mph	1tph direct, also 1tph changing at Bristol Parkway
Cardiff – Manchester	B = 2-3tph at 100mph	2tph direct, also 1tph changing at Bristol Parkway
Cardiff – Birmingham	C = 1-2tph at 80mph	3tph direct, also 2tph changing at Bristol Parkway
Bristol – Leeds	C = 1-2tph at 80mph	2tph direct
Bristol – Manchester	B = 2-3tph at 100mph	2tph direct
Bristol – Birmingham	B = 2-3tph at 100mph	4tph direct

4.8 Routeing Options

The potential routeing of trains north of Birmingham also reveals two further features, namely the impact of HS2, and the requirement for routeing options.

North of Birmingham, there may be the opportunity to use HS2 infrastructure to accelerate trains that have come from the south or west of Birmingham towards Leeds and Manchester. However this is not part of the consulted HS2 Phase 1 scheme (for further information reference the following link: HS2), and would require additional infrastructure in the Birmingham area to connect the classic and high-speed lines. Thus, there are two routeing options north of Birmingham shown on the Cross-Boundary ITSS, using either classic or high-speed infrastructure.

4.9 Choices for Funders

Emerging industry thinking indicates that within the Western Route Study area, there are a number of choices for funders regarding cross-boundary routeing. Those related to HS2 are set out in Section 4.8 above. In addition, the emerging development of proposals for the East West Rail Link will present some opportunities which funders may wish to take forward.

4.10 Ongoing Process

The Cross-Boundary ITSS is unconstrained and is provided as an input to the Route Study, which seeks to accommodate it alongside trains that run purely within the Western Route Study area.

Where it is not possible to accommodate all trains on the 2019 baseline infrastructure using the rolling stock assumptions then Route Studies can:

- use different rolling stock assumptions and/or longer trains
- re-route, or
- consider the case for additional infrastructure.

Where these affect cross-boundary trains (passenger or freight) then it is important to work with all the other Route Studies to ensure that assumptions are consistent on routeing, rolling stock type and length (in terms of accommodating demand but also platform lengths) and to inform the Cross-Boundary Working Group on any differing requirements.

Where a value for money business case is being made for infrastructure to accommodate cross-boundary trains, then it is important to work with other Route Studies to ensure that all costs are captured on the line of route.

This is managed by the Cross-Boundary Working Group.

4.11 Summary

This chapter has outlined how the cross-boundary process has been developed for both passenger and freight services, how it has been applied in the Western Route Study, as well as the broad range of services which are included within it, which are set out in detail in the Cross-Boundary 2043 ITSS. It also presents a number of worked examples to set out how the approach works.

05 Accommodating the Conditional Outputs - Choices for Funders

This chapter presents the choices available for funders to accommodate the Conditional Outputs to 2043 and for Control Period 6. The chapter builds on the Conditional Outputs interpretation work detailed in Chapter 3 and presents choices on a Route Section basis considering:

- the specific capacity and/or connectivity Conditional Output
- baseline infrastructure and train service patterns
- system capability constraints
- making best use of capacity
- an outline of potential choices.

5.1 Process

Following the interpretation of the Market Studies Conditional Outputs into a Western Route Study perspective, the process consisted of two initial and concurrent strands of activity:

- construction of a 30-year Indicative Train Service Specification (ITSS)
- development of passenger and freight forecast demand.

The ITSS for 2043, as presented in Chapter 3, was produced using the connectivity Conditional Outputs. Constraints were identified by overlaying this onto the anticipated 2019 baseline infrastructure. Alongside this, the established growth forecasts from the Market Studies were interpreted to ascertain passenger and freight demand for the Western Route over the next 10 (2023) and 30 years (2043) and an assessment of the requirements to accommodate this was undertaken.

Scenario planning exercises were undertaken to explore options for making best use of the existing infrastructure to accommodate the Conditional Outputs. These choices are presented in the following Route Section assessments. Where the existing infrastructure was found to be constrained, choices to relieve the constraints have been developed and consider the particular trade-off of requirements versus interventions. This presents a number of choices for funders.

For the purposes of presentation and analysis, the geographical scope area of the Western Route Study has been divided into 16 Route Sections, with Conditional Output requirements and constraints identified per Route Section. The pattern of services operated necessitate that there is a degree of overlap when considering adjoining Route Sections.

The Route Sections are presented in Figure 5.1 and Figure 5.2.

Figure 5.1: Western Route Study Route Sections

Reference	Route Section	Reference	Route Section	Reference	Route Section
A.	London Paddington – Reading (inclusive)	J.	[Bristol Parkway – Pilning]**	O.	Exeter area, defined by limits at: • Barnstaple • Axminster (boundary with Wessex Route Study) • Exmouth • Paignton • Newton Abbot • Cogload Junction (north of Taunton).
B.	Thames Valley branches east of Reading, namely: • West Ealing – Greenford • Southall – Brentford Goods • West Drayton - Colnbrook • Slough – Windsor & Eton Central • Maidenhead – Marlow • Twyford – Henley-on-Thames	K.	Westbury – Salisbury		
		L.	Swindon – Westbury		
		M.	Greater Bristol area, defined by limits at: • Pilning (Severn Tunnel) (boundary with Welsh Route Study) • Bristol Parkway • Thingley Junction (west of Chippenham) • Bradford Junction (between Bradford-on-Avon and Trowbridge) • Cogload Junction (north of Taunton).	P.	Newton Abbot – Penzance and Cornish branches: • St Budeaux Ferry Road – Gunnislake (via Bere Alston) • Liskeard – Looe • Par – Newquay • Truro – Falmouth Docks • St Erth – St Ives.
C.	Reading – Basingstoke (boundary with Wessex Route Study)				
D.	[Reading – Gatwick Airport]*				
E.	Reading – Taunton (the Berks & Hants line)				
F.	Castle Cary – Dorchester				
G.	Reading – Oxford				
H.	Oxford – Worcester (boundary with West Midlands & Chilterns Route Study at Norton Junction)	N.	Worcester – Bristol Parkway and Gloucester – Swindon		
I.	Didcot Parkway – Bristol Parkway				

* Route Section D Reading to Gatwick Airport is addressed as part of the **Wessex Route Study** which covers the routes out of London Waterloo and branches.

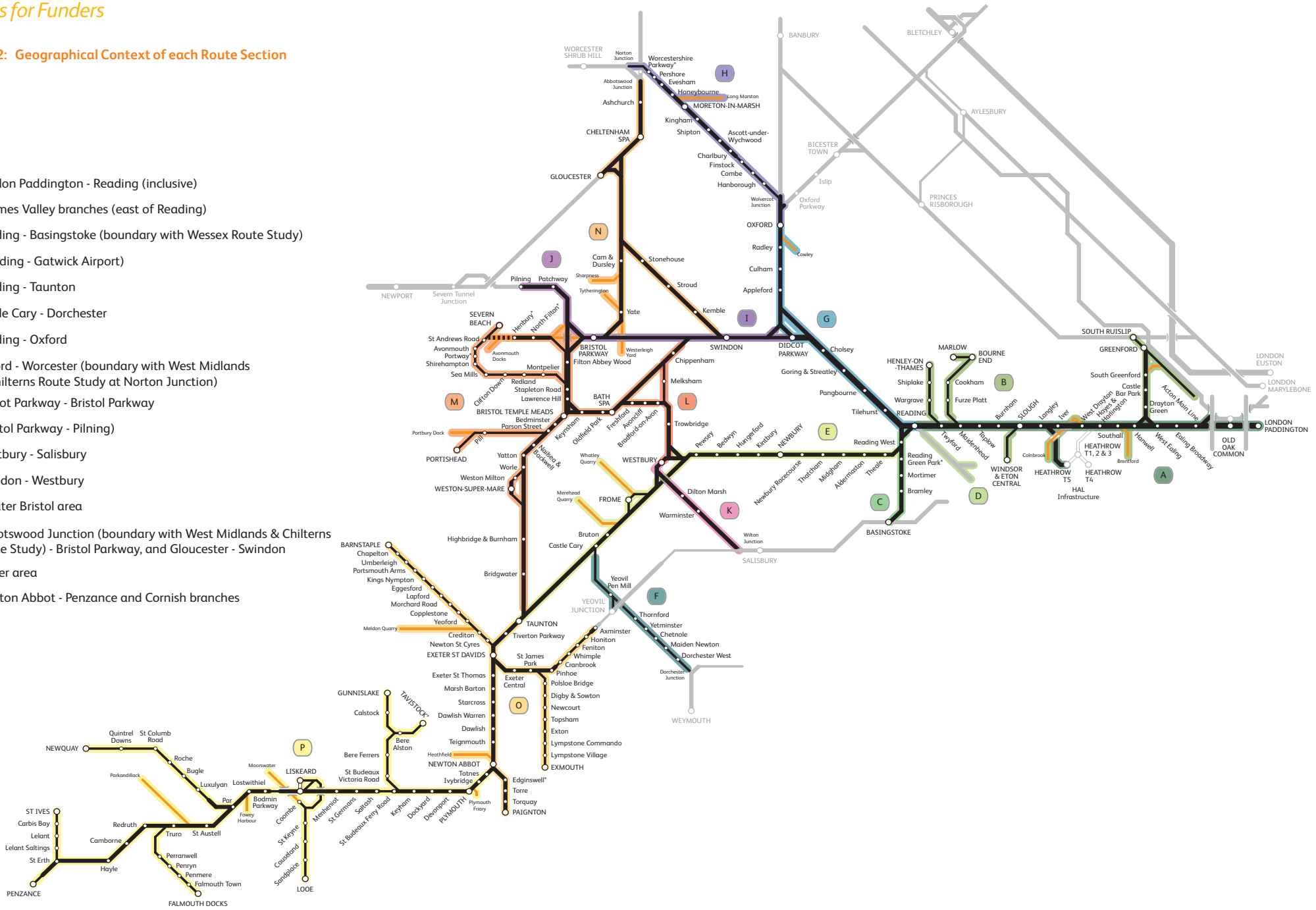
** Route Section J Bristol Parkway to Pilning is incorporated in the **Welsh Route Study** which covers the routes in Wales and its borders including the Severn Tunnel.

05 Accommodating the Conditional Outputs - Choices for Funders

Figure 5.2: Geographical Context of each Route Section

Key

- A London Paddington - Reading (inclusive)
- B Thames Valley branches (east of Reading)
- C Reading - Basingstoke (boundary with Wessex Route Study)
- D (Reading - Gatwick Airport)
- E Reading - Taunton
- F Castle Cary - Dorchester
- G Reading - Oxford
- H Oxford - Worcester (boundary with West Midlands & Chilterns Route Study at Norton Junction)
- I Didcot Parkway - Bristol Parkway
- J (Bristol Parkway - Pilning)
- K Westbury - Salisbury
- L Swindon - Westbury
- M Greater Bristol area
- N Abbotswood Junction (boundary with West Midlands & Chilterns Route Study) - Bristol Parkway, and Gloucester - Swindon
- O Exeter area
- P Newton Abbot - Penzance and Cornish branches



5.2 Route Section Analysis

Each Route Section has been analysed in terms of the anticipated 2019 baseline infrastructure and its ability to accommodate capacity and capability requirements. Using this information, choices for funders have been developed to enable the Conditional Outputs to be accommodated and these are presented in specific Route Sections of this chapter.

A longer-term strategy to 2043 has been developed based on accommodating the Conditional Outputs with a prioritised context for Control Period 6 (CP6, 2019-2024). To identify the strategy for CP6, the longer-term requirements have been prioritised, the process of which has been based on the following Long Term Planning Process (LTPP) agreed prioritisation criteria:

- the intervention is required to meet forecast passenger and/or freight demand in CP6
- there is a renewals opportunity during CP6 which provides the lowest Whole Life Cost option for delivery
- the intervention reduces whole-industry costs
- the intervention is indicated to be a funder priority
- the intervention is required for better connectivity to High Speed Two (HS2).

In reviewing the choices proposed, the following caveats need to be considered:

- all work undertaken is high level and as such is at an early stage of development (in terms of Network Rail's 'Governance for Railway Investment Projects' it would be referred to as 'pre-GRIP')
- indicative cost ranges are provided for interventions where known. This indicative cost is the Anticipated Final Cost based on 2013 prices
- value for money assessments are undertaken for proposed CP6 interventions only and presented as choices for funders. These are presented in Appendix D, the choices for CP6 have been appraised from a rail industry financial impact and socio-economic perspective. These choices have been categorised into those that:
  - worsen the rail industry's net operating position (in other words, the additional operating costs exceed the value of revenue generated); or
  - improve the industry's net operating position. For these schemes, the Route Study also indicates the extent to which this improvement is able to cover the capital cost of the initial investment
- the appraisal methodology used includes the recent procedural changes (August 2014) recommended by the Department for Transport (DfT).

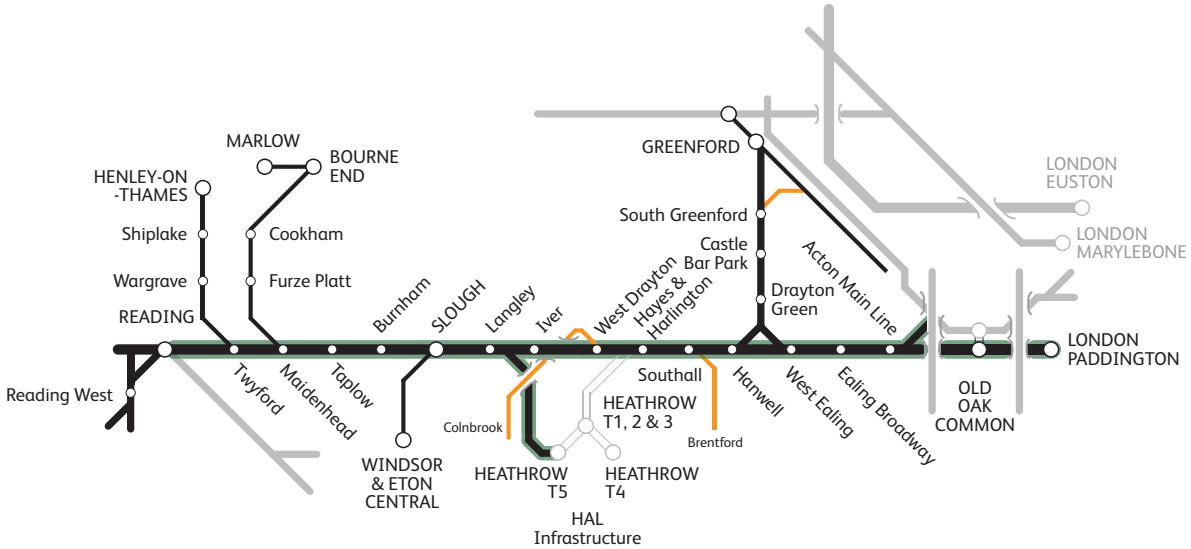
This chapter presents each Route Section identifying the anticipated 2019 baseline, making best use of baseline infrastructure, and any interventions identified for CP6 and 2043 in order to accommodate the Conditional Outputs. Additional details on the Conditional Outputs can be found in Chapter 3.

Other Conditional Outputs that the Route Study seeks to accommodate are also described further in this chapter under Section 5.3.2.

For information outlining the current infrastructure for each Route Section please refer to the **Western Route Specification**. Further detail on current and proposed 2019 baseline schemes is available in the Network Rail **Control Period 5 Delivery Plan**.

Route Section A: London Paddington – Reading

Figure 5.3: Route Section A: London Paddington – Reading (inclusive)



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- renewal of signalling equipment
- Overhead Line Electrification (OLE) of all lines between London Paddington and Reading and three of the Thames Valley branches (excluding Greenford), allowing electric trains to operate on these routes:
  - London to Oxford, Newbury, Bristol Temple Meads (via both Bristol Parkway and Bath Spa) and South Wales
  - Slough – Windsor & Eton Central
  - Maidenhead – Marlow
  - Twyford – Henley-on-Thames.
- Intercity Express Programme (IEP) introduces either electric or bi-mode rolling stock for long distance services from London Paddington to Worcester, Cheltenham Spa, Bristol and South Wales
- introduction of Crossrail services from Reading eastwards to central London and beyond
- depot and maintenance facilities for Crossrail at Old Oak Common and IEP at North Pole, with a potential new depot at Langley (under consideration)
- provision of Western Rail Link to Heathrow (WRLtH) consisting of a new, electrified railway from a new junction near Langley to Heathrow Airport (scheduled for completion during CP6 subject to confirmation of funding, value for money assessment, and the agreement of acceptable terms with the aviation industry).

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

Main Line trains:

- 4tph London Paddington – Heathrow Terminal 5
- 1tph London Paddington – Oxford
- 1tph London Paddington – Newbury
- 1tph London Paddington – Cheltenham Spa
- 1tph London Paddington – Worcester Foregate Street via Oxford
- 4tph London Paddington – Bristol Temple Meads (2tph via Bath Spa, and 2tph via Bristol Parkway with 1tph extended to Weston-super-Mare)
- 2tph London Paddington – South Wales
- 1tph London Paddington – Westbury (with two-hourly extensions to Exeter St Davids)
- 1tph London Paddington – Exeter or beyond.

Relief Line trains:

- 4tph London Paddington Crossrail – Heathrow Terminal 4 (extending beyond Paddington through the Crossrail tunnels to central London and beyond)
- 2tph London Paddington Crossrail – Maidenhead
- 2tph London Paddington Crossrail – Reading
- 2tph London Paddington – Reading or beyond (residual semi fast outer suburban service operating on the Relief Lines using the existing London Paddington Station)
- 4tph Heathrow Terminal 5 - Reading (anticipated implementation during CP6)
- 4tph Freight.

During peak hours, a number of additional passenger services operate over this Route Section to carry high passenger volumes into and out of London Paddington, which include additional peak services from West Drayton, Oxford and Reading.

There are a number of additional services that operate at an ad-hoc frequency during the day such as the service from South Ruislip into London Paddington, charter trains and engineering trains (including measurement and test trains).

A significant volume of freight runs through parts of the London Paddington to Reading route section comprising aggregate, petroleum, waste, steel, automotive and intermodal traffic. The level of traffic varies across the day, with up to four freight trains per hour running in each direction on the busiest section outside the peak (with a reduced number of services operating in the passenger peak periods).

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section are presented in Figure 5.4.

Figure 5.4 Reference	Western Route Study Conditional Output
CO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – inner suburban services (Relief Line and Thames Valley branches)
CO2	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – Main Line services

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **London & South East and Long Distance Market Studies**. Details can be found in Figure 5.5.

Figure 5.5: Interpretation of Passenger Connectivity Conditional Outputs

Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
From the Cross-Boundary ITSS	London Paddington – Worcester	2 to 3tph at 100mph	2tph (1tph via Cheltenham)
From the Cross-Boundary ITSS	London Paddington – Cardiff	3 to 4tph at 160mph	4tph
From the Cross-Boundary ITSS	London Paddington – Swansea	2 to 3tph at 100mph	2tph
CO20	London Paddington – Bristol	3 to 4tph at 160mph	4tph
CO43	London Paddington – Bath	2 to 3tph at 100mph	2tph
CO76	London Paddington – Gloucester*	2 to 3tph at 100mph	1tph
CO103	London Paddington – Exeter	2 to 3tph at 100mph	3tph
CO114	London Paddington – Plymouth	2 to 3tph at 100mph	2tph
CO123	London Paddington – Penzance**	1 to 2tph at 80mph	1tph

* The Gloucester zone in the **Long Distance Market Study** includes Cheltenham.

** The Truro zone in the **Long Distance Market Study** includes the whole of Cornwall.

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study ITSS, shown in Figure 3.32 , (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as follows:

- **Long Distance Market Study** (LDMS): ITSS delivers the connectivity Conditional Outputs in terms of opportunities to travel each hour
- **London & South East Market Study**: the 30 – 40 minute travel time radius has been taken to apply to stations between London Paddington and Taplow or Heathrow Airport. The ITSS provides four journey opportunities per hour by stopping services from London Paddington to Taplow or Heathrow Airport
- the outer suburban services have been taken to include those to Reading, Oxford and Newbury.

These Conditional Outputs reflect the emerging requirements for capacity and connectivity over this Route Section building on the substantial volume of planning and specification that culminated with the publication of the **London & South East RUS** (July 2011). The Western Route Study has sought to refine previous analysis, using outputs from the established Market Studies, in the context of continuing development of major interventions such as Crossrail, Electrification and HS2.

Two points in particular on the Western Route Study interpretation of the connectivity Conditional Outputs are worth noting for this Route Section:

- London Paddington to Cheltenham/Gloucester

The LDMS Conditional Output is for two journey opportunities per hour. However, the Gloucester zone in the LDMS also includes Cheltenham Spa. Within the Western Route Study, it is proposed this output could be delivered by providing one London Paddington – Gloucester and one London Paddington – Cheltenham Spa train each hour (extending to Worcester, see below). This could allow the service to Cheltenham Spa to be improved by potentially avoiding reversal at Gloucester, which may reduce journey times to/from Cheltenham Spa by at least 12 minutes in each direction.

Additional journey opportunities could be available by changing at Gloucester/Birmingham (for Cheltenham Spa), or Cheltenham Spa/ Birmingham (for Gloucester) recognising the significant journey time improvement between Birmingham and London due to HS2 which could provide additional and potentially faster journey opportunities.

- London Paddington to Worcester

The LDMS Conditional Output is for two journey opportunities per hour. The Cross-Boundary ITSS has options for an additional train to run via Oxford or via Cheltenham Spa. Within the Western Route Study, it is proposed that the additional train is routed via Cheltenham for the following reasons:

- to avoid the already-congested Didcot – Oxford corridor (See Route Section G) and single line sections on the North Cotswold route (see Route Section H)
- to improve connectivity between Worcester, Swindon and the south west
- as an efficient way of delivering the Conditional Output which makes best use of existing infrastructure, by extending the London Paddington – Cheltenham Spa services and providing a comparable journey time to the other routeing option via Oxford.

However, this is only one possible means of meeting the Conditional Output interpreted by the Western Route Study. It would be possible to route the additional train via Oxford should improvements be made to the North Cotswold route; a train routed that way could potentially offer faster journey times than via Cheltenham.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand which is presented in Chapter 3.

The freight forecasts for this route section are affected by the revised construction traffic forecasts produced since the publication of the **Freight Market Study** (FMS); these are presented in Chapter 3. The implied changes to the train path requirements for 2043 are presented in the table below for the busiest point on this Route Section to the east of West Drayton):

Figure 5.6: Construction Traffic Forecasts

Train type	Freight Market Study (as used in the Draft Route Study)	With revised construction traffic forecasts
Class 4	2tph	2tph
Class 6 or Class 7	2tph	6tph

The effect of the latest forecasts is such that for 2023 it is anticipated that the traffic can be accommodated with a better utilisation of the standard four off-peak paths per hour provided as part of the 2019 ITSS. As described in Chapter 3, the Route Study does not assess the full impact of these forecasts to 2043 as this will be addressed via subsequent planning cycles.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Changes to the Indicative Train Service Specification to 2043

Between 2019 and 2043 it is anticipated that there will be a number of further service changes. Consequently, the following changes are anticipated beyond the 2019 ITSS subject to future planning cycles:

Relief Lines:

- extension of 2tph Crossrail beyond Maidenhead to Reading.

The above is in addition to the 4tph Heathrow Terminal 5 – Reading introduced upon the opening of WRLtH, anticipated to occur during CP6, and assumed in the 2019 baseline.

Main Lines:

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes requirements for the following additional services:

- 1tph London Paddington – Gloucester
- 2tph London Paddington – Cardiff
- 1tph London Paddington – Exeter or beyond.

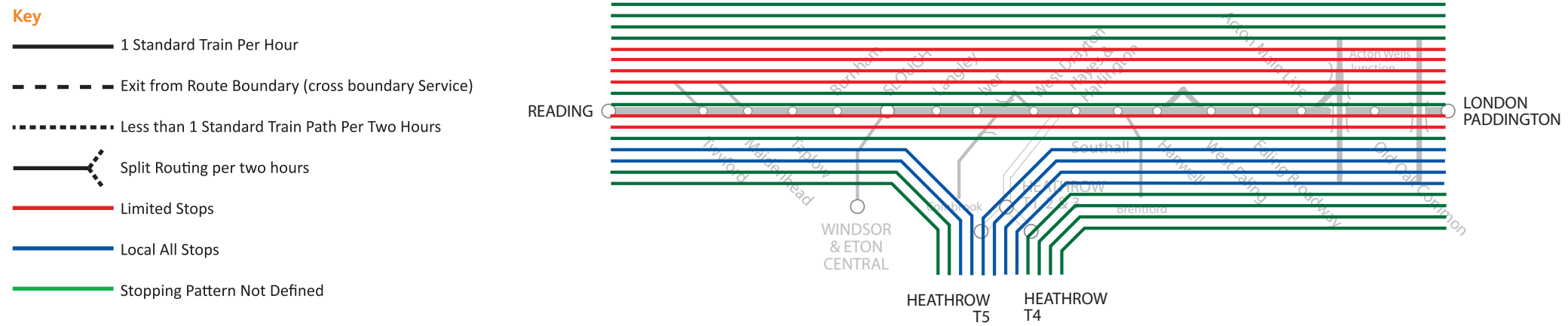
Upon the introduction of HS2 and the new station at Old Oak Common, it is likely that further potential service changes will occur.

To accommodate the capacity Conditional Outputs, analysis anticipates that two additional high-peak Main line services (or equivalent capacity) are likely to be required to accommodate rail passenger demand between London Paddington and Swindon in CP6. Should these services be implemented, they would be additional to the ITSS for 2043.

The FMS forecasts the requirements of four standard freight paths per hour (2tph Class 4 paths and 2tph Class 6 or Class 7 paths) between Reading and London which are anticipated to be provided in 2019 and will be sufficient to cater for growth to 2023.

The impact of excavated material and construction traffic for HS2 may increase these requirements during the construction period. HS2 Limited will continue to review its strategy and work with Network Rail in defining outcomes.

Figure 5.7: 2043 Indicative Train Service Specification London Paddington – Reading



System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements identifies the following emerging constraints on the 2019 baseline infrastructure (not in any order of priority):

- Main Line capacity and utilisation, on the whole route - in particular east of Airport Junction
- Relief Line capacity and utilisation given variation in passenger train stopping patterns and freight services
- variation in rolling stock capability with mixed rolling stock characteristics as expressed in acceleration and maximum speeds
- platform capacity at London Paddington
- junction capability at Ladbroke Grove (on the approaches to London Paddington)
- capacity and platforming constraints within Heathrow Airport Limited infrastructure, notably the Central Terminal Area Station with its junction connections to Terminal 4
- platform capacity at Reading Station could become a constraint if additional terminating services are specified, including WRLtH services, beyond those for which the station was designed
- provision of, and access to, suitably located train stabling and maintenance facilities to allow efficient use of system capacity and resources
- high passenger volumes and station capacity at London Paddington Station as a result of predicted growth.

Making Best Use of Capacity

Analysis carried out by Network Rail has shown that in 2019 the Route Section will already be considerably constrained with minimal capacity to operate additional train services, or to modify calling patterns beyond those already anticipated in the 2019 baseline without an adverse impact on journey times.

In order to make best use of the existing system capacity, consideration has been given to optimising use of the available capacity by:

- harmonising train speeds and rolling stock capabilities to make best use of the linespeed profile
- optimising calling patterns to support the delivery of overall market requirements
- the ability to handle high passenger volumes at origin and destination stations, especially at London Paddington and Reading
- minimising conflicts caused by trains crossing or merging from one line to another
- increasing train length and train occupancy to match capacity to demand better
- a considered view to the resilience of the overall train plan.

Applying these principles presents the following choices to make best use of existing capacity. This list may not be exhaustive and is not necessarily in priority order:

- A1a: Separation of Main and Relief Line passenger services
- A1b: Options to serve Heathrow Airport using the Relief Lines
- A2: Optimising service provision and connectivity with anticipated future developments
- A3: Alterations to anticipated calling patterns to accommodate demand
- A4: Improving freight rolling stock capability.

Each of these choices is now addressed in further detail:

A1a: Separation of Main and Relief Line passenger services

- Capacity analysis suggests that long distance capacity and connectivity requirements could be accommodated better through continued optimisation of network capacity.

- Operationally separating the railway into dedicated Main and Relief Lines for long distance non-stop and intermediate calling services respectively could release valuable Main Line capacity. The Main Lines could be the primary routeing for fast non-stop services between London Paddington and Reading, and the Relief Lines could accommodate all other passenger services and freight.
- At present, principally in the peak hours, a number of passenger services cross between the Relief and Main Lines resulting in more intense use of the Main lines closer to London Paddington, restricting the number of fast trains that could run from Reading and beyond.
- Optimising the use of the Main Lines could support additional capability that could address the growth forecast as part of the Market Studies, and support delivery of the long term connectivity Conditional Outputs.
- However, there would be a journey time impact for those peak passenger services that cross from the Relief Lines to the Main Lines. It is unlikely that these services could be maintained in the longer term without further infrastructure as demand for additional long distance capacity increases. See Option A18.

A1b: Options to serve Heathrow Airport using the Relief Lines

- Optimising Main Line passenger capacity could be achieved through the utilisation of paths for long distance services rather than dedicated airport services. This supports the principle of harmonising rolling stock types and maximising the passenger capacity of the Main Lines by allowing longer trains to run that carry more passengers, particularly in the peak periods.
- The current track access agreement governing the operation of the Main Line express airport services runs to 2023. The terms of any subsequent agreement will be subject to standard industry track access agreement processes regulated by the Office of Rail and Road (ORR).
- Currently express airport services run every 15 minutes on the Main Lines between London Paddington and Airport Junction. Serving Heathrow Airport solely from the Relief Lines could release capacity on the Main Lines for up to four additional long distance trains each hour. Optimising the use of the Main Lines could support additional capability that could address the growth forecast as part of the Market Studies. It could also support delivery of the long term connectivity Conditional Outputs and short term capacity requirements. In 2019 it is anticipated that there are four London Paddington – Terminal 5 services, plus four Crossrail trains to Terminal 4 trains each hour. This equates to eight trains per hour, with a journey time of between 15 and 23 minutes to the Central Terminal Area.
- Capability analysis identifies that eight passenger services per hour could be accommodated on the existing Relief Line infrastructure; subject to further assessment. Analysis provided by Transport for London shows that there would be a positive Generalised Journey Time (GJT) impact for passengers travelling between points east of London Paddington and Heathrow Airport who currently use the London Underground network to reach London Paddington. There would be a small negative GJT impact for those who continue to interchange at Paddington Station with other modes, e.g. walk and taxi.
- Analysis provided by Heathrow Airport Limited shows the following potential impacts:
  - Mode share – analysis shows that a combination of express and Relief Line services provides the highest rail and overall public transport mode share. Removal of the fast services could increase car trips to and from the airport and related emissions
  - Passenger experience – passengers value the speed and reliability of the current express service. Removing this will reduce passenger experience and reduce choice for travelling to Heathrow Airport by rail
  - Resilience – a mix of services by different operators could offer better resilience and ensures that the airport can continue to provide public transport alternatives during times of disruption due to incidents, maintenance or industrial action
  - Economic value – Heathrow Airport is an important asset and engine for growth generating jobs and global opportunities. Business passengers from both the UK and abroad particularly value the express service, with two thirds of its passengers travelling on business.

A2: Optimising service provision and connectivity with anticipated future network developments

- network electrification and future developments such as East West Rail offer the opportunity to introduce new direct journey opportunities to locations on this Route Section, including Heathrow Airport, through the linking of services
- such service provision would optimise system utilisation as well as meeting market needs
- preliminary timetable analysis suggests that running services through Reading could enhance connectivity and reduce platform occupancy on the Relief Line side of Reading Station
- options will arise to connect the proposed East West Rail service and other services with Heathrow Airport to provide the optimum level of service and connectivity.

A3: Alterations to anticipated calling patterns to accommodate demand

- the use of train capacity could be optimised to accommodate rail passenger demand through alterations to the anticipated 2019 ITSS. This could allow long distance services to call additionally in the peak at stations such as Reading, Newbury, Didcot Parkway and Swindon. Although this could provide additional capacity, it is not sufficient on its own to accommodate all predicted rail passenger demand. Such additional calls may also be inconsistent with the reduced inter-urban journey time outputs anticipated by the Intercity Express Programme.

A4: Improved freight rolling stock capability

- Class 7 freight trains operate between the Mendip Quarries and London. Some of these wagons are restricted to 45mph whilst others have the capability to operate at 60mph
- capacity analysis has shown that due to the differences in running times on the Relief Lines, Class 7 (45mph) freight paths result in insufficient capacity to operate the anticipated eight passenger services per hour (4tph between Reading and London Paddington and 4tph between Reading and Heathrow Airport). The Relief Lines cannot accommodate the 8tph frequency of passenger trains west of Langley in the hours that a Class 7 freight train also operates
- to enable current Class 7 freight paths to be substituted with faster Class 6 (60mph) paths carrying the same tonnage, consideration could be given to upgraded or new freight rolling stock thereby reducing the speed differential between passenger and freight services on the Relief Lines east of Reading
- further analysis would be required to demonstrate any capacity benefits given the increased acceleration and deceleration distances required for freight services of this length and weight.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, a subset of the longer-term requirements have been identified, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand:
  - analysis for the Route Study shows that Main Line capacity will be insufficient in 2023 for forecast peak passenger demand
  - in addition to options A1-A3 above, there is scope for accommodating rail passenger demand by train lengthening and through the provision of additional services. Both methods of intervention require increased expenditure so are subject to a value for money assessment presented in A5-A7 and A9
  - freight demand is expected to increase on this Route Section; however it is anticipated that the growth will be accommodated within the four standard opportunities each off-peak hour included in the 2019 ITSS during CP6.
- connectivity to HS2. The HS2 station at Old Oak Common will provide access to fast services towards the Midlands and North and is anticipated to open in 2026. This is likely to lead to an increase in rail passenger demand towards London Paddington as journeys from Reading to Manchester, for example, could be faster via HS2 with an interchange at Old Oak Common than by using the existing cross-country route

- current proposals for the layout will require all Main (and Relief) Line trains to call at Old Oak Common Station. There is also likely to be an impact from the construction of HS2 which may temporarily drive requirements for an increase in freight paths, or bring forward longer term requirements
- renewals opportunities. The renewal of Ladbroke Grove Junction and the approaches to London Paddington is forecast, following life extension work in CP5. The forecast increases in demand for both passengers and freight, and in the context of wider network optimisation, provides an opportunity to improve the layout on the approach to London Paddington. Grade separation of Ladbroke Grove Junction would increase the capability of the whole system, reducing the level of conflicting train movements creating greater timetable capability, increasing flexibility in the platforming and operation of services using London Paddington and associated depots. The intervention is subject to a value for money assessment presented in A13
- the opportunity exists to align the enhancement of Ladbroke Grove Junction and Paddington approaches with the renewal and the opening of the new HS2 station at Old Oak Common. Such an approach could minimise passenger impact while achieving efficient delivery of a system enhancement through alignment with the renewals.

To meet these drivers for change, the following choices have been investigated.

Accommodating rail passenger demand

- A5: Lengthen morning and evening high peak services between London Paddington and Newbury from the anticipated 8-car train formation in the 2019 ITSS to 12-car trains
- A6: Lengthen the morning and evening high-peak West of England long distance services, from 8 -cars to 9- cars.
- A7: Lengthen the morning and evening high-peak semi-fast services between London Paddington and Oxford from the anticipated 8-car train formation in the 2019 ITSS to 12-car trains
- A8: Lengthen Super Express Trains (SETs). Analysis was undertaken of the likely operational costs and capacity benefits from a theoretical lengthening of the SETs, provided as part of the Intercity Express Programme, to 11 or 12-car from the 9 and 10-car peak formations anticipated to operate in 2019. This indicated that value for money may be low due to the cost of procuring additional SET rolling stock, operating and stabling requirements and the potential infrastructure interventions that would be required. This choice has not been developed further at this stage although lengthening of such services remains a choice for funders
- A9: Provide two additional morning and evening high-peak services between London Paddington and Swindon calling at Didcot Parkway and Reading (as an alternative to A8 – lengthening of Super Express Trains)
- A10: Assessment of capacity and capability requirements for Relief Line services to meet emerging demand
- A11/A12: Combined Options of A3, A5, A6, A7 and A9.

Each of the choices is addressed in further detail:

A5: Lengthening high peak services between London Paddington and Newbury	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand between London Paddington and Newbury.
Description	Lengthening the anticipated 2019 high peak 8-car services between London Paddington and Newbury to 12-cars to service both the morning and evening peak rail passenger demand
Indicative Cost	• additional vehicle operating costs for additional rolling stock • accommodating longer trains would require investigation into platform lengthening on a case by case basis
Indicative Value for Money	Very High
Relates to other options	Alternative to A6 - Lengthening of the West of England long distance, high-peak services
Analysis The average Load Factor across peak services between London Paddington and Newbury is predicted to reach 93 per cent by 2023 on departure from Newbury. With train lengthening, the average load factor is anticipated to reduce to 63 per cent. This option, although the same value for money category as the alternative option A6, would remove potential performance implications of operating long distance trains with lengthened formations over the London Paddington – Reading section (see A6). See Appendix D for financial and socio-economic appraisal.	

A6: Lengthening high peak West of England long distance services	
Conditional Output	Capacity
Timeframe	2019 –2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand between London Paddington and stations on the Reading to Taunton Line (via Newbury)
Description of the option	Provision of longer morning and evening high peak services between London Paddington and the West of England increased from the current 8-car to 9-car formations
Indicative Cost	• additional vehicle operating costs • longer trains can be accommodated on the 2019 infrastructure so no platform extensions assumed to be needed for this option
Indicative Value for Money	Very High
Relates to other options	Alternative to A5 - Lengthening high peak services between London Paddington and Newbury
Analysis The average Load Factor across peak services departing Newbury for London Paddington is predicted to reach 93 per cent by 2023. With train lengthening, the average load factor is anticipated to reduce to 86 per cent. Lengthening of the long distance services between London Paddington and the West of England would provide sufficient capacity to accommodate predicted increases in rail passenger demand to 2023 from Newbury into London Paddington. This intervention could offer very high value for money if it is assumed that there are no infrastructure interventions required to accommodate the longer trains; or adverse performance implications arising from their operation which have not been included as part of this analysis. See Appendix D for financial and socio-economic appraisal.	

A7: Lengthening high peak semi-fast services between London Paddington and Oxford	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand between London Paddington and stations on the Oxford-Reading Route Section
Description of the option	Lengthening the anticipated 2019 high peak 8-car semi-fast services between London Paddington and Oxford to 12 cars; in both the morning and evening peaks
Indicative Cost	• additional vehicle operating costs for additional rolling stock • further platform lengthening is likely to be required at some stations on the 2019 infrastructure
Indicative Value for Money	Medium
Relates to other options	None
Analysis The average Load Factor across peak services between Tilehurst and London Paddington is predicted to reach 100 per cent by 2023. With train lengthening, the average load factor is anticipated to reduce to 82 per cent. An alternative to this option is to lengthen to 10-car formations (subject to availability), reducing the associated leasing and operating costs and infrastructure requirements. This option shifts the value for money categorisation from Medium to High. See Appendix D for financial and socio-economic appraisal.	

A8 : Lengthening of Super Express Trains to provide more peak capacity between London Paddington and Swindon	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand between London Paddington and Swindon
Description	Lengthening certain of the anticipated 2019 high peak 9 and 10-car Super Express Train services between London Paddington and Bristol/South Wales to 11 or 12 cars; in both the morning and evening peaks
Indicative Cost	• leasing costs for the additional vehicles required • additional vehicle operating costs for additional rolling stock • further platform lengthening would be required at some stations on the 2019 infrastructure • alterations to depots and other infrastructure
Indicative Value for Money	Not evaluated. Likely to be Poor due to large costs for leasing and alterations to infrastructure to accommodate train lengths greater than 11-cars with 26-metre vehicles
Relates to other options	Alternative to A9: Additional high-peak services between London Paddington and Swindon

Analysis

In order to accommodate the forecast passenger demand into London Paddington from Reading, Didcot Parkway and Swindon, additional capacity will be required as on-train crowding is predicted inward to London from as far as Swindon. The addition of calls during the high peak hour in fast Super Express Train (SET) services could smooth the demand profile but would still not deliver sufficient capacity from Didcot Parkway and Reading. Such additional calls may also be inconsistent with the reduced journey time outputs anticipated from the Intercity Express Programme.

Demand forecasting identifies the need for additional high-peak capacity equal to 24 vehicles to be provided during CP6. This option provides the additional capacity through lengthening of SETs. The 2019 baseline timetable assumes 12 train arrivals in the high-peak hour formed of SETs; thus on average each of these trains would require to be lengthened by two vehicles to achieve the necessary capacity, i.e. 9-car SETs to 11 cars, and 10-car SETs to 12 cars. However, not all trains are anticipated to call at Swindon, Didcot or Reading so some trains might require further lengthening.

Analysis has been undertaken to understand the impacts of lengthening on station infrastructure which suggests significant costs to remodel station layouts particularly at London Paddington and Swansea. In addition, due to the restrictions on construction and resourcing of the timetable, more vehicles would be required to be leased to provide the required capacity. The operating costs would be high due to the high daily mileage incurred.

A financial and socio-economic appraisal has not been undertaken for this option as a feasible and better value for money option appears to be available.

A9: Additional high-peak services between London Paddington and Swindon	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand between London Paddington and Swindon
Description	Provision of two additional high-peak services between London Paddington and Swindon to accommodate increased passenger demand
Indicative Cost	Capital cost assumed to be nil for this option.
Indicative Value for Money	• A9a: High (achieved by replacing two high-peak hour Airport services on the Main Lines) • A9b: Very High (as above but replacing two Main Line services with two additional Relief Lines services) • Note the above does not include any capital expenditure that may be required.
Relates to other options	This option needs to be considered in the context of: • A1 and A13

Analysis

In order to accommodate forecast passenger demand into London Paddington from Reading, Didcot Parkway and Swindon additional capacity will be required as on-train crowding is predicted inward to London from as far as Swindon. The addition of calls during the high peak hour in fast Super Express Train (SET) services could smooth the demand profile but would still not deliver sufficient capacity from Didcot Parkway and Reading. Such additional calls may also be inconsistent with the reduced journey time outputs anticipated from the Intercity Express Programme.

This option provides the additional passenger capacity through new high-volume services which would allow this intervention to be targeted to the locations and times where this significant demand is forecast to occur, i.e. arriving London Paddington between 8am and 9am, and departing between 5pm and 6pm.

The introduction of two additional high-peak 12-car services between London Paddington and Swindon calling at Didcot Parkway and Reading is forecast to provide the additional capacity necessary to meet the Conditional Outputs for Main Line demand into London Paddington until the end of CP6.

However, adding two additional services to the high-peak hour above the 2019 ITSS, without other changes such as those presented in A1, would increase the number of services into London Paddington on the Main Line to 22tph.

In order to deliver this option without capital cost for increased infrastructure would require two services to be removed from the Main Lines in the high-peak hour, to provide sufficient capacity and deliver performance at a level consistent with the target for the end of CP5.

Option A13 considers an alternative choice should 22tph be required to be maintained on the Main Lines; this presents the additional infrastructure that would be required.

It is recommended that the rolling stock provided for such additional trains is capable of 125mph operation otherwise journey time extensions of several minutes will need to be applied to long distance services during peak periods to accommodate the difference in running speeds. Choices to accommodate the additional peak services at Swindon are provided in Route Section I: Didcot Parkway – Bristol Parkway. See Appendix D for financial and socio-economic appraisal.

A10: Assessment of capacity and capability requirements for Relief Line services to meet emerging demand

Demand forecasts for the use of Relief Line services between London Paddington and Reading indicate that additional capacity will be required from 2023. To ensure that interventions in CP6 are part of a long-term, affordable and deliverable strategy, it is essential to consider system requirements beyond 2024 as part of the CP6 strategy. These are being developed by the industry, now the requirements for the 2019 ITSS have been confirmed and in light of the need to serve the HS2 station at Old Oak Common from 2026. Choices may include both longer trains and additional or modified services which may or may not require infrastructure interventions.

A11/A12: Combined Options

To provide the necessary additional capacity from Reading and stations to the west into London Paddington will require one or more of the choices identified above. To illustrate this, a number of combined options have been assessed to support the provision of additional capacity and are presented in Figures 5.8 and 5.9:

Figure 5.8: Alternative Option A11

A11		High Peak On Train Departure average Load Factors[1] at key stations at 2023			
Combined Option 1		Newbury	Swindon/Didcot	Tilehurst	Reading
A3	Changes to service pattern	63%	56% / 73%	76%	88%
A5	Newbury train lengthening				
A7	Oxford train lengthening				
A9	2 high peak services between Swindon and London Paddington – Swindon				

Figure 5.9: Alternative Option A12

A12		High Peak On Train Departure average Load Factors[2] at key stations at 2023			
Combined Option 2		Newbury	Swindon/Didcot	Tilehurst	Reading
A3	Changes to service pattern	86%	56% / 73%	76%	89%
A6	West of England train lengthening 9 cars				
A7	Oxford train lengthening				
A8/A9	2 high peak services between Swindon and London Paddington				

1, 2 Load factor is defined as the proportion of on-train capacity being taken, expressed as a percentage. Capacity is defined as the number of standard class seats plus standing allowance when appropriate

A13: Grade Separation at Ladbroke Grove Junction	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To enable the delivery of: • infrastructure capacity sufficient to meet forecast increases in demand and the provision of additional train services • operational flexibility and capability improvements • levels of performance which meet (or exceed) those achieved at the end of CP5 • improved network resilience through the provision of additional capacity to support a more-intensive maintenance and engineering access regime required post-2019 • improved access to depots and stabling facilities
Description	Provision of a grade separated junction in the vicinity of Ladbroke Grove which would enhance the functionality of the existing Ladbroke Grove Junction.
Indicative Cost	£75m – £175m
Indicative Value for Money	High
Relates to other options	This option needs to be considered in the context of A1 and A9
Analysis The service alterations and additions such as two additional high-peak services between London Paddington and Swindon could be accommodated on the 2019 baseline infrastructure should A1 be implemented and a better utilisation of the existing network capability realised. However, this is a short-term intervention with a maximum of four additional paths likely to be achieved, which is also dependent upon certain other assumptions on system capability. The longer-term forecasts for this Route Section post-CP6 indicate that further paths would still be required to accommodate future growth and infrastructure interventions would be required to achieve this. The enhanced junction would permit optimal utilisation of network capability at the key terminal point on the route through the ability to maximise the use of train paths while providing a layout which supports a robust maintenance and engineering access strategy, reduces perturbation and supports higher levels of operational performance. This is a key Route Section where demand is forecast to continue to grow significantly and will increase further following the opening of the new station at Old Oak Common and the introduction of HS2. Delivering this enhancement in conjunction with the planned renewal also provides the optimum time to achieve efficient delivery and the lowest whole life cost.	

Longer Term Strategy

To fully accommodate forecast demand plus the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required on this Route Section. To accommodate the Conditional Outputs there are a number of potential choices. However to meet them, there are likely to be significant constraints including deliverability and affordability. Choices for funders will involve trade-offs between journey time, service frequency and performance.

Initial capacity analysis suggests that it might be possible to move to a theoretical maximum of 24tph on the Main Lines between London Paddington and Reading subject to:

- harmonisation of train speeds
- reduction in planning headways (potentially enabled through the anticipated introduction of the European Train Control System (ETCS) with additional infrastructure)
- elimination of any planned train movements which cross between the Main and Relief Lines
- the ability of London Paddington Station to accommodate the assumed number of trains planned to arrive and depart, particularly within the high peak periods.

The theoretical platform capacity of London Paddington can only be used at its assumed potential if there are no constraints for the pathing of trains on departure or arrival. Choice A13 provides a possible means of eliminating this constraint which is apparent from the initial timetable studies carried out on the 2019 service levels.

The 2019 ITSS is based on outer suburban services continuing to provide peak hour limited-stop services from Twyford and Maidenhead, which run on the Main Line having crossed over from the Relief Lines at Maidenhead East Junction. The ability to support this particular service provision in the long term is likely to become more challenging as the Main Line service frequency intensifies. By 2043 the peak requirement for Main Line services will require all 24 potential paths, which will not support the continuation of these crossing moves on existing infrastructure.

The service that operates on the Relief Lines between London Paddington and Reading during the day makes a number of intermediate calls en route. This service – referred to as the residual stopping service – is anticipated in the 2043 ITSS to have been replaced by Crossrail services extended west of Maidenhead. The ability to run services along the Relief Lines all the way into London Paddington is likely to become increasingly constrained once the HS2 station at Old Oak Common opens in 2026 and further services from the Crossrail core are extended to serve Old Oak Common Station.

Using all theoretical track capacity would also not deliver a resilient timetable or provide for service recovery from unavoidable perturbation, and would therefore be detrimental to the performance and reliability of the railway. A high-performing railway also requires a consistent maintenance strategy which invariably requires pairs of lines to be taken out of use for inspection at quieter times of the day or week. This necessitates a "two track railway operation" which reduces overall network capacity and could increase journey times. The ability to cross from Main Lines to Relief Lines and vice versa in order to provide an overtaking capability and to maximise system capacity becomes essential.

In order to achieve the best fit of Conditional Outputs for the 2043 ITSS from the 2019 baseline service and infrastructure, there is a range of possible interventions to be considered for the longer term. Optimisation of service specification is possible; however, given Relief Line capacity utilisation the opportunities to accelerate stopping services are, and will be, increasingly limited without infrastructure intervention.

Once the available track capacity has been exhausted, potential infrastructure interventions exist that would improve outcomes on the most densely trafficked parts of the Route Section. Such interventions would seek to increase capacity and capability for the Relief Lines to permit a better range of timetable options for passenger and freight users beyond that provided in 2019.

The following choices set out a range of actions and interventions which seek to address this issue. A14 describes choices for accommodating forecast rail passenger demand. A15 and A16 are potential timetable solutions involving train service changes which may adversely impact journey times to/from certain other stations. A16 runs contrary to the principles set out in the Making Best Use scenario (reference section A1). A17 and A18 propose alternatives for additional infrastructure and the implications are described.

- A14: Interventions to accommodate rail passenger demand
- A15: Improving end to end journey times by reducing the number of trains calling at intermediate stations between Maidenhead and London
- A16: Routeing selected Crossrail services on the Main Lines
- A17: Enhancements to the Relief Lines to enable additional semi-fast Crossrail services
- A18: Enhancements to the Main Lines to enable semi-fast trains to continue to operate

Each of the choices is addressed in further detail:

A14: Interventions to accommodate rail passenger demand

For long distance services, additional system capacity will be required to accommodate forecast rail passenger demand by 2043 between London Paddington and Reading. The requirement is to cater for growth on the outer suburban and long distance markets. This additional capacity could take the form of higher density rolling stock, further lengthening of trains and/or the provision of more services in the peaks to cater for demand, where possible. Choices will need to be made to deliver best value and optimise the use of available capacity.

For Relief Line stopping services, additional system capacity will be required. It is forecast that demand will exceed capacity by 2030 and may become an issue from 2026 with the implementation of HS2 and the opening of the new station at Old Oak Common. Significant additional capacity for suburban travel to London will be provided through the 2019 baseline timetable with further interventions needed to accommodate forecast demand. The options for delivery of this capacity are being developed by the industry. Choices may include both train lengthening and additional services, where feasible and where they can demonstrate value for money.

In order to deliver this increased system capability there are a number of potential interventions that could influence both the scope and timing of future service changes.

A15: Improving end to end journey times by reducing the number of Relief Line trains calling at intermediate stations between Maidenhead and London

A reduction in average journey time from Maidenhead and stations further west to London on the Relief Lines could potentially be achieved by reducing the frequency of calls at smaller intermediate stations. However, this choice would reduce service connectivity for these stations from 4tph to 2tph and the economic disbenefit may be significantly greater than the benefits, as well as failing to meet the full Conditional Outputs for capacity, connectivity and journey times from these stations.

A16: Routeing selected Crossrail services on the Main Lines

This option could provide additional Crossrail services using Main Line paths. This option is not recommended for further development as the 90mph maximum speed of the rolling stock specified for Crossrail is inconsistent with the strategy to harmonise Main Line operating speeds to maximise capacity and would result in significant journey time impacts to long distance services. In addition to the negative effects on longer distance journey times, a new grade-separated junction would be required to the east of Acton Main Line to allow the services to access the Crossrail tunnel from the Main Lines. This junction would be technically challenging and expensive to construct with a benefit limited to the few services which would run via the Main Lines and is likely to offer low value for money.

The remaining two choices relate to possible interventions outlined in choice A10 above and are described below in the summary tables in order to inform strategic choices for funders and the industry.

A17: Relief Line Enhancements	
Conditional Output	Connectivity – reduced journey times
Timeframe	Longer Term - review the case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	To allow additional semi-fast services to run on the Relief Lines along with the peak stopping service pattern, and provide an overtaking capability for times when a two-track railway is in operation
Description	Two additional tracks providing Up and Down dynamic loops for semi-fast services to overtake slower services calling at all stations in this section
Indicative Cost	£75m – £175m Cost of operating and providing additional rolling stock is not included
Indicative Value for Money	Medium – based on the provision of two additional semi-fast services each hour. However additional costs and benefits such as greater timetable flexibility, additional capacity for passenger and freight services and network resilience will be possible which have not been quantified.
Relates to other options	N/A

Analysis

To avoid reducing the proposed service level at intermediate stations to a level deemed unacceptable, the additional semi-fast services would be incremental to the 2019 ITSS. The additional costs of rolling stock and associated requirements have not been assessed or quantified as part of this high level analysis.

To facilitate the 'flighting' of Relief Line services, thus optimising the use of available capacity, the interval between services at some stations such as Twyford and Maidenhead are unlikely to be even, thus reducing the connectivity benefits of the approach.

In order to access the Crossrail tunnel such services join and diverge from the Relief Lines at Portobello Junction near London Paddington. Any trains using the Relief Lines to access the existing platforms at London Paddington would cross the route of the Crossrail trains. Once HS2 Phase 1 is operational such movements will become increasingly difficult to path due to the increased frequency of stopping services operating between the Crossrail tunnel and Old Oak Common. Thus in the long term, any additional services on the Relief Lines would need to go to/from Crossrail in order to avoid conflicts at Portobello Junction and to maximise the use of system capacity and maintain a high performing railway.

The creation of additional capacity on the Relief Lines for a suitable length of this Route Section may deliver the potential for timetable flexibility, service resilience and enhanced maintenance access to support future system requirements for both infrastructure and rolling stock, stabling and maintenance. This choice therefore merits further analysis as other work streams develop, including the maintenance and engineering access requirements and final form of the service specification.

A18: Main Line Enhancements	
Conditional Output	Connectivity – reduced journey times
Timeframe	Longer Term - review case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	Allows semi-fast services to run on the Relief Lines from Reading to Slough before crossing over to the Main Lines as part of a 24tph Main Line service
Description	• grade separation at Langley (note an enhancement to the proposed grade separation at Langley as part of Western Rail Link to Heathrow could be made subject to requirements, remit and funding) • reduce planning headways between Reading and Airport Junction
Indicative Cost	Not costed
Indicative Value for Money	Likely to be Poor – if based solely on the benefits of retaining semi-fast services, however additional benefits such as greater timetable flexibility, additional capacity and network resilience will be possible which have not yet been quantified
Relates to other options	A1

Analysis

Grade separation would be required to allow semi-fast services to form part of a 24tph Main Line service pattern – an opportunity could exist to enhance the proposed grade separation incrementally at Langley that would be required as part of the proposed Western Rail Link to Heathrow scheme (scheduled for completion during CP6 subject to confirmation of funding, a value for money assessment, and the agreement of acceptable terms with the aviation industry). 125mph rolling stock would also be required for these services to operate on the Main Line or a speed reduction in the long distance services would be required. More detailed analysis would be necessary should this choice be developed further to assess the feasibility of merging trains from the Relief Lines into a service pattern running of 24tph at 125mph on improved headways on the Main Lines.

The ability to cross between Main and Relief Lines provided under this option may offer benefits in respect of service resilience and timetable capability particularly when future maintenance access requirements are taken into consideration.

Access to Gateways (HS2 and Heathrow Airport)

HS2

The completion of HS2 Phase 1, including a new station at Old Oak Common, is anticipated to occur in 2026. As part of this development, the new station will be built to provide interchange with the London Paddington – Reading Route Section, improving connectivity by allowing passengers to interchange between Main and Relief Line trains, or with HS2 services. Current assumptions are that all trains on the Main and Relief Lines will call at Old Oak Common station. Some Crossrail trains which would otherwise terminate at London Paddington Crossrail Station (having arrived from the Crossrail tunnel to the east) are anticipated to be extended to Old Oak Common and will take all remaining Relief Line capacity east of Old Oak Common. Given this level of service, it is not anticipated that any further interventions are required to improve connectivity to Old Oak Common from this Route Section.

Access to Airports

The High Level Output Specification (HLOS) for Control Period 5 includes the development of Western Rail Link to Heathrow for implementation in CP6, and this forms part of our 2019 baseline for the purposes of the Western Route Study subject to confirmation of funding, a value for money assessment, and the agreement of acceptable terms with the aviation industry.

Current proposals provide a new two-track railway from Heathrow Terminal 5 station to the existing railway, via a new junction near Langley with grade separation to provide connections to the Up and Down Relief Lines towards Reading.

The anticipated service pattern consists of four trains per hour between Heathrow Airport and Reading, operating on the Relief Lines. This would provide significant improvements in connectivity to Heathrow Airport from the west of Reading and for stations where there is currently a requirement to change, such as at London Paddington or Hayes & Harlington, or to use road transport from Reading. Connectivity could be further maximised depending on how train services are connected at Reading; this is also desirable to optimise the infrastructure available at Reading supporting a through-running station.

Connectivity at Reading in the longer term

The 2043 ITSS presents a range of connectivity options to/from/through Reading Station. The ITSS includes a number of services assumed arriving and potentially terminating at Reading from the east totalling 16tph as follows:

- 4tph to/from London Paddington Crossrail
- 2tph to/from London Paddington (semi-fast)
- 4tph to/from London Paddington via Heathrow Airport (semi-fast)
- 3tph to/from London Waterloo *
- 2tph to/from Gatwick Airport *
- 1tph to/from Guildford *.

* Note the last three listed services are assumed to use the dedicated 'bay' platforms at Reading serving the lines towards Guildford and London Waterloo. Thus they would not occupy through platforms, but there may be an opportunity to improve connectivity by combining them with the services listed below.

9tph arriving and potentially terminating from the west:

- 2tph to/from East West Rail (semi-fast)
- 2tph to/from Oxford
- 1tph to/from Bedwyn *
- 1tph to/from Westbury *
- 1tph to/from Southampton or Bournemouth *
- 2tph to/from Basingstoke *.

* Note the last four listed services could use the 'bay' platforms at Reading serving the lines towards Newbury and Basingstoke. Thus they do not necessarily occupy through platforms, but there may be an opportunity to improve connectivity by combining them with the services listed above.

Provision also needs to be made to allow trains to/from the Basingstoke direction and to/from the Oxford direction to reverse at Reading, which will use some platform capacity.

Not all of the anticipated terminating or reversing services in the 2043 ITSS could be accommodated in the six bay platforms provided at Reading. Having services terminating at Reading is therefore undesirable from both an operational and a passenger perspective.

A train which terminates in a through platform uses more capacity than one which calls and then continues on its journey. For example, during the time which elapses between the terminating train arriving on one service and departing on another service no other trains can use that platform as a through platform. This therefore limits the number of services that could be operated given the overall capacity of the station.

For passengers, it is preferable where possible to complete a journey on one train rather than two, or at least to have the option to do so even when faster journey opportunities may be available by changing trains. This is particularly important for infrequent users, people with restricted mobility, or passengers with luggage (especially those travelling to airports).

The baseline scheme for the Reading Station Area Redevelopment (as defined in Chapter 2) has delivered a flexible track layout for the station area providing more platforms whilst reducing conflicts which previously used to occur between trains crossing from one route to another.

To maximise the operational and passenger benefits of the Reading Station Area Redevelopment scheme, it is recommended that services should, as far as possible, be linked together to provide through journeys and create improved connectivity opportunities. In considering how best to do this, there are a number of elements to take into account:

- compatibility of rolling stock
  - traction type – diesel or electric (overhead or 3rd rail electrification or Independently-Powered Electric Multiple Units (IPEMUs))
  - seating layout and overall journey time
  - train length – optimising use of network capacity
- forecast passenger demand
  - focussing on providing new or improved connections where there is likely to be overall market growth as a result
- avoiding the creation of infrastructure conflicts and delivering resilient operational performance.

Applying the rolling stock and passenger demand criteria to the services anticipated to terminate at Reading in the 2043 ITSS, it is apparent that extending Crossrail trains west of Reading is unlikely to be a desirable choice due to the assumed rolling stock constraints associated with fixed formation trains configured for a high density, metro-style service designed to maximise carrying capacity rather than provision of seats for the majority of travellers.

Considering market potential highlights the following possible linkages:

- London to Oxford (stopping service). An existing service pattern which links significant origins and destinations west and east of Reading
- London to Basingstoke. Provides access from Old Oak Common and Heathrow Airport to Basingstoke, and the Wessex Route by interchange
- Gatwick Airport to Oxford. Potentially attractive if journey times are competitive with road transport
- Heathrow Airport to Oxford. Potentially very attractive if journey times are competitive with road transport
- Heathrow Airport to Newbury. Likely to be less demand than the Oxford or Basingstoke options, based on catchment data provided by Heathrow Airport Ltd.

There are a number of other constraints assumed:

- only electric trains can serve Heathrow Airport
- the maximum train length which can be accommodated in the platform at Heathrow Airport Terminal 5 is 217m (e.g. 10x20m vehicles), and 195m at the Central Terminal Area
- it is assumed that electrification of the Berks & Hants line does not extend beyond Newbury (as per the anticipated 2019 baseline).

Figure 5.10 below summarises the connectivity choices at Reading Station.

Figure 5.10: Table of principal connectivity choices at Reading for the longer-term

Frequency	Link from	Link to (via Reading)	Anticipated train power and length	New journey opportunities, comments
2tph	London Paddington	Oxford (local)	Electric, 8 cars	Maintains the existing link between London Paddington and the local stations west of Reading
1tph	London Paddington (via Heathrow Airport)	Southampton or Bournemouth	Electric, 8 cars	This link is specified in the Cross-Boundary ITSS. It would provide improved connectivity from the Wessex Route Study area to Reading, Heathrow Airport and Old Oak Common.
1tph	London Paddington (via Heathrow Airport)	Basingstoke	Electric, 8 cars	Increases the London Paddington and Heathrow Airport to Basingstoke frequency to 2tph. On completion of electrification of the route between Reading and Basingstoke. This may drive platform lengthening requirements at stations between Reading and Basingstoke
2tph	London Paddington (via Heathrow Airport)	Oxford, or destinations beyond (semi-fast)	Electric, 8 cars to Oxford	Creates a new direct Heathrow Airport-Oxford rail link.

Other choices may depend on the future potential electrification of the 'North Downs line' between Reading and Gatwick Airport, and between Newbury and Westbury (Berks & Hants). Electrification is being reviewed under the refresh of the **Network Route Utilisation Strategy (RUS): Electrification**.

The following example service pattern could be operated:

- 1tph Gatwick Airport – Westbury
- 1tph Gatwick Airport – Basingstoke
- 1tph Guildford – Bedwyn.

Figure 5.11: Table of further connectivity choices at Reading				
Frequency	Link from	Link to (via Reading)	Anticipated train power and length	New journey opportunities, comments
1tph	Gatwick Airport	Bedwyn	Diesel, 3-4 cars or Electric, 4 cars	Links services together operated by similar diesel rolling stock and provides links such as Newbury to Guildford
1tph	Gatwick Airport	Westbury	Diesel, 3-4 cars or Electric, 4 cars	Links services together operated by similar diesel rolling stock and provides links such as Newbury to Guildford
1tph	Guildford	Basingstoke	Diesel, 3-4 cars or Electric, 4 cars	Although the Basingstoke line is planned to be electrified, this pairing would be a good match for train type and length and would allow some new direct journey opportunities such as Wokingham -Basingstoke.

In the above scenarios , the following services would continue to terminate at Reading:

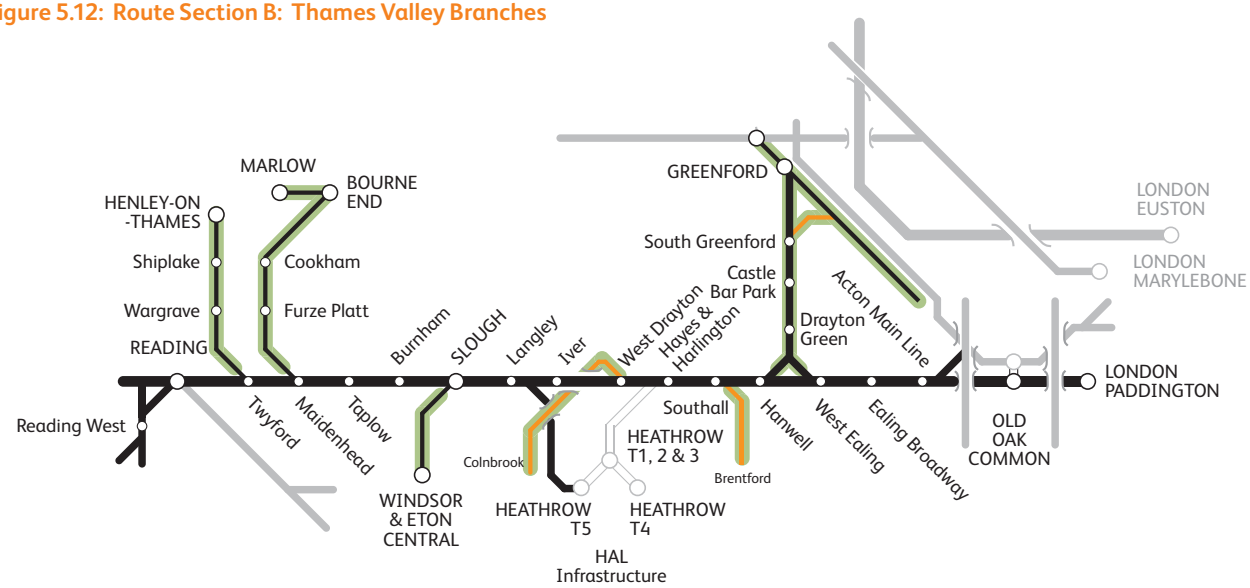
- 4tph London Paddington Crossrail – Reading
- 3tph London Waterloo – Reading (as per **Wessex Route Study** ITSS).

To deliver the optimal provision of train services detailed analysis of both market requirements and the operational feasibility will be required.

Route Section B: Thames Valley Branches (east of Reading)

- West Ealing – Greenford
- Southall – Brentford Goods
- West Drayton – Colnbrook
- Slough – Windsor & Eton Central
- Maidenhead – Marlow
- Twyford – Henley-on-Thames

Figure 5.12: Route Section B: Thames Valley Branches



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- electrification of the Marlow, Henley-on-Thames and Windsor & Eton Central branches
- a new bay platform at West Ealing Station and a service between West Ealing and Greenford in preparation for Crossrail services. This will sever the existing direct London Paddington to Greenford link with connectivity opportunities at West Ealing via an interchange.

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows: (tph = trains per hour, each direction)

- 2tph Greenford – West Ealing
- 3tph Slough – Windsor & Eton Central
- 1tph Marlow and Bourne End – Maidenhead
- 1.3tph (45-minute frequency) Henley-on-Thames – Twyford
- 9 freight trains per day Greenford – West Ealing and beyond
- 5 freight trains per day Brentford Goods – Southall and beyond
- 6 freight trains per day Colnbrook – West Drayton and beyond.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority in the Western Route Study and relevant to this Route Section is:

Figure 5.13:

Reference	Western Route Study Conditional Output
CO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – inner suburban services (Relief Line and Thames Valley branches)

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to the Thames Valley branches are defined by the **London & South East Market Study**.

For outer suburban journeys to London, and longer distance (>30 mile), non-London journeys, the Conditional Output is to provide a total Generalised Journey Time (GJT) of significantly less than 100 minutes and as close to 40 minutes as possible, provided that this is an improvement on the 2019 baseline position (see Chapter 3 for further details on GJT).

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation of the connectivity Conditional Outputs is to provide an all-day service frequency of 2tph on each of the branch lines with the exception of the Windsor & Eton Central branch, which maintains its current 3tph all day service frequency.

The frequency of the Greenford branch reflects the 10tph service provided by London Underground Limited (LUL) with the Central Line from Greenford Station.

The high-frequency Central Line service consumes the vast majority of current passenger demand from this location and exceeds the Conditional Output for connectivity to central London. The Conditional Output for the branch has consequently been set at 2tph.

London & South East Market Study

For inner suburban journeys to London, the Conditional Output is to provide a minimum of three or four trains per hour to and from central London during off-peak hours, from stations broadly within a 30 – 40 minute travel time of central London.

For short distance, non-London journeys of less than 30 miles, the Conditional Output is a target journey time of 60 minutes.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand and apply to the Greenford, Brentford and Colnbrook branch lines. No freight terminals exist or are forecast on the Windsor, Marlow and Henley-on-Thames branch lines.

Forecast demand for freight traffic on the Greenford and Brentford branches is in line with the number of paths anticipated in 2019. Due to forecast continued growth in construction traffic, increased demand on the Colnbrook branch is expected, requiring an hourly freight path in most hours across the day by 2043 to serve the terminals adjoining the branch.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Figure 5.14: Interpretation of Passenger Connectivity Conditional Outputs

Reference	Flow (to central London in each case)	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
CO8	Greenford	3 to 4tph	2tph
CO9	Windsor & Eton Central	GJT as near to 40 minutes as possible	3tph
CO10	Marlow – Bourne End	GJT as near to 40 minutes as possible	2tph
CO11	Henley-on-Thames	GJT as near to 40 minutes as possible	2tph

Changes to the Indicative Train Service Specification to 2043

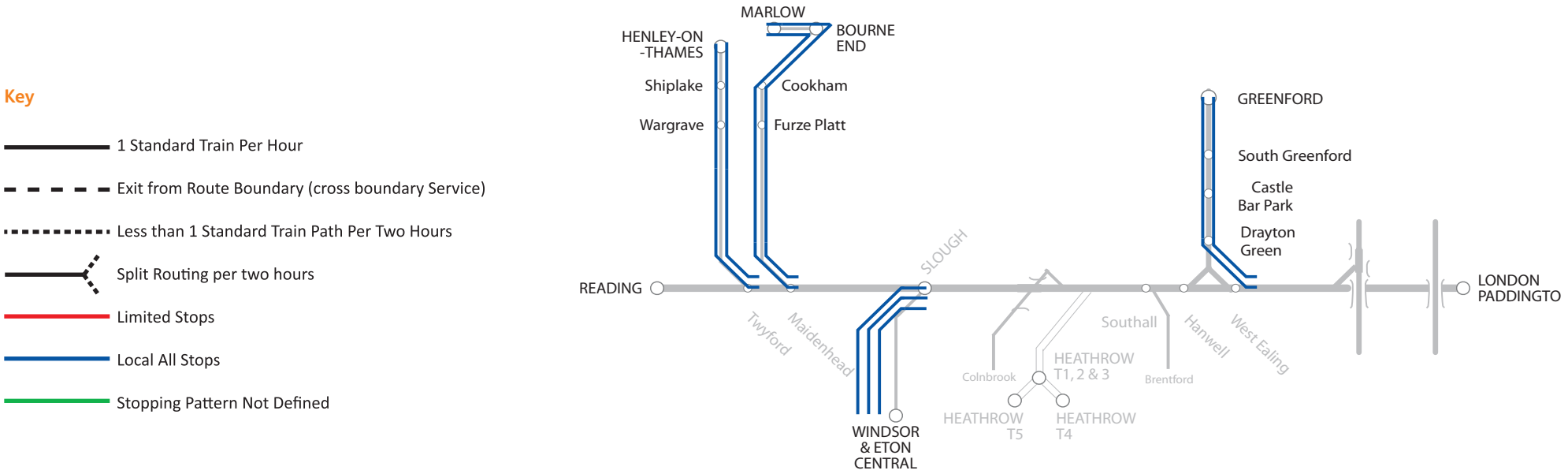
To accommodate the connectivity Conditional Outputs for short distance journeys to London Paddington from within the South East up to four trains per hour have been tested on each of the Thames Valley branches.

This would represent a significant increase in service frequency, which is in excess of the capacity required during the period under consideration in this Route Study. In order to accommodate the connectivity Conditional Output of four trains per hour, infrastructure interventions would also be required as described in System Capability Constraints. The Western Route Study interpretation of the connectivity Conditional Outputs is to provide two opportunities to travel per hour on the Greenford, Marlow/ Bourne End and Henley-on-Thames branch lines with three opportunities to travel per hour on the Windsor & Eton Central branch line.

It is expected that freight traffic on the Greenford branch will remain at levels such that an hourly path for freight in either direction will be sufficient to cater for forecast traffic levels, including any additional requirements associated with the construction of High Speed Two (HS2). Forecast demand for traffic supporting construction of HS2 is sensitive to routeing assumptions, especially for excavated material. The industry is working with HS2 Limited to understand better its logistics requirements and any impact on the Western Route.

Freight demand to the Southall branch is forecast to remain at 2019 levels, which means that the baseline capacity requirement for five trains per day is carried forward to 2043. Forecast growth on the Colnbrook branch indicates that demand across an 18-hour day is expected to be between 0.5 and 1tph by 2043.

Figure 5.15: 2043 Indicative Train Service Specification Thames Valley Branches



System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements of four trains per hour, identifies the following emerging constraints:

- capacity on single line sections of the Greenford branch
- junction capacity at Southall West and East junctions due to freight trains crossing passenger trains on the Main Line, whilst accessing the Brentford branch
- linespeed and single track section constraints on the Windsor & Eton Central, Marlow and Henley-on-Thames branches.

On the Greenford Branch, the capacity of the single line section at Greenford (LUL) Bay Junction is the constraint to increased service frequency. At four passenger trains per hour capacity utilisation is close to maximum. In order to accommodate freight trains alongside the increased frequency of passenger service, infrastructure interventions are required which includes improvements to planning headways and linespeeds.

The primary constraint on the Windsor & Eton Central, Marlow/ Bourne End and Henley-on-Thames branches is the running time needed for a train to complete a round trip. The secondary constraint on these three branches is the presence of single line infrastructure. Road and footpath level crossings additionally constrain line speed, which in turn limits service frequency.

Linespeed improvements or reductions in the number of intermediate calls might permit an increase in service frequency. If an additional train were required to deliver higher frequency, this would require provision of infrastructure to allow two trains to pass. There would be a corresponding step-change in the operational cost of running the additional service and potential provision for additional infrastructure.

Making Best Use of Capacity

On the Greenford branch, it would be possible to operate four passenger trains per hour with two trains on the 2019 baseline infrastructure. However, it is not possible to provide capacity for freight services at the same time without infrastructure intervention. This increased service frequency could therefore be limited to peak periods on the Great Western Main Line (GWML) when freight does not currently operate, which would make best use of existing capacity should there be a sufficient requirement and value for money case to provide four passenger trains per hour.

On the Windsor & Eton Central branch, it is not possible to operate more than three services per hour with one train on the 2019 baseline infrastructure. The introduction of a second train to the branch would drive requirements for significant infrastructure interventions to restore the second track.

It would be possible to increase all day frequency on the Marlow branch to two services per hour through replicating the current peak operation of splitting the service at Bourne End. This would require a second train to operate throughout the day, increasing operational cost but without incurring capital expenditure on infrastructure interventions.

However, as a result of this a passenger from Marlow to destinations along the GWML would have to change trains at both Bourne End and at Maidenhead throughout the day, assuming the 2019 ITSS is implemented. To avoid the need for passenger interchange at Bourne End, additional infrastructure could be provided to permit a 2tph service direct from Marlow through to Maidenhead . However, the total journey time to Maidenhead will be similar to the time taken if the service is split at Bourne End due to the time required to reverse services.

On the Henley-on-Thames branch it is possible to operate two passenger trains per hour on the 2019 baseline infrastructure with a modification to the calling pattern at intermediate stations. An alternative to calling pattern modifications would be infrastructure interventions that permit increased maximum permissible speeds on the line, allowing reduced running times with electric rolling stock. The reduced running times could allow for sufficient productivity to be achieved with one train such that a 2tph service could be delivered.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- access to HS2 (at Old Oak Common).

The busiest trains on the Thames Valley branches are those that provide connections to arrive into London Paddington in the high peak hour between 08.00-08.59. The 2023 demand forecasts suggest that the 2019 ITSS provides sufficient capacity to meet demand requirements in CP6.

With the 2019 baseline anticipated to deliver sufficient capacity to accommodate peak demand throughout CP6, the primary driver for change would be improving connectivity to destinations along the GWML and also specifically to HS2 via the new station at Old Oak Common once open in 2026.

These connectivity improvements can be achieved through the choices presented above.

Longer Term Strategy

To accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, there are a number of potential choices which are likely to involve trade-offs between journey time, service frequency and performance. As evidence suggests it would be possible to deliver the connectivity Conditional Outputs on 2019 infrastructure, the longer-term strategy focuses on delivering sufficient capacity to accommodate rail passenger demand during peak times.

By 2043, demand is expected to significantly exceed the proposed high peak capacity on the Thames Valley branches and will require additional capacity. However, the 2043 connectivity Conditional Outputs interpreted in the 2043 ITSS for the Thames Valley branch lines includes an increase in service frequency (from 1tph to 2tph) on the Henley-on-Thames and Marlow branches. These could provide sufficient capacity to accommodate high peak demand, and are presented as choices for funders in order to provide sufficient capacity as well as to meet the 2043 connectivity Conditional Outputs.

By 2043, either lengthening of Greenford services from 2- to 3-car or an increase in frequency from 2tph will be required to meet peak capacity. If the frequency is increased above 2tph then a 4tph frequency is preferred to provide convenient connections in to the 4tph stopping service from West Ealing. The strategy for the Greenford route is not to preclude platform extensions for 3-car lengths at any of the intermediate stations between West Ealing and Greenford.

Provision of 4-car trains, three times per hour on the Windsor & Eton Central branch would provide sufficient capacity to cater for peak demand to 2043. The longer-term strategy is to provide for this service option on the branch.

By 2043 peak demand on the Marlow branch will exceed capacity of the 2019 baseline service frequency between Bourne End and Maidenhead. Train lengthening beyond 3-cars would address on-train crowding but is likely to require significant infrastructure work at Bourne End to increase the length of Platform 1. Increasing the frequency of the train service to 2tph to meet the connectivity Conditional Output would also deliver the required peak capacity whilst removing the need for infrastructure intervention, should an interchange at Bourne End be made. The longer-term strategy is therefore to deliver the connectivity Conditional Output on the Marlow branch.

2tph on the Henley-on-Thames branch will provide sufficient capacity to meet peak demand. The frequency increase could be delivered with one train either through amendments to the calling pattern, or each train calling at all stations in association with line speed increases that match the increased capability of modern electric trains. If the service frequency is not increased to 2tph then train lengthening by up to two additional vehicles will be required to meet peak capacity requirements by 2043.

Route Section C: Reading – Basingstoke

Figure 5.16: Route Section C: Reading – Basingstoke

Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. This includes:

- electrification of the route between Reading and Basingstoke .

Anticipated 2019 Service Patterns

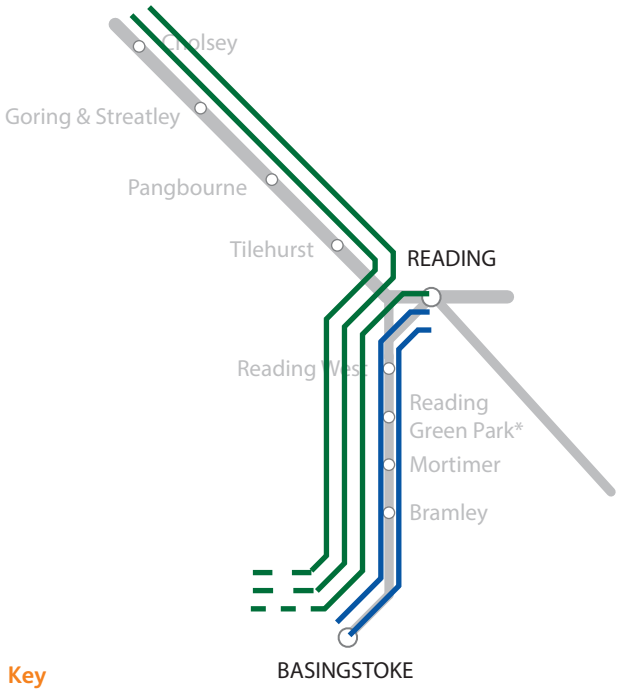
The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph= train per hour, each direction):

- 1tph London Paddington – Newbury
- 2tph London Paddington – Exeter or beyond (via the Berks & Hants line)
- 2tph Basingstoke – Reading
- 1tph Bournemouth – Manchester Piccadilly
- 1tph Southampton Central or Reading – Newcastle
- 1tph Basingstoke to Manchester (via East West Rail)
- 2-3tph Freight.

In addition to the off-peak anticipated 2019 service pattern, an additional peak service is expected to operate between Newbury and Reading, allowing the London Paddington to Newbury service to omit a number of calls at smaller stations and provide a reduced journey time to London.

The Reading to Basingstoke Route Section forms part of the Strategic Freight Network (SFN) from the Port of Southampton to the West Coast Main Line (WCML), West Midlands and beyond with significant quantities of freight traffic transported, the majority of which is intermodal. Typically there are two freight paths per hour per direction throughout the day, in some hours increased to three.

Figure 5.17: 2043 Indicative Train Service Specification Reading – Basingstoke



Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to the Reading to Basingstoke Route Section are defined by the **London & South East Market Study**, please refer to Chapter 3 for further information.

London & South East Market Study

Short distance, non-London journeys. For non-London journeys of less than 30 miles, the Conditional Output is a target journey time of 60 minutes.

Outer suburban journeys to London, and longer distance (>30 mile), non-London journeys. The Conditional Output is to provide a total Generalised Journey Time (GJT) of significantly less than 100 minutes and as close to 40 minutes as possible, provided that this is an improvement on the 2019 baseline position (see Chapter 3 for further details on GJT).

Interpretation of the Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is to provide a local service frequency of 2tph between Reading and Basingstoke. Longer distance services are described in Route Section A (London Paddington – Reading), Route Section E (Reading – Taunton (the Berks & Hants line)) and Route Section G (Reading – Oxford).

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. Since the draft Route Study was published, the forecasts for construction traffic have been revised in light of rail's increased market share for this traffic. This implies that a significantly greater number of paths will be required for this traffic in the long term, which will need to be addressed in future planning cycles. For Control Period 6 (CP6), there are expected to be sufficient paths available in the 2019 ITSS.

Two distinct freight markets drive demand for capacity between Reading and Basingstoke. Intermodal traffic runs from Basingstoke to Reading West Junction en-route between the South Coast and the West Midlands and is the predominant form of freight traffic between Basingstoke and Southcote Junction. At Southcote Junction aggregates and petroleum traffic joins the route. Due to the different characteristics north and south of Southcote Junction, the 2043 demand forecasts are shown below separately for each part of the Route Section.

The 2043 demand forecasts from the **Freight Market Study** (FMS) between Basingstoke and Southcote Junction are:

- 2 - 3tph Class 4 (typically intermodal or automotive traffic)
- 0 - 1tph Class 6 (typically aggregate-type heavier traffic).

The 2043 demand forecasts between Southcote Junction and Oxford Road Junction are:

- 2 - 3tph Class 4 (typically intermodal or automotive traffic)
- 1 - 2tph Class 6 (typically aggregate-type heavier traffic).

The updated forecasts for construction traffic would increase the number of Class 6 paths required between Southcote Junction and Oxford Road Junction by 2043 to 3-4tph, the implications of which would need to be addressed in future planning cycles.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 2tph passenger services from the Berks & Hants route which joins the Reading – Basingstoke Route Section at Southcote Junction
- 2tph Freight.

The FMS forecasts that the provision of four standard freight paths per hour over the majority of this Route Section will be sufficient to cater for demand to 2043, which represents an increase of one path per hour over the 2019 ITSS. Between Southcote Junction and Oxford Road Junction the increased volume of aggregates traffic means that in some hours five freight paths will be required.

The majority of the traffic will be intermodal freight (Class 4 – 75mph) however at least two paths per hour will need to be capable of accommodating Class 6 (60mph freight).

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies that the section between Southcote Junction and Oxford Road Junction inclusive is the primary constraint.

This is due to the high volume of services and the number of conflicting train movements at either end of the section, which limit the number of additional services which could be operated. Although this is a key constraint, the junction at Basingstoke at the southern end of the Route Section also limits the number of additional services which could run from the South West Main Line (SWML) along this Route Section. Choices relating to Basingstoke Junction are presented in the **Wessex Route Study** and will be developed as part of the **Network RUS: Freight** in conjunction with the choices identified in the Western Route Study and provide a line of route analysis for requirements between the Port of Southampton, Oxford and on to the North.

Making Best Use of Capacity

The emerging analysis of the 2019 timetable and performance studies has indicated that in 2019 the Route Section will be considerably constrained, with minimal capacity to operate any additional train services or modify calling patterns beyond those already assumed, without an adverse impact on journey times.

In order to make best use of the existing system capacity, the strategy needs to consider optimisation of each train path taking into account:

- harmonisation of train speeds and rolling stock capabilities to make best use of the linespeed profile
- maximising the utilisation of each train path.

Applying these principles implies consideration of the following choices to make best use of existing capacity:

- C1: Harmonisation of average rolling stock speeds
- C2: Additional cross-country service to create 3tph.

Each of the choices are addressed in further detail:

C1: Harmonisation of average rolling stock speeds

Introduction of electric rolling stock for the stopping service between Reading and Basingstoke would improve the capability of these trains through improved acceleration. This would reduce the capacity which cannot currently be used due to the speed differentials between the stopping service and long distance services over the Route Section.

C2: Additional cross-country service

The Western Route Study 2019 ITSS anticipates an additional cross-country service on the Reading – Basingstoke Route Section to create 3tph. This service is anticipated to run between Basingstoke and Manchester Piccadilly via the East West Rail route, offering a significant improvement in journey time between Reading, Oxford and Manchester. However, it would further add to capacity utilisation between Southcote Junction and Oxford Road Junction and at Reading Station.

In order to make best use of system capacity, this proposed additional cross-country service per hour in the 2019 ITSS should be included in the optimisation of train paths on this route. The proposed additional service parallels existing services between Basingstoke and Reading and would bring forward the point at which an infrastructure intervention is required. Starting this additional cross-country service from Reading or a location to the east would avoid the inefficient use of capacity at Reading Station and also between Southcote Junction and Oxford Road Junction, while potentially creating new connectivity choices. Possible locations to start the service from include Heathrow Airport and Old Oak Common to support the Cross-Boundary Conditional Outputs.

Drivers of Change, and Choices for Funders, in Control Period 6

The drivers of change for the Route Section in CP6 are as follows:

- accommodating passenger and freight demand
  - there is scope for accommodating rail passenger demand by lengthening cross-country services between Reading and Basingstoke. This is subject to a value for money assessment presented in options LD3/LD4
  - the 2019 infrastructure is already constrained. Given the significance of the Route Section as part of the SFN, freight volume is anticipated to continue to grow.
- any intervention which reduces whole industry cost
  - implementation of the choices for both infrastructure and services on this corridor as a combined intervention could present cost and delivery efficiencies
  - the choices presented here are consistent with those proposed in the **Wessex Route Study**. A line of route assessment between Southampton and the West Midlands is underway as part of the **Network RUS: Freight** and the optimum choices identified for the core SFN corridor
- access to HS2 (at Old Oak Common). The HS2 station at Old Oak Common will provide access to fast services towards the North West and is due to open in 2026. Cross-Boundary Conditional Outputs drive a Basingstoke to London Paddington via Heathrow Airport and Old Oak Common service which would offer the following opportunities:
  - capacity relief to the SWML by offering a parallel route with comparable journey times
  - platform capacity relief at Reading Station
  - connectivity between destinations along the SWML and Heathrow Airport
  - connectivity between destinations along the SWML and HS2 at Old Oak Common.

To meet these drivers for change, the following choices for funders have been investigated:

Accommodating demand and reducing whole industry cost

Demand analysis indicates that by 2023 additional capacity will be required on the long distance services into Reading along the Reading – Basingstoke corridor. Provision of an additional vehicle on these services provides sufficient capacity for 2023 demand into Reading, and across the long distance service.

LD3/LD4/LD6: Cross-country train lengthening between Bournemouth/Southampton/Reading and the North East/North West	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand into Reading on the cross-country corridor from Basingstoke and from Oxford. This option also addresses capacity requirements throughout the day and outside the Western Route Study area
Description	Lengthen cross-country services to 5-car and 6-car between Bournemouth/Southampton/Reading and Manchester/Newcastle
Indicative Cost	Additional vehicle operating costs, depending on the variation of the option: LD3: Southampton/Reading – Newcastle services – 15 additional vehicles LD4 : Southampton/Reading – Newcastle services – 4 additional vehicles LD6: Bournemouth – Manchester services – 17 additional vehicles
Indicative Value for Money	LD3: Poor LD4: Medium LD6: Low
Relates to other options	N/A
Analysis The business case also includes the benefits of relieving crowding in West Yorkshire, East Midlands and the South Coast on the cross-country services. LD3 and LD4 are variations to address crowding on the same line of route. See Appendix D for financial and socio-economic appraisal.	

C3: Capacity enhancements between Southcote Junction and Oxford Road Junction	
Conditional Output	Connectivity
Timeframe	2019 – 2024 (Control Period 6) or Longer Term
Purpose	Capacity for additional passenger and freight services within the 2043 ITSS
Description	• grade separation at Southcote Junction • provision of a third bi-directional line alongside the current two-track railway between Southcote Junction and Oxford Road Junction to provide increased track capacity. Reading West Station would need to be relocated to permit the introduction of the third track
Indicative Cost	• £20m – £50m for grade separation of Southcote Junction • £35m – £75m for a third line between Southcote Junction and Oxford Road Junction (includes relocation of Reading West station) • The combined cost if both choices were implemented together is between £50m – £100m as efficiencies could be achieved
Indicative Value for Money	Requirement to be assessed by a Line of Route Study for the corridor between Southampton and West Midlands/West Coast, to understand the timing of interventions across three Route Study areas.
Relates to other options	Basingstoke Junction, and other constraints outside the Western Route Study area (**Wessex Route Study, West Midlands and Chilterns Route Study** and **Network RUS: Freight**)

Analysis

The infrastructure between Southcote Junction and Oxford Road Junction limits the potential service level due to the track layout, the proximity of the two junctions and the convergence of routes from the south and south-west onto the Great Western Main Line (GWML). The infrastructure layout also imposes performance risk on the timetable due to all services requiring to be planned with conflicting crossing moves between northbound and southbound services at either Southcote Junction or Oxford Road Junction.

Timetable analysis of the 2019 ITSS highlights that the section of line between Southcote Junction and Oxford Road Junction will be at capacity in 2019. Any further capacity that would be available is linked to the wider specifications and availability of paths on the routes from the south and onto the GWML, along with the constraints of the infrastructure between Southcote Junction and Oxford Road Junction.

Grade separation and a third, bi-directional line would be a key contributor to provide further capacity for future services and accommodate the connectivity Conditional Outputs, the full utilisation of which is also dependent on ensuring capability on the wider network with the SWML and GWML.

Should passenger and freight demand increase in line with forecasts that may drive consideration of the connectivity requirements presented in the 2043 ITSS, then development work on this option is recommended including more detailed analysis of the wider timetable impacts of this infrastructure intervention.

Assess requirements in CP6 as a line of route analysis from the Port of Southampton to the WCML in conjunction with the **Wessex Route Study, West Midlands and Chilterns Route Study** and the **Network RUS: Freight**.

Access to HS2 (at Old Oak Common)

Provision of a new service between Basingstoke and London Paddington via Heathrow Airport and Old Oak Common would improve connectivity from destinations along the SWML via an interchange at Basingstoke. Connectivity could be further enhanced should the service start from Southampton or Bournemouth.

Longer Term Strategy

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, interventions will be required on the Route Section between Southcote Junction and Oxford Road Junction. There are a number of potential choices going forward to deliver the Conditional Outputs however, to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

Initial capacity analysis suggests provision of grade separation at Southcote Junction and a third line between Southcote Junction and Oxford Road Junction, as described in option C3 would provide the additional capacity required to deliver the Conditional Outputs. Whether these two interventions are required in combination or can be delivered individually would be determined by future development work. They would also depend on when the connectivity Conditional Outputs are required and any further constraints identified outside of this Route Section. As identified in the **Wessex Route Study**, the grade separation of Basingstoke Junction is a choice for funders which is required in order to unlock the capacity for a third hourly intermodal freight path between the South Coast and the West Midlands.

Either choice would increase capacity and reduce performance risks along the Route Section. However, it is anticipated that the delivery of these choices would still be insufficient to deliver the full 2043 ITSS without compromising the journey time improvements anticipated in 2019. This is due to capacity utilisation in key constrained areas such as London Paddington to Reading being high. The implementation of both choices together is expected to mitigate this with the combined intervention allowing efficiencies to be realised which would reduce the overall cost.

By 2043, in addition to the lengthening of the long distance services, further capacity will be required to accommodate peak demand on the suburban stopping service between Reading and Basingstoke. Significant crowding is expected on arrival into Reading in the morning peak.

Access to Airports

Western Rail Link to Heathrow (WRLtH) provides the infrastructure capability for four services per hour to access Terminal 5 at Heathrow Airport. The Cross-Boundary connectivity Conditional Output could be met by an extension of some of these four services per hour to Basingstoke or beyond. These services would be limited to the length of the East Bay platform at Basingstoke if the trains terminated there, unless a further infrastructure intervention was undertaken.

Route Section D: Reading – Gatwick Airport

This Route Section is incorporated within the scope areas of the Wessex and Sussex Route Studies and will be described in detail in the Wessex Route Study. It is included here due to the possibility of operating cross-boundary services from the Wessex and Sussex Route Study areas into the Western Route Study area, specifically services from Gatwick Airport to beyond Reading.

Figure 5.18: Route Section D: Reading – Gatwick Airport

Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 (CP5) mean that the infrastructure assumptions for the baseline differ from today's infrastructure. This includes:

- an additional platform at Redhill (Platform 0).

Anticipated 2019 Baseline Service Patterns

The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 4tph Reading – London Waterloo
- 3tph Reading – Redhill – Gatwick Airport (1tph terminates at Redhill).

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to the Reading to Gatwick Route Section are defined by the **London & South East Market Study**.

London & South East Market Study

- The Conditional Output for rail connectivity to airports can be found in Chapter 3, Section 3.6.7.

Interpretation of Passenger Connectivity Conditional Outputs

The services between Reading and Gatwick Airport will be considered in the **Wessex Route Study**.

Freight Market Study

There is no freight forecast for this Route Section.

Figure 5.19: 2043 Indicative Train Service Specification Reading – Gatwick Airport

Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- Less than 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

Changes to the Indicative Train Service Specification to 2043

Between 2019 and 2043 it is anticipated that there will be a number of further service changes, detailed in the **Wessex Route Study**. Within the Western Route Study, the purpose is to consider the feasibility of cross-boundary services and the case for extending or linking trains across Reading. Choices to link services at Reading in the 2043 ITSS are presented in Route Section A: London Paddington – Reading.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- Reading Station platform capacity
- Reading – Oxford capacity (if additional services are proposed).

Making Best Use of Capacity

In order to make best use of the existing system capacity, the strategy needs to consider optimisation of system capacity taking into account cross-boundary requirements, connectivity improvements and the linkage of services.

Applying these principles implies consideration of the following choice:

D1: Improved connectivity across Reading	
Conditional Output	Connectivity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast demand and provide improved connectivity from west of Reading to Gatwick Airport
Description	Choices could include linking either 2tph Basingstoke – Reading, 2tph Oxford (or beyond including from East West Rail) or 2tph from the Newbury corridor with 2tph Reading – Gatwick to provide through connectivity from these areas to Gatwick Airport subject to further assessment to determine sufficient capability to accommodate such links at Reading
Indicative Cost	No additional cost assuming train lengths either side of Reading are consistent and infrastructure capacity and capability exists. If not, additional operating costs may be incurred to accommodate longer trains
Indicative Value for Money	Expected to be financially positive if there is a workable timetable solution
Relates to other options	D2 regarding extending Gatwick Airport trains west of Reading
Analysis In the 2019 ITSS, there are a small number of services terminating at Reading from the west, namely from East West Rail and local stopping services from Basingstoke. To make best use of existing system capacity, these services could be linked at Reading to services to Gatwick Airport: providing improved connectivity opportunities via a through service from, for example, Basingstoke or Newbury to Guildford and Gatwick Airport. However the current timetable on both routes is constrained in a number of ways so it may prove difficult to provide a workable timetable without a major recast over a large area.	

Drivers of Change, and Choices for Funders, in Control Period 6

The following driver of change for the Route Section in CP6 has been identified:

- Accommodating demand: a potential increase in demand may arise for Gatwick Airport, depending on Government's plans for airport expansion

Based on the 2019 ITSS and applying the Reading growth forecast, initial analysis suggests that additional capacity will be required on arrivals into Reading in the high peak hour by 2023. The **Sussex Route Study** is reviewing an option to increase capacity on the Brighton Main Line by lengthening Platform 2 at Reigate to enable 12-car trains. If this intervention were to proceed, an opportunity exists to relieve infrastructure constraints at Reigate incrementally to these enhancements, and lengthen Platform 1 to enable longer services on the North Downs Line. Additional count data is required to confirm the additional capacity required in 2023. More detail on this is available in the **Wessex Route Study**.

Improvements to connectivity would also present opportunities for improved journeys and provide additional capacity as presented in D2. Capacity analysis for this Route Section is presented in detail in the **Wessex Route Study**.

Electrification

Possible future electrification of the remaining sections of the Reading – Gatwick Airport route would allow an electric train service to operate from west of Reading to Gatwick Airport, potentially with a change of traction power supply en route in the Reading Station area.

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

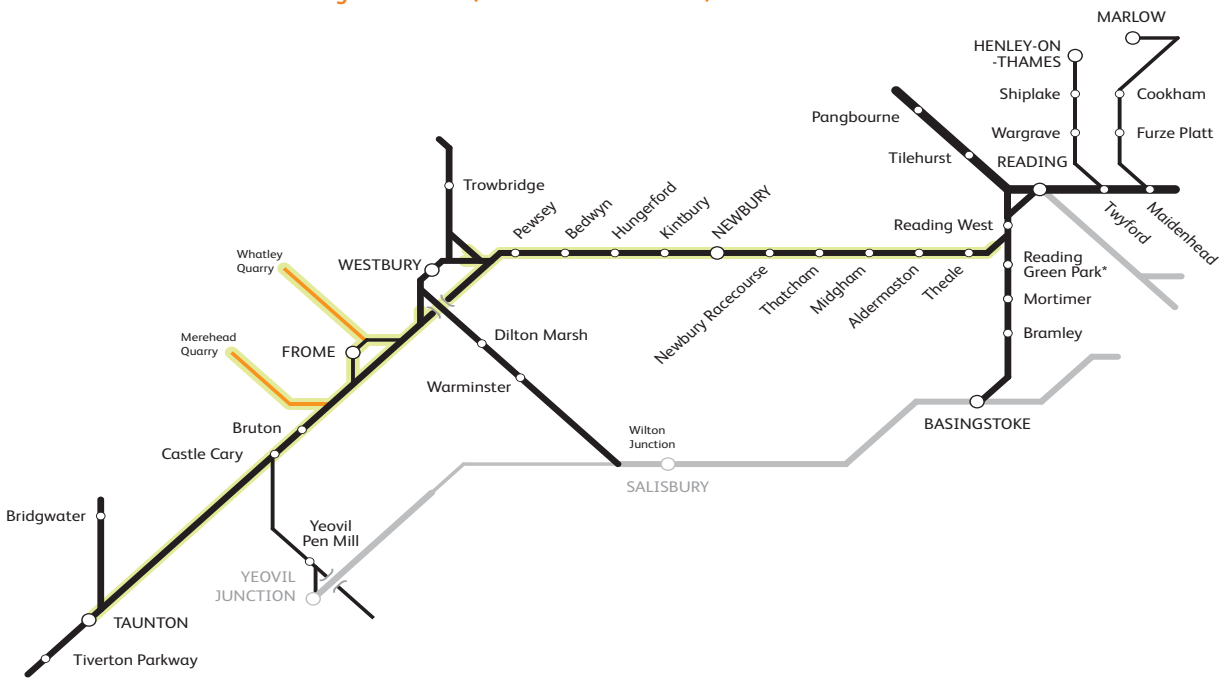
Longer Term Strategy

Longer term strategy for this Route Section will be considered further in the **Wessex Route Study**.

D2: Improved connectivity from Oxford to Gatwick Airport	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate demand from catchments west of Reading, principally Oxford, to Gatwick Airport
Description	Extension of 1 or 2tph Reading – Gatwick Airport services to become Oxford – Gatwick Airport
Indicative Cost	Operating costs would be incurred as this choice proposes additional services between Reading and Oxford, which will require infrastructure interventions for any increase above 1tph on this corridor
Indicative Value for Money	Not assessed.
Relates to other options	D1 for linking existing services at Reading, and G2 and G3
Analysis An alternative scenario to D1 would be to extend one or two of the trains per hour between Reading and Gatwick Airport to Oxford as a fast service, either with or without a limited number of intermediate calls west of Reading. Analysis suggests there is theoretical capacity for one additional train per hour at Didcot which is a key constraint on the route between Reading and Oxford. Such constraints are detailed further in Route Section G. Rolling stock would also need to be suitable for a journey of the duration implied by a semi-fast service between Oxford and Gatwick Airport.	

Route Section E: Reading – Taunton (the Berks & Hants line)

Figure 5.20: Route Section E: Reading – Taunton (the Berks & Hants line)



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 means that the infrastructure assumptions for the baseline differ from today's infrastructure. This includes:

- electrification of the route between Reading and Newbury.

Anticipated 2019 Baseline Service Patterns

Following electrification to Newbury, the 2019 Indicative Train Service Specification (ITSS) assumes that the current London Paddington – Bedwyn service will operate with electric rolling stock and therefore be truncated at Newbury. A diesel shuttle service is proposed between Newbury and Bedwyn. These services will operate all day.

The principal off-peak train services anticipated in the 2019 ITSS are as follows (tph = trains per hour, each direction):

- 1tph London Paddington – Newbury
- 1tph Newbury – Bedwyn
- 1tph London Paddington – Westbury
- 1tph London Paddington – Exeter or beyond
- less than hourly train service between Yeovil Junction and Salisbury via Westbury anticipated to start from December 2015
- 1tph Freight.

In addition to the off-peak anticipated 2019 service pattern, an additional peak service is expected to operate between Reading and Newbury in the 2019 ITSS to provide additional capacity.

Other train services cross the route at Westbury including one train approximately every two hours between Bristol and Weymouth which follows the route as far as Castle Cary.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section are:

Figure 5.21:

Reference	Western Route Study Conditional Output
CO2	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – Main Line services.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **London & South East** and **Long Distance Market Studies**.

London & South East Market Study

For non-London journeys of less than 30 miles, the Conditional Output is a target journey time of 60 minutes.

Journeys which are longer distance (>30 mile), non-London journeys (including outer suburban journeys) have a different Conditional Output. The Conditional Output is to provide a total Generalised Journey Time (GJT) of significantly less than 100 minutes and as close to 40 minutes as possible, provided that this is an improvement on the 2019 baseline position, see Chapter 3.

Figure 5.22: Interpretation of Passenger Connectivity Conditional Outputs

Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
CO103	London Paddington – Exeter	2 to 3tph at 100mph	3tph
CO114	London Paddington – Plymouth	2 to 3tph at 100mph	2-3tph
CO123	London Paddington – Penzance*	1 to 2tph at 80mph	1tph

* The Truro zone in the **Long Distance Market Study** includes the whole of Cornwall

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown on the 2043 ITSS.

The ITSS includes additional train services for stations between Reading and Bedwyn which would improve GJTs from these stations.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts are:

- 1.5 – 2tph Reading – Westbury
- >2tph Westbury – Frome
- 0.5 – 1.5tph Frome – East Somerset Junction (for Merehead quarry branch)
- <0.25tph East Somerset Junction – Cogload Junction (north of Taunton).

All freight movements on this Route Section are Class 6 or Class 7 (typically 'heavier' traffic).

Since the publication of the **Freight Market Study** (FMS), the forecasts for construction traffic have been revised in light of rail's increased market share for this traffic. This implies a significantly larger number of paths required for this traffic in the long term, which will need to be addressed in future planning cycles. For Control Period 6, it is anticipated that the traffic can be accommodated with a better utilisation of the standard off-peak paths per hour provided as part of the 2019 development timetable.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- extension of baseline 1tph London Paddington – Westbury to terminate at Plymouth
- extension of baseline 1tph semi-fast London Paddington – Newbury to Newton Abbot thence every 2 hours to either Paignton or Plymouth
- up to 1tph London Paddington – Newbury (with options to extend to Westbury)
- up to 1tph Reading – Newbury (with options to extend to Bedwyn)
- increased frequency of Bristol – Yeovil to 1tph (extension to Weymouth remains 2 hourly)
- 1tph Freight.

The updated forecasts for construction traffic would increase the number of Class 6 paths required between Westbury to Southcote Junction by 2043 to 3-4tph, the implications of which would need to be addressed in future planning cycles.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

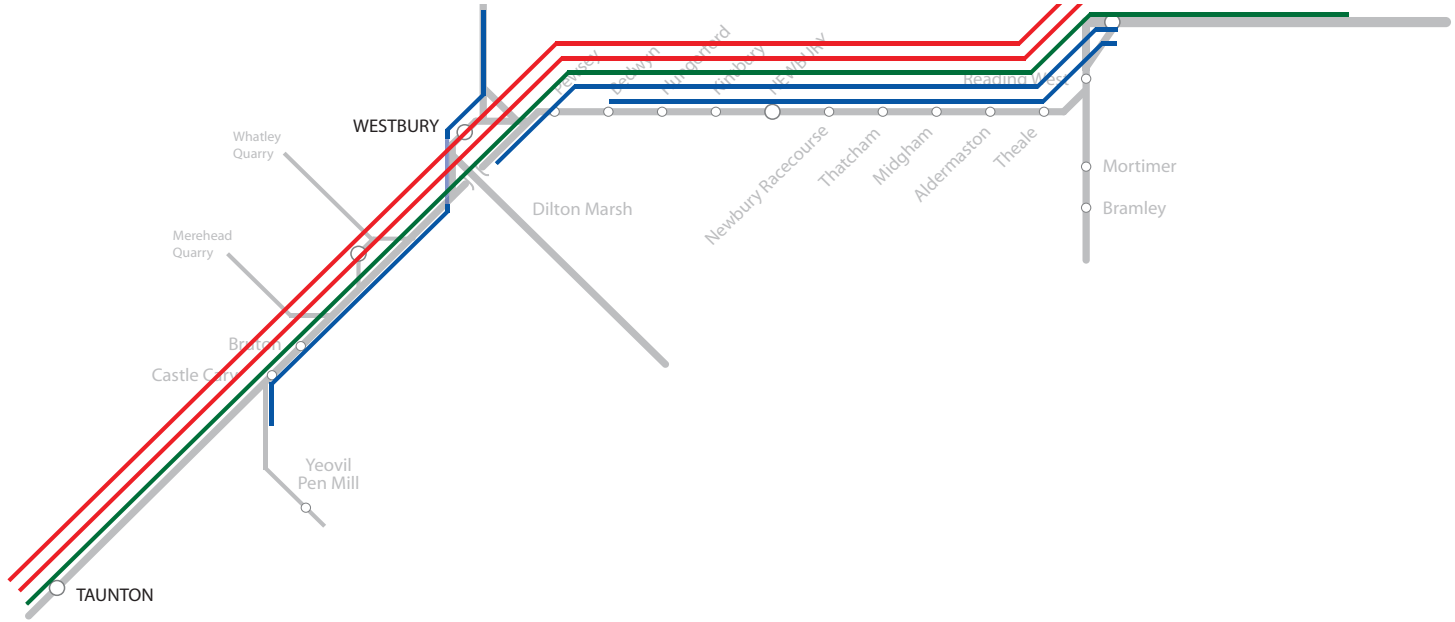
- the speed mix of services on the two-track railway between Westbury and Reading ranging from 45mph Class 7 freight services to non-stop 100mph long distance passenger services
- on-train crowding on services into London Paddington from west of Reading.

Making Best Use of Capacity

The analysis suggests that in 2019 the Route Section has little capacity to accommodate any additional train services in the peak period.

There are occasional Class 7 freight paths which are timetabled at 45mph along this route in both directions and the significant speed differential between these and other services drive a relatively inefficient use of capacity with the mix of traffic becoming a principal limitation on capacity utilisation.

Figure 5.23: 2043 Indicative Train Service Specification Reading – Taunton



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- Less than 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

As referred to in Route Section A, work is ongoing to understand whether it would be possible to operate the Class 7 freight services at 60mph (Class 6) rather than 45mph, the principal physical limitation being the design of the wagons used. This will identify whether the operational and performance gains from such a change would release additional capacity for further train paths.

The network could potentially accommodate an additional service in the off-peak between Reading and Newbury and in terms of route capacity, this service could be extended to Bedwyn. However, as the limit of electrification is currently proposed as Newbury, this would depend on the rolling stock strategy and the extent of any further electrification.

Should the appropriate traction capability be provided, the service could be extended beyond Bedwyn depending on the ability to:

- optimise calling patterns across the route, and optimise the weights of freight services in the relevant hours.

There is a clear opportunity to consider and develop the proposals.

Drivers of Change, and Choices for Funders, in Control Period 6

The following drivers of change for the Route Section in CP6 have been identified and includes a number of choices for funders:

- accommodating passenger and freight demand
  - there is scope for accommodating rail passenger demand by train lengthening
  - freight demand is expected to increase however it is assumed the growth will be accommodated within the standard opportunities provided each hour for freight in the 2019 ITSS
  - alignment with renewals (resignalling): the signalling renewal of the Westbury area (between Kintbury and Castle Cary) is forecast in CP7.

Accommodating demand

Demand analysis indicates that the morning peak services on this route into London Paddington will experience on-train crowding from Newbury by 2023. The Western Route Study presents two choices to provide additional capacity in order to accommodate this growth in demand and minimise on-train crowding. In terms of providing sufficient capacity, the choices represent alternative options.

- see Route Section A: London Paddington – Reading: A5: Lengthening peak services between Newbury and London Paddington
- see Route Section A: London Paddington – Reading: A6: Lengthening the high-peak services between the West of England and London Paddington.

Renewals

The opportunity exists to align enhancement requirements to the signalling renewal to provide additional capacity through the reduction of planning headways between Southcote Junction and Westbury, and between Westbury and Cogload Junction. This would achieve efficient delivery of a capacity enhancement through alignment with the renewals.

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required between Reading and Taunton due to the number and speed mix of trains. There are a number of potential choices to deliver the Conditional Outputs. However, in order to meet all of them there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between rolling stock, journey time, service frequency and performance.

Analysis has identified that significant infrastructure would be required to accommodate the full 2043 ITSS. This level of service frequency would require making use of all existing looping capability and creates a need to provide additional capability. The result would be an extensive looping of freight services across this Route Section. The capability required would need to include:

- additional Up running line between Westbury and Hungerford, or
- additional Up loops between Westbury and Lavington, Lavington and Woodborough and Bedwyn and Hungerford.

Equivalent infrastructure would be also required in the Down direction (assuming the requirements for freight capability continue to be equivalent in that direction).

Extending local passenger services beyond Bedwyn within the context of the 2043 ITSS would also require equivalent significant infrastructure.

The extent of these interventions is considered inappropriate in the short term and as such alternative options for delivering additional incremental services are given below, alongside the proposals for delivering peak demand. The following choices set out a range of interventions which seek to address this issue:

- E1: Interventions to accommodate rail passenger demand
- E2: Capacity enhancements
- E3: Extension of electrification to Westbury.

E1: Interventions to accommodate rail passenger demand

By 2043, further capacity will be required to accommodate predicted rail passenger demand into London Paddington in the peak period. This could be provided through train lengthening and extending the anticipated Newbury to Reading service proposed in the 2019 ITSS to run from Reading to London Paddington to cater for increased demand between Reading to London.

Alternatively, replacement of the existing West of England HST services with an equivalent or better capacity, high performance rolling stock might provide the opportunity for an increase in capacity and enable a more efficient operation of the rolling stock fleet as a whole.

E2: Capacity Enhancements

This option could deliver a third long distance service as per the 2043 ITSS whilst maintaining freight capacity and capability as present, noting that a Class 7 freight train could not operate in the same hour as a third long distance service.

By:

- reducing planning headways between Southcote Junction and Westbury

And:

- **either**: increased looping of freight services, making more use of existing loops in both directions and building additional looping capability in the Up and Down direction between Newbury and Woodborough, (ensuring minimal impact on planning headways caused by freight entering and exiting the loops)
- **or:** improve the traction capability for freight services (e.g. through electrification to Westbury and the use of electric traction) to remove the need for additional looping

Alternatively, the third long distance service could be routed via Melksham in order to reduce the quantum between Reading and Taunton. However, this would have an impact on end to end journey times, and would require additional infrastructure of the Melksham Line which is unlikely to have a sufficient value for money business case.

E3: Extension of electrification to Westbury

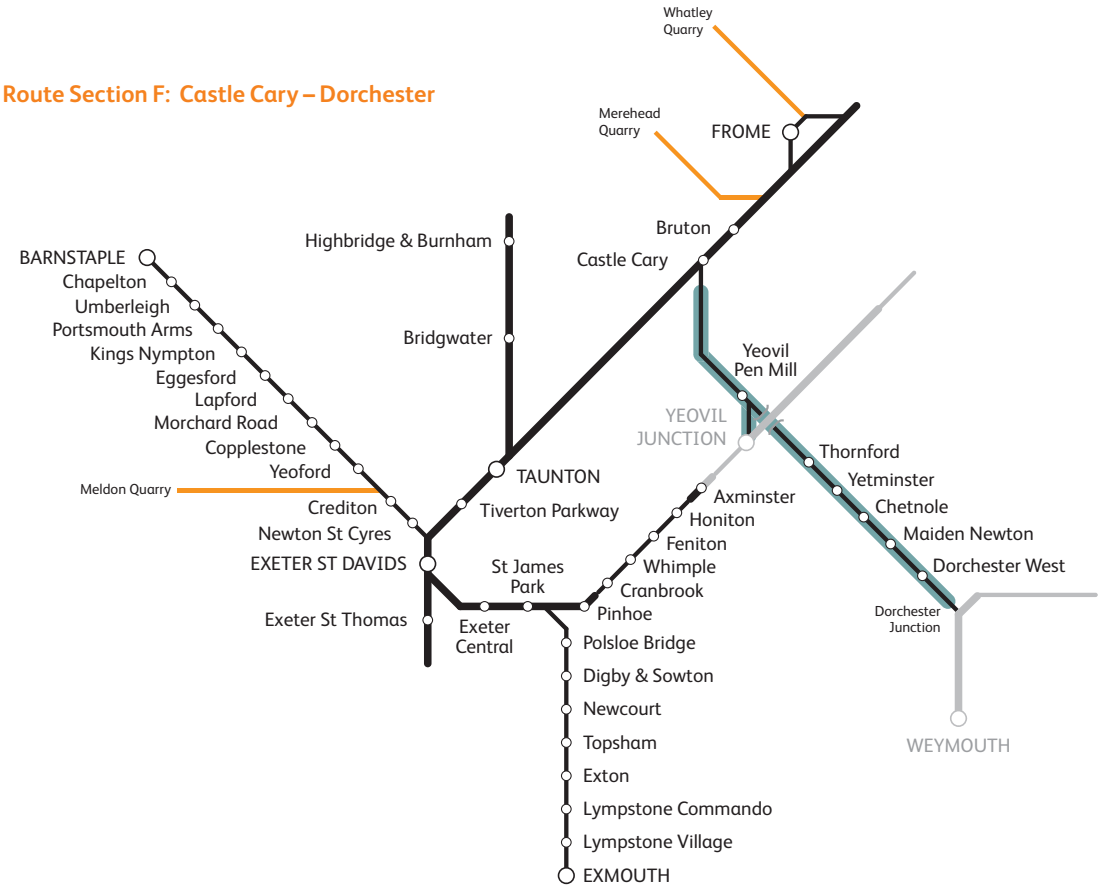
Electrification of both lines between Newbury and Westbury, and the provision of electric traction and rolling stock, would harmonise the speed mix of services in order to sufficiently accommodate the passenger and freight services in the 2043 ITSS.

Initial analysis indicates up to a 20 minute reduction in journey time for Class 6 freight services operating under electric traction between Southcote Junction and Westbury (comparing an equivalent Class 66 as 60mph to an equivalent Class 92 as 75mph). It is anticipated that this would be sufficient to remove the requirement for additional looping capability on this route, and reduce the need to loop freight services, whilst enabling an additional long distance passenger service to operate.

With the provision of electrification and Class 92 electric locomotives operating at 75mph, a theoretical journey time improvement of between 15 and 20 minutes could be achieved between Westbury and Southcote Junction (excluding other timetabling constraints), compared to an equivalent diesel-powered train. The provision of electric traction could also improve performance and potentially remove the requirement for an additional loop (as per E2). This would be subject to further analysis.

Route Section F: Castle Cary – Dorchester

Figure 5.24: Route Section F: Castle Cary – Dorchester



Description of the Anticipated 2019 Baseline Infrastructure

There are currently no planned interventions between 2014 and 2019, therefore the infrastructure assumptions for the 2019 baseline remain unchanged from today.

Anticipated 2019 Baseline Service Patterns

The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1 train per 2 hours (approximately) Bristol – Weymouth.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

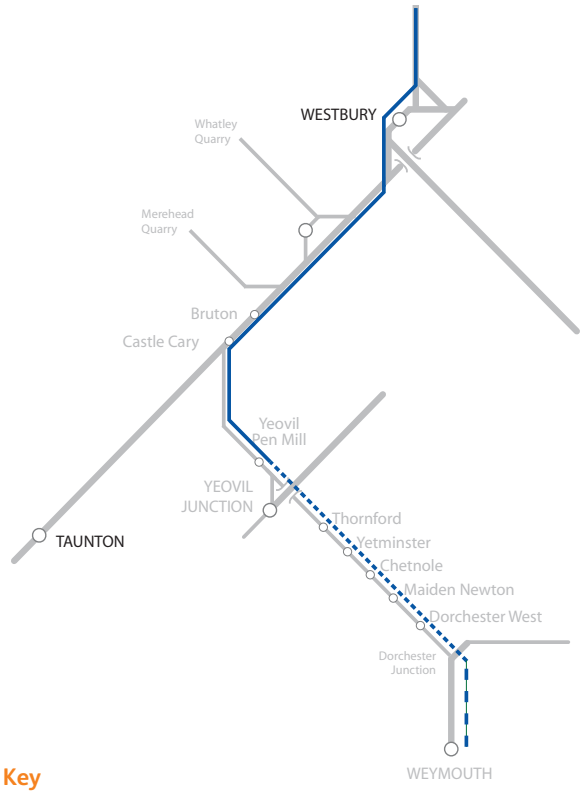
Connectivity

In terms of passenger services the connectivity Conditional Output is to at least maintain the current service level.

Freight Market Study

There is no freight forecast for this Route Section.

Figure 5.25: 2043 Indicative Train Service Specification Castle Cary – Dorchester



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional service:

- 1 train per 2 hours Bristol – Yeovil increasing the frequency between Bristol and Yeovil to 1tph, with extensions every two hours to Weymouth.

System Capability Constraints

Overlaying the 2043 ITSS on the 2019 baseline infrastructure has not highlighted any areas of constraint on this line of route.

Making Best Use of Capacity

There is sufficient capacity to accommodate 2023 peak demand along this corridor. There is sufficient capacity on the 2019 baseline infrastructure to operate the proposed 2043 ITSS.

Drivers of Change, and Choices for Funders, in Control Period 6

In CP6 this Route Section does not experience a change in service level and the strategy has not identified any constraints. However, the linespeeds on this Route Section are low, particularly for the heavier rolling stock used to carry seasonal peak loads, and will be reviewed as part of the wider Western Route Journey Time Improvement programme; see Section 5.2.3.

The section of this route between Castle Cary and Yeovil Pen Mill, including the chord link to Yeovil Junction Station, provides diversionary route capability between London Paddington and the South West Peninsula during periods where the Berks and Hants route between Castle Cary and Taunton is unavailable. Due to the single line sections on this route, the pathing of diverted services conflicts with the pathing of the scheduled local service to Weymouth. The accommodation of services along this Route Section for diversionary purposes has been aligned with the **Wessex Route Study** and is presented in more detail in Route Section O: Exeter area.

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

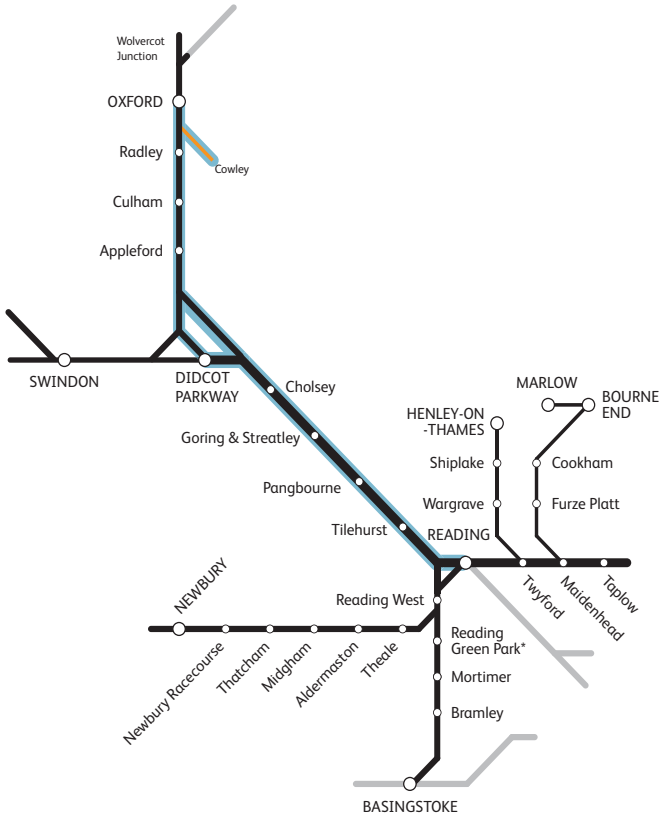
Longer Term Strategy

The 2043 ITSS has an hourly service between Westbury and Yeovil Pen Mill; this is an increase over the approximately once every two hours service frequency anticipated in 2019. This increase in service frequency can be accommodated on current infrastructure. Between Yeovil Pen Mill and Weymouth the service frequency would remain as today.

By 2043, further capacity will be required to accommodate forecast rail passenger demand into Bristol on services from Weymouth.

Route Section G: Reading – Didcot – Oxford

Figure 5.26: Route Section G: Reading – Didcot – Oxford



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. The full list is provided in Chapter 2: Baseline. Those relevant to this route are anticipated to include:

- resignalling of the Oxford area
- Oxford Corridor Capacity Improvements
- Electrification
- Intercity Express Programme
- East West Rail.

Anticipated 2019 Baseline Service Patterns

The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1tph London Paddington – Oxford
- 1tph London Marylebone – Oxford (via East West Rail)
- 1tph Bournemouth – Manchester Piccadilly
- 1tph Southampton Central or Reading – Newcastle
- 1tph Basingstoke – Manchester Piccadilly
- 1tph Reading – Bedford via East West Rail
- 1tph Reading – Milton Keynes via East West Rail
- less than 1tph Oxford – Banbury
- 3tph Freight
- 1tph London Paddington – Cheltenham via Gloucester
- 1tph London Paddington – Worcester Foregate Street
- 2tph London Paddington – Cardiff
- 4tph London Paddington – Bristol Temple Meads (2tph via Bath Spa and 2tph via Bristol Parkway with 1tph extended to Weston-super-Mare).

During peak hours, two additional trains per hour are anticipated to operate to carry peak passenger loadings between Oxford, Reading and into London Paddington.

A significant volume of freight runs between the north and south through the Reading – Oxford Route Section comprising aggregate, automotive, intermodal, steel, petroleum goods and defence traffic. The anticipated level of traffic in 2019 is between two and three paths per hour throughout the day with fewer freight trains running during peak periods.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section is shown in Figure 5.27.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the London & South East and Long Distance Market Studies.

Figure 5.27

Reference	Western Route Study Conditional Output
CO1	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – inner suburban services (Relief Lines and Thames Valley branches)

London & South East Market Study

Outer suburban services include those to Reading, Oxford and Newbury, have a Conditional Output to provide a total Generalised Journey Time (GJT) to London as close to 40 minutes as possible, provided that this is an improvement on the 2019 baseline position, see Chapter 3 for further details on GJT.

Figure 5.28: Interpretation of Passenger Connectivity Conditional Outputs			
Reference	**Flow**	**Market Study Connectivity Conditional Output**	**Western Route Study interpretation of service frequency**
From the Cross-Boundary ITSS	Reading – Birmingham	1 to 2tph at 80mph	2tph direct
From the Cross-Boundary ITSS	Reading – Cambridge	1 to 2tph at 80mph	Via London
From the Cross-Boundary ITSS	Southampton – Cambridge	1 to 2tph at 80mph	Via London
From the Cross-Boundary ITSS	Reading – Leicester	1 to 2tph at 80mph	1tph direct via East West Rail
From the Cross-Boundary ITSS	Reading – Nottingham	1 to 2tph at 80mph	1tph direct via East West Rail
From the Cross-Boundary ITSS	Reading – Leeds	1 to 2tph at 80mph	Via Old Oak Common
From the Cross-Boundary ITSS	Reading – Manchester	1 to 2tph at 80mph	Via Old Oak Common
From the Cross-Boundary ITSS	Swindon – Nottingham	1 to 2tph at 80mph	1tph direct
CO79	Oxford – Bath	1 to 2tph at 80mph	1tph direct

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study (or Cross-Boundary ITSS) has interpreted the Conditional Outputs as follows:

- **Long Distance Market Study** - ITSS delivers the connectivity outputs in terms of opportunities to travel each hour
- **London & South East Market Study** - provision of two local services each hour between Reading and Oxford. The calling pattern of these trains between Didcot and Oxford is discussed in A7.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts (measured at the busiest point taken as between Oxford and Radley) are:

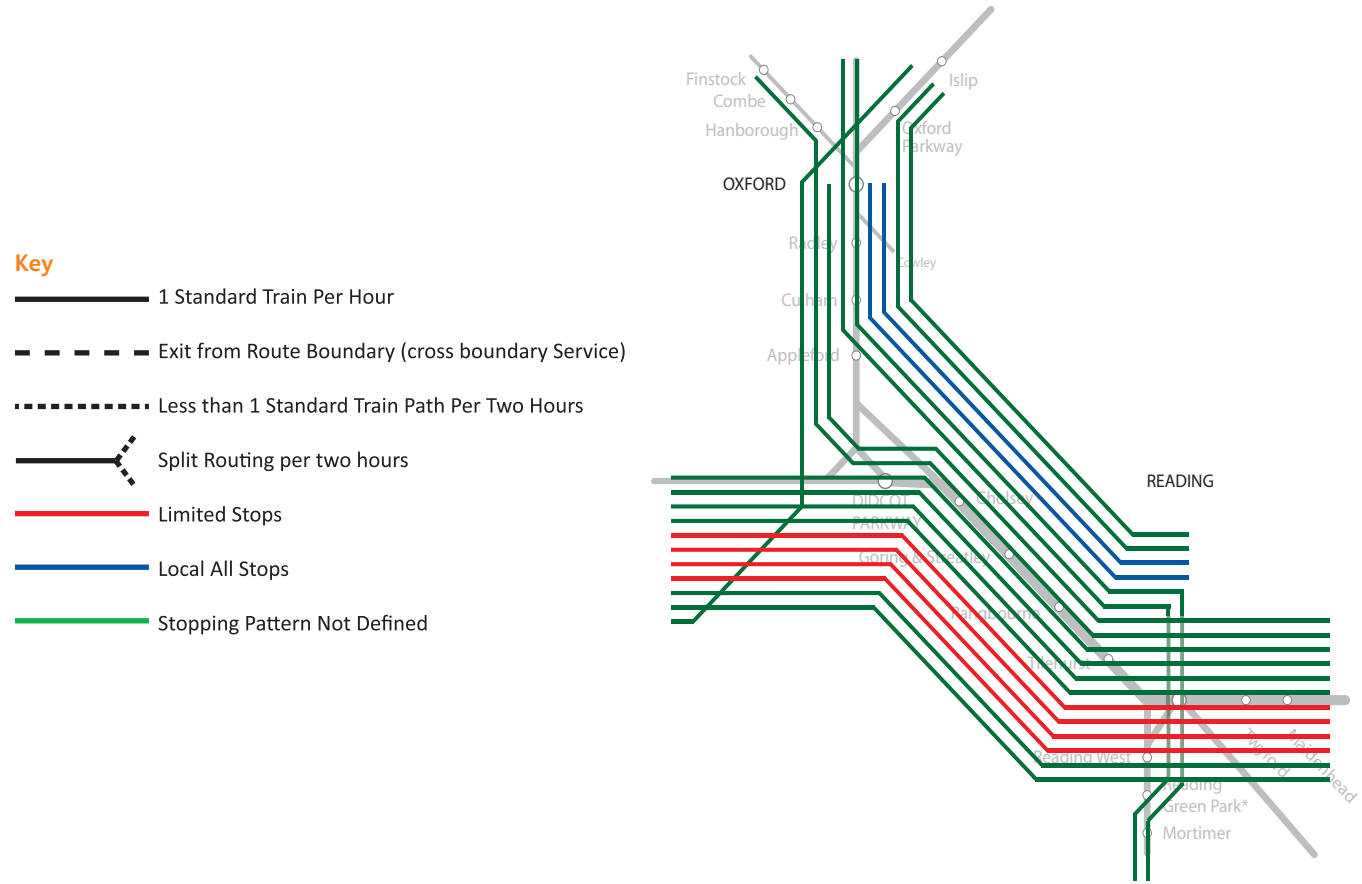
- 3 – 4tph Class 4 (typically intermodal or automotive traffic)
- 1tph Class 6 (typically 'heavier' traffic).

It is noted that in order to achieve the daily requirement for freight paths in 2043, alongside constraints in peak periods, it is likely that two Class 6 freight paths will be needed on this Route Section in some hours.

Following the introduction of East West Rail, freight operators will have the option to route either via Banbury and Birmingham to the North West or via East West Rail to access the West Coast Main Line and the Midlands, subject to sufficient track capacity and capability to do so.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Figure 5.29: 2043 Indicative Train Service Specification Reading – Didcot – Oxford



Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 2tph from north of Oxford via East West Rail to Reading or Bristol (1tph to each)
- 1tph Oxford – Worcester (with the option to form through services from London Paddington at Oxford if a suitable service exists at Oxford. This would be in addition to the baseline 1tph London Paddington – Worcester, and the 1tph London Paddington – Cheltenham – Worcester)
- Extension of 2tph from Reading to London Paddington (assumed to be East West Rail services contained within the 2019 baseline which are extended)
- 1tph Freight.

The following additional services would operate over the Reading to Didcot Parkway section of the route:

- 1tph London Paddington – Gloucester (alongside extension of the existing Cheltenham service to Worcester)
- 2tph London Paddington – Cardiff.

During the production of the Western Route Study, the 2043 ITSS for East West Rail services has been increased from 2tph to 4tph. This was agreed by the Route Study Working Group to ensure consistency with the Conditional Outputs agreed more recently by the East West Rail Programme Board.

There are a number of different choices available for connecting these services across Oxford which will affect the level of infrastructure required. For example, the incremental service specification for East West Rail and the connectivity Conditional Output for Oxford to Reading could both be met by running two additional services per hour direct from the East West Rail route to Reading via Oxford. Such options for connectivity across Oxford form part of the choices for funders.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- varied speed profiles and calling patterns of services between Oxford and Didcot, and between Didcot and Reading on the Relief Lines utilises track capacity to the extent that this section operates at close to capacity with the 2019 ITSS and baseline infrastructure
- planning headways on the Main Lines between Reading and Didcot constrain flexibility in the construction of a timetable pattern containing up to the required 14 paths per hour between Reading and Didcot East Junction
- the high speed and frequency of services on the GWML making crossing movements from the Main Lines to the Relief Lines for services towards Oxford at Didcot East Junction
- the high capacity utilisation at Oxford North Junction expected as a result of the number of services planned to operate to/from the East West Rail route
- Oxford Station capacity – constraints imposed through the number of platforms and rising passenger volumes are expected to increase following the delivery of committed schemes
- on-train crowding on services between London Paddington and Oxford.

In 2019, the ITSS anticipates that Oxford North Junction will be at maximum capacity utilisation with both Didcot East Junction and the platform utilisation at Oxford Station approaching a similar level of saturation. Any increase in the number of services above the level set in the 2019 ITSS would require a comprehensive infrastructure intervention to improve the separation and management of traffic flows on this corridor that diverge north of Oxford.

Making Best Use of Capacity

Analysis of the 2019 development timetable and performance studies indicates that in 2019 the Route Section will be considerably constrained with minimal capacity to operate any additional train services or modify calling patterns beyond those already assumed, without an adverse impact on journey times.

An additional train path per hour could potentially be accommodated between Oxford and Reading via Didcot East Junction over and above the 2019 ITSS, provided that the service terminates at Oxford Station (due to the anticipated capacity constraints at Oxford North Junction).

Beyond this additional path, no further capacity would be available at Didcot East Junction unless an infrastructure intervention is provided.

The 2019 ITSS anticipates that two trains per hour running from Bedford/Milton Keynes to Oxford will be extended to Reading in place of the existing stopping service over this section of route, picking up intermediate station calls. This timetable solution is driven by the limited capacity available over the two-track section from 2019 between Oxford and Didcot and at Didcot East Junction.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand:
  - there is scope for accommodating rail passenger demand by train lengthening. This intervention requires increased expenditure so is subject to a value for money assessment presented in A7
  - additional station capacity will be required to accommodate the anticipated growth in rail passenger throughput at Oxford Station
  - freight demand is expected to increase on this Route Section however it is assumed the growth will be accommodated within the standard provision included for freight each hour in the 2019 ITSS
- access to HS2 (at Old Oak Common). The HS2 station at Old Oak Common will provide fast services towards the North West, and is anticipated to open in 2026. This is likely to lead to an increase in rail passenger demand on the route towards London Paddington due to the increased connectivity opportunities
- Funders' Priority.

To meet these drivers for change, the following choices have been investigated:

Accommodating rail passenger demand

Demand analysis confirms that the limited-stop services between London Paddington and Oxford anticipated in the 2019 ITSS will provide sufficient capacity for forecast rail passenger demand in CP6.

Demand analysis on the peak stopping services between London Paddington and Oxford indicates that additional capacity will be required in CP6 as on-train crowding is forecast to occur inwards from Tilehurst on two high peak hour services arriving into London Paddington between 08:00 and 09:00. The choice for funders to lengthen these high peak services to accommodate rail passenger demand is presented in A7.

With forecast rail passenger demand and anticipated increases in service provision at 2019 and beyond, capacity interventions will be required to facilitate passenger throughput at Oxford Station during CP6.

In July 2014, Network Rail, Oxford City Council and Oxfordshire County Council jointly launched consultation on the outputs from an Oxford Station Masterplan. This Masterplan study includes proposals for a significantly enhanced station which incorporates provision for future growth and would allow rail to play its part in driving economic growth through the regeneration and growth of the west end of Oxford. Further analysis of Masterplan options, including modelling of pedestrian movements, will be required if this intervention is developed further for CP6.

Access to HS2 (at Old Oak Common).

The HS2 station at Old Oak Common will provide fast services towards the North West and is anticipated to open in 2026. This is likely to lead to an increase in rail passenger demand on the route towards London Paddington due to the increased connectivity opportunities. Current proposals for the layout assume all Main Line trains call at Old Oak Common.

Funders' Priority

The Oxfordshire Local Enterprise Partnership's Strategic Economic Plan (SEP) promotes the concept of the "Oxfordshire Knowledge Spine". This would form an arc from Didcot to Bicester incorporating internationally renowned centres for scientific and technological research near Didcot and Culham. The SEP notes the aspiration to provide public transport connectivity between nodes on the Knowledge Spine with a minimum of four opportunities to travel each hour, including Culham.

The connectivity Conditional Outputs contained in the 2043 ITSS would provide for frequent connections between Didcot Parkway (potentially linking with the onward bus connections to Science Vale centres at Milton Park and Harwell), Oxford and Bicester. There are choices to be made with respect to the provision of public transport connectivity at Culham.

If rail is identified as the appropriate method of connectivity for Culham and the service level increased above the 1tph frequency anticipated in the 2019 ITSS, then it will not be possible to deliver the full 2043 ITSS without infrastructure intervention on this corridor. This choice arises due to the constraints of the two-track railway between Didcot North Junction and Hinksey North Junction and the provision of station stops at both Appleford and Culham (stops are usually alternated between the stations during the day). This would increase the speed differential between stopping services and non-stop services and therefore increases the capacity consumed.

Accommodating the full 2043 ITSS including the baseline service level at Radley and Appleford, alongside the potential requirement for 2-4tph calling at Culham would need additional infrastructure such as four-tracking between Didcot and Oxford. Should the development of frequent rail connectivity at Culham for the Science Park be a priority then the infrastructure interventions required to support this could be accelerated to CP6 from the longer term scenario.

The Department for Transport and the East West Rail Consortium are undertaking work to develop the case for a further eastward extension of East West Rail services. This could lead to more train services being required to operate between Didcot and Oxford. In addition to increased passenger train movements facilitated by East West Rail, should freight growth above CP6 levels occur earlier than forecast (stimulated by East West Rail), additional capacity would be required on this route section. Choices G1 to G3 to deliver this increased capacity are described under Longer Term Strategy.

Longer Term Strategy

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS and freight growth beyond CP5, further interventions will be required between Reading and Oxford. The timing of these interventions will depend on changes to the service specification and the addition of any further services above the 2019 ITSS – as and when these will be implemented, additional infrastructure will be required.

There are a number of potential choices going forward to deliver the Conditional Outputs however, in order to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

To provide capacity for the 2043 ITSS on this Route Section the choice exists between the following packages of interventions:

G1: Interventions to accommodate rail passenger demand

G2: Grade separation of Didcot East Junction and Oxford North Junction and associated capacity improvements at Oxford Station

G3: Grade separation of Didcot East Junction, four-tracking between Didcot and Oxford and associated capacity improvements at Oxford Station.

Each of the choices is addressed in further detail:

G1: Interventions to accommodate rail passenger demand at Oxford Station
Further capacity will be required to accommodate predicted rail passenger demand by 2043 beyond that provided in CP6. Meeting this demand could be addressed by a combination of higher density rolling stock, further lengthening of trains or the provision of network capability to accommodate additional peak services. As described previously, passenger volumes and train movements at Oxford Station are forecast to grow which will lead to a requirement for increased capacity of the station facilities and the operational layout. The Masterplan proposals address the requirements to expand and enhance the station facilities. This outline design assumes a fourth through-platform line, on the east-side of the station.

G2 Grade Separation at Didcot East and Oxford North Junctions and associated capacity improvements at Oxford Station	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6) or Longer term (subject to funders' priorities)
Purpose	Provides capacity for four additional trains per hour: two additional passenger services per hour plus up to two additional freight services per hour above the 2019 ITSS. This also supports a high performing railway.
Description	Infrastructure interventions required in this package are: • incremental signalling upgrade between Reading and Didcot to permit an improved planning headway on Main and Relief Lines • grade separation at Didcot East Junction to allow trains from the Great Western Down Main to cross the Great Western Up Main without conflict • provision of a fourth through platform at Oxford Station • grade separation at Oxford North Junction to permit movements from the Down Passenger Loop to the Down Bletchley line without conflict • potential requirement for an additional track and platform on the avoiding route at Didcot Parkway (subject to further assessment)
Indicative Cost	• £50m – £100m for Didcot East Junction • £50m – £100m for Oxford North Junction • costs for the fourth platform at Oxford and incremental signalling enhancement to be determined through detailed development work
Indicative Value for Money	Poor – based on the limited number of benefits which can be quantified at this point in time.
Relates to other options	Alternative to G3 - Grade separation at Didcot East Junction and capacity improvements between Didcot and Oxford. Choices identified for funders in the **West Midlands and Chilterns Route Study** which affect the service outputs on the route between Oxford and Bicester will also interrelate with this option given that additional services to and from the East West route are a key driver for this choice.

Analysis

Grade separation of Didcot East Junction and Oxford North Junction would provide sufficient additional capacity to accommodate the 2043 ITSS whilst also providing significant performance benefits by reducing delays at these junctions and supporting a high performing railway. With no further interventions, sufficient capacity is available between Oxford and Didcot for the anticipated quantum of trains in the 2043 ITSS only if calls at the intermediate stations remain limited (as per today). A total of three local stops per hour would be deliverable, distributed between two trains per hour. This requires a trade-off between frequency of calls, system capacity and overall journey times.

Providing additional capability north of Didcot, would improve the overall value for money of this intervention. When combined with the potential interventions outlined in G3, significantly greater capacity benefits could be achieved.

Provision of a fourth through platform at Oxford by conversion of one of the two bay platforms provided in the 2019 baseline would allow the Up side (towards London) platform capacity to match that provided in the Down direction (towards Birmingham) and would provide the necessary capacity for additional services between Oxford and Reading as included in the 2043 ITSS. This also supports the optimum operation of the Oxford Station area by providing additional capacity to enable improved flexibility and construction of the service pattern. Passive provision for this fourth platform is also included in the Oxford Station Masterplan.

Improving the planning headways between Reading and Didcot Parkway would support both performance and capacity requirements.

More detailed analysis as part of further development work should be undertaken as this may identify that the performance implications of not providing additional infrastructure between Didcot and Oxford is too great and partial four-tracking may need to be incorporated (as per option G3).

Option G2 was subject to a significant public response during the consultation period with responders noting their objection to grade separation at Oxford North Junction. This has been noted and will inform the selection of options for the next stage of development.

G3: Grade separation at Didcot East Junction, capacity improvements between Didcot and Oxford and at Oxford Station	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6) or Longer term (subject to funders' priorities)
Purpose	In addition to the capacity identified in G2, this provides capacity for enhanced local stopping services as well as supporting potential additional services required to meet forecast passenger and freight demand. This includes the option of providing additional calls at intermediate stations to support proposed local developments.
Description	• incremental signalling upgrade between Reading and Didcot to improve planning headways on Main and Relief Lines • grade separation at Didcot East Junction to allow trains from the Great Western Down Main to cross the Great Western Up Main without conflict • provision of a fourth through platform at Oxford Station on the eastern side • provision of two additional tracks adjacent to the existing two-track railway between Didcot and Oxford to create four tracks • provision of an additional line and platform on the avoiding route at Didcot Parkway
Indicative Cost	• £50m – £100m for Didcot East Junction • £175m – £375m four-tracking between Didcot and Oxford • costs for the fourth platform at Oxford and incremental signalling enhancement to be determined through detailed development work
Indicative Value for Money	Poor – based on the limited number of benefits which can be quantified at this point in time.
Relates to other options	Alternative to G2 - Grade Separation at Didcot East and Oxford North Junctions and associated capacity improvements at Oxford Station. Choices identified for funders in the **West Midlands and Chilterns Route Study** which affect the service outputs on the route between Oxford and Bicester will also interrelate with this option given that additional services to and from the East West route are a key driver for this choice.

Analysis

Grade separation of Didcot East Junction would provide sufficient additional capacity to accommodate the 2043 ITSS whilst also providing significant performance benefits in reducing delays at the junction.

Provision of a four-track railway between Didcot and Oxford would provide increased capacity and capability by enabling the operational separation of traffic flows to the North Cotswolds/Banbury from those destined for the East West Rail route. This would potentially eliminate conflicting crossing moves at Oxford North Junction and would allow each pair of through platforms at Oxford Station to be dedicated to each route throughout most of a typical traffic day, improving capacity and performance utilisation of the station area as well as offering opportunities for enhanced maintenance access and operational flexibility.

The primary difference between this option and G2 is that the provision of two extra tracks between Didcot Parkway and Oxford allows for services running to/from Bicester to remain segregated from traffic to/from Banbury and the Cotswold Line. This removes the requirement for grade separation of Oxford North Junction as the associated conflicting movements are no longer assumed to be present.

Sufficient capacity would also be provided for an increased number of calls at intermediate stations between Reading and Oxford if required. In addition, the additional capacity provided by four-tracking might offer opportunities to accelerate some services and optimise calling patterns to provide better journey times and connectivity for longer distance journeys between key population centres.

Provision of a fourth through platform at Oxford by conversion of one of the two bay platforms provided in the 2019 baseline would allow the Up side (towards London) platform capacity to match that provided in the Down direction (towards Birmingham) and would provide the necessary capacity for additional services between Oxford and Reading as included in the 2043 ITSS. This also supports the optimum operation of the Oxford Station area by providing additional capacity to enable improved flexibility and construction of the service pattern. Passive provision for this fourth platform is also included in the Oxford Station Masterplan.

Improving the planning headways between Reading and Didcot Parkway would support both performance and capacity requirements. More detailed analysis as part of further development work should be undertaken to identify the optimum requirements.

An intervention at Didcot East Junction appears to be required to accommodate any increase in services above the 2019 baseline. Options G2 and G3 present the main alternatives to accommodate the full 2043 ITSS on this route section; four-tracking between Didcot and Oxford (including four through platforms) could remove the need for grade separation at Oxford North Junction while allowing an increase in train services.

Determining the capability required by 2043 is dependent on the required service structure. G2 and G3 set out potential infrastructure interventions that would support enhanced levels of passenger and freight services to meet the full 2043 ITSS. To determine best value for money, there are other combinations of infrastructure enhancement that need to be assessed. Depending on the exact detail of the train service specifications, these could include assessments of the following:

- enhancements to Didcot East Junction which would avoid full grade separation but only deliver a proportion of the benefits.
- provision of a fifth track between Oxford North Junction and Oxford, to enable more services to operate north of Oxford towards East West Rail. This would require appropriate platform capacity at Oxford Station.

Further, detailed analysis will be undertaken as part of further GRIP development work on this Route Section.

Access to Airports

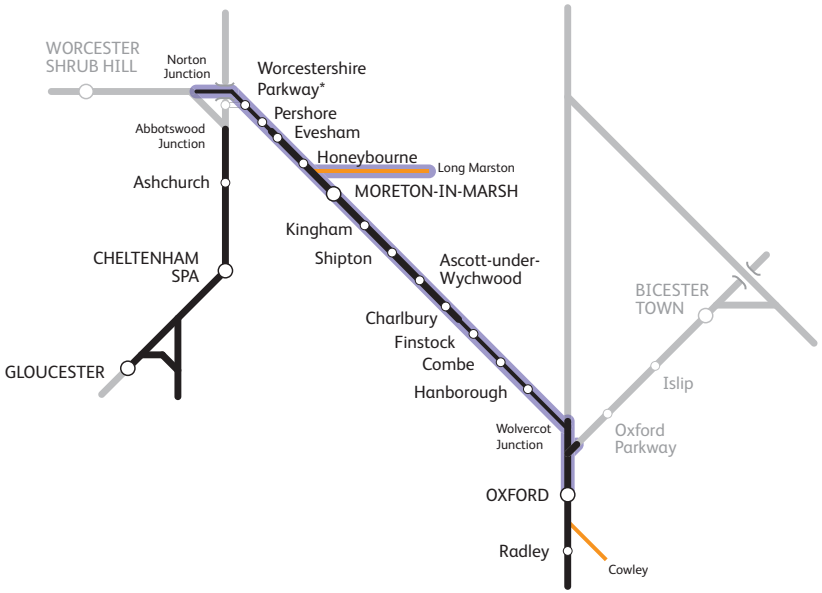
Opportunities exist to enhance connectivity Conditional Outputs for airport services between Oxford and Gatwick Airport and between Oxford and Heathrow Airport.

Route Section A: London Paddington – Reading presents choices for the most significant opportunities for potential connectivity improvements (which are not otherwise served) subject to deliverability.

Further details can be found in Route Section A: London Paddington – Reading.

Route Section H: Oxford – North Cotswolds

Figure 5.30: Route Section H: Oxford – North Cotswolds



Description of the Anticipated 2019 Baseline Infrastructure

There are currently no planned interventions between 2014 and 2019, therefore the infrastructure assumptions for the 2019 baseline remain unchanged from today.

Anticipated 2019 Service Patterns

The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1tph London Paddington – Worcester Foregate Street
- Less than 1 train per day Freight

During peak hours, a number of additional passenger services operate over this Route Section to carry peak passenger loadings between London Paddington, Oxford and Worcester.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the Long Distance Market Study:

Figure 5.31: Interpretation of Passenger Connectivity Conditional Outputs

Reference	Flow (to central London in each case)	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
From the Cross-Boundary ITSS	London Paddington to Worcester	2 to 3tph at 100mph	2tph London – Worcester, also 2tph Oxford – Worcester

Interpretation of Passenger Connectivity Conditional Outputs

The Cross-Boundary ITSS presented options for the second train per hour between London Paddington and Worcester to run via Oxford or via Swindon. The Western Route Study interpretation for the connectivity Conditional Outputs is that this output could be met by 1tph via this corridor and 1tph via Cheltenham. There would also be 2tph on the Oxford-Worcester corridor, see Route Section A for further details.

Figure 5.32: 2043 Indicative Train Service Specification Oxford – North Cotswolds

Freight Market Study

There is a small amount of freight on the route (less than one train per day) which is predominantly wagons and other rolling stock movements to/from Long Marston. There is no forecast increase based on current freight routeing.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 Indicative Train Service Specification.

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional service:

- 1tph Oxford – Worcester stopping service

The 2043 ITSS provides an option to meet the connectivity Conditional Output of two opportunities per hour for travel between London and Worcester.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- single line sections between Wolvercot Junction and Charlbury, and between Evesham and Norton Junction.

Increasing the all-day service frequency on the route to two trains per hour would increase the utilisation of the single line sections to nearly 100 per cent capacity utilisation. This level of capacity utilisation is not acceptable for consistent delivery of a high performing railway.

Making Best Use of Capacity

Increased utilisation of existing capacity relies on minimisation of the time for which each of the single line sections is occupied. It should be noted that two of the stations which have seen a significant increase in ticket sales – Hanborough and Pershore – are located on single line sections.

Maintaining the current level of station calls at Combe and Finstock is consistent with the principle of making best use of existing network capacity and matches the level of demand at these stations, which are located on the single line sections. Given capacity constraints, any improvement in service levels at these stations is likely to provide poor value for money; improvement in non-rail connectivity that allows current and potential users to access the stations at Charlbury and Hanborough would offer a choice of service provision that does not increase journey times over, or utilisation of, the single line sections.

Another choice for improving the capacity available on the single line sections is through the implementation of linespeed improvements between Wolvercot Junction and Charlbury and between Evesham and Norton Junction which could have the additional benefit of reducing journey times.

However, there is a limit to the degree of flexibility which such linespeed enhancements could offer in respect of improvements in service frequency and overall journey times, while maintaining both appropriate connectivity from intermediate stations, and an acceptable level of performance. Initial analysis has indicated that linespeed improvements can only provide a benefit to journey times or single-line capacity on services which do not call at any of the intermediate stations on the single line.

Capacity utilisation of the single line sections could also be optimised through minimising the dwell times at stations. This could be achieved by lengthening the platforms at the busiest stations on the single lines to permit passengers to board or alight from more carriages of peak services simultaneously.

At Hanborough in particular, its role as a railhead for North West Oxfordshire has led to potential capacity issues with the busier services given the relatively short platform length and the time available for passengers to board. This would require an infrastructure intervention to enable platform lengthening (see H2).

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand
  - capacity analysis has indicated that the anticipated 2019 ITSS would provide sufficient capacity to accommodate demand on the North Cotswolds corridor
  - H1: However, should local factors cause growth to exceed that forecast then interventions are expected to be limited to train lengthening or through the provision of additional peak services at the eastern end of the route, utilising the existing turn back capability at Charlbury and/or Moreton-in-Marsh. There is also the potential for an additional Hanborough/ Charlbury starting service to economically serve rail passenger demand
  - H2: Platform lengthening at Hanborough may be required to support the utilisation of existing system capacity and facilitate improvements in passenger boarding and alighting specifically during the peak.
- renewal opportunities. There are currently a number of potential renewals due in CP6 and CP7 which present the opportunity to efficiently align incremental enhancement requirements with the planned renewals, to support the delivery of the Conditional Outputs in an optimised way. These include the resignalling of the Worcester area and possible remodelling of the track layout at Norton Junction.

The choice exists for funders to prioritise longer-term connectivity aspirations for delivery in CP6, which will bring forward the requirements for infrastructure interventions.

The Route Study has not identified a driver for increased service frequency to meet CP6 demand. There may be opportunities for enhanced connectivity, and reduced journey times between the main population centres of Worcester, Oxford and London Paddington which could be achieved with the introduction of the Super Express Trains (SETs) to the route; but these may require infrastructure interventions.

Electrification

The proposed electrification of the route between Oxford and Banbury as part of the Electric Spine (subject to funding and business case) would mean that the route north of Oxford including the junction at Wolvercot Junction is electrified in CP6.

A choice exists regarding the possible extension of electrification along the eastern end of the North Cotswolds route between Wolvercot Junction and Charlbury which could be desirable for both operational efficiency and in order to serve peak demand from Hanborough and Charlbury to Oxford and locations east towards London. This output might also be achieved by use of Independently-Powered Electric Multiple Units (IPEMUs) on through services to these locations from London Paddington. While this would not require electrification of this Route Section, the technological solution offered by IPEMU might mean that journeys 'off the wire' were relatively short in length.

Given the base level of service, which from 2019 is anticipated to be provided by bi-mode SETs, the business case and rationale for electrifying from Oxford to Worcester would appear to be weak when compared to other routes on the network. The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

Demand analysis suggests that the 2019 ITSS provides sufficient capacity to accommodate predicted demand to 2043.

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, it is likely that further interventions will be required on the corridor. There are a number of potential choices going forward to deliver the Conditional Outputs however, in order to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

The following choices set out interventions which seek to address this issue.

- H3: Redoubling of the North Cotswold line
- H4: Wolvercot Junction.

Each of the choices is addressed in further detail:

H3: Redoubling of the North Cotswold Oxford-Worcester line	
Conditional Output	Connectivity
Timeframe	Longer Term
Purpose	To provide infrastructure capacity to operate an all-day service frequency of two trains per hour between Worcester and Oxford
Description	To increase service provision the doubling of some or all of the sections between Wolvercot and Charlbury and between Evesham and Norton Junction would be required. A range of full and partial doubling options exist, with further development required to determine the optimum choice.
Indicative Cost	Cost ranges from £50m – £500m
Relates to other options	H4 Wolvercot Junction

Analysis

Two trains per hour could be accommodated between Worcester and Oxford on the 2019 baseline infrastructure however the capacity utilisation of the single line sections along this route would be nearly 100 per cent which is incompatible with delivery of a high performing railway.

Reduction in journey times via linespeed improvements between Wolvercot Junction and Charlbury, and between Evesham and Norton Junction, could reduce the utilisation of the single line and possibly offer reduced end to end journey times. However, it would also require reductions in the number of calls at stations such as Hanborough and Pershore, both of which experienced strong growth in rail passenger demand in 2013, and is therefore not likely to be a viable option.

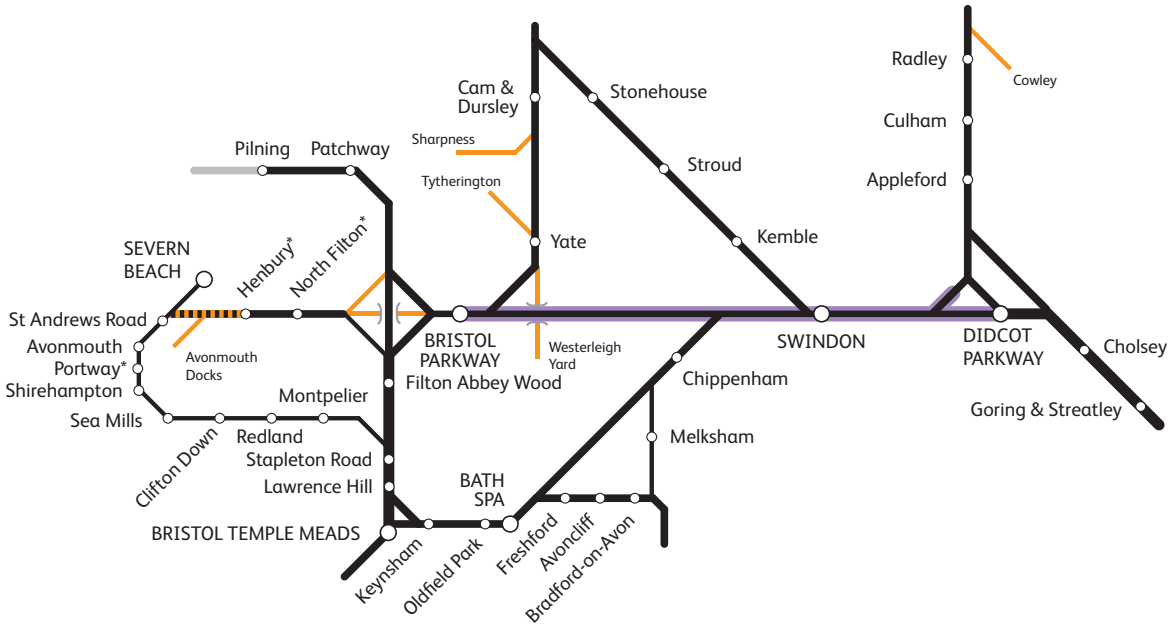
The alternative is to redouble remaining sections of single line. In the east providing capability for trains to pass in the vicinity of Hanborough would be required with the extension of double-track from Wolvercot Junction to Hanborough inclusive providing four miles of double track for robust dynamic passing capability. At the western end of the route, capability for services to pass in the vicinity of Pershore is required. This could be delivered by the provision of a dynamic loop through Pershore station (requiring a second platform at Pershore) or by extension of the double-track from Evesham to Norton Junction – removing the remaining section of single line at the western end of the route.

Full redoubling of the route is not required to deliver the 2043 ITSS however the scale of redoubling that would be required is subject to a value for money assessment incorporating the performance benefits which the removal of all single-line sections could bring. It may also provide a greater industry benefit to redouble the entire line at one opportunity.

H4: Wolvercot Junction
An assessment of capability requirements of Wolvercot Junction is also recommended in conjunction with the above option H3. Whilst the renewal is not due until 2040, the opportunity to incrementally enhance capacity and functionality as part of any infrastructure intervention at the time of renewal merits investigation for an efficient whole life cost delivery.

Route Section I: Didcot Parkway – Bristol Parkway

Figure 5.33: Route Section I: Didcot Parkway – Bristol Parkway



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- electrification of the Great Western Main Line from London Paddington to South Wales
- an additional platform at Bristol Parkway.

Anticipated 2019 Service Patterns

The principal off-peak train services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph =trains per hour, each direction):

- 1tph London Paddington – Cheltenham Spa
- 4tph London Paddington – Bristol Temple Meads (2tph via Bath Spa and 2tph via Bristol Parkway with 1tph extended to Weston-super-Mare)
- 2tph London Paddington – Cardiff/Swansea
- 1 train every 2 hours Swindon – Westbury
- 2tph Freight.

Anticipated freight services consist of Class 4 and Class 6/7 trains serving a wide variety of origins and destinations. The majority of freight movements are Class 6 services conveying aggregates, scrap, steel and automotive parts with a small number of Class 4 and 7 freight trains.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section are:

Figure 5.34

Reference	Western Route Study Conditional Output
CO2	To provide sufficient capacity for passengers travelling into central London during peak hours, taking into account anticipated growth over the period to 2043 – Main Line services

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **London & South East, Long Distance** and **Regional Urban Market Studies**.

London & South East Market Study

For non-London journeys of less than 30 miles, the Conditional Output is a target journey time of 60 minutes.

Journeys which are longer distance (>30 miles), non-London journeys (including outer suburban journeys) have a different Conditional Output. The Conditional Output is to provide a total Generalised Journey Time (GJT) of significantly less than 100 minutes and as close to 40 minutes as possible, provided that this is an improvement on the 2019 baseline position, see Chapter 3 for further details on GJT.

Figure 5.35: Long Distance Market Study

Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
CO20	London Paddington – Bristol	3 to 4tph at 160mph	4tph
CO71	London Paddington – Cardiff	3 to 4tph at 160mph	4tph
CO73	London Paddington – Swansea	2 to 3tph at 100mph	2tph
CO76	London Paddington – Gloucester	2 to 3tph at 100mph	1tph London – Gloucester and 1tph London – Cheltenham (to Worcester)
CO43	London Paddington – Bath	2 to 3tph at 100mph	2tph
CO19	Bristol – Swindon	3 to 4tph at 60mph	3tph
CO21	Bath – Oxford	1 to 2tph at 45/80mph	1tph

Figure 5.36: Regional Urban Market Study			
Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
CO53 CO54	Swindon – Bath/Chippenham/ Melksham	Increase service from Trowbridge and Melksham and improve GJT at these stations	1tph Swindon – Westbury via Chippenham, Melksham and Trowbridge
CO135 CO136	Reading and Thames Valley stations – East of Oxford/Swindon/Newbury inclusive	Provide incremental journey time improvements and provide total journey time of less than 60 minutes	2tph

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown in the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other constraints. The Western Route Study (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as follows delivering the connectivity outputs in terms of opportunities to travel each hour.

London Paddington to Gloucester

The Western Route Study interpretation for the connectivity Conditional Outputs is a requirement for two journey opportunities per hour. The Gloucester zone in the **Long Distance Market Study** also includes Cheltenham. The Western Route Study proposes to provide 1tph London Paddington to Gloucester and 1tph London Paddington to Cheltenham Spa (extending to Worcester, see Route Section A). This would allow the journey times to/from Cheltenham to be improved by at least 12 minutes in each direction through the potential removal of calls at Gloucester Station. Additional journey opportunities would be available by changing at Gloucester/ Birmingham (for Cheltenham Spa), or Cheltenham/Birmingham (for Gloucester) in the context of the significant journey time improvement between Birmingham and London provided by HS2 with additional and faster journey opportunities.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts (measured at a point east of Swindon) are:

- 1 – 2tph Class 4 (typically intermodal or automotive traffic)
- 1tph Class 6 (typically 'heavier' traffic).

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

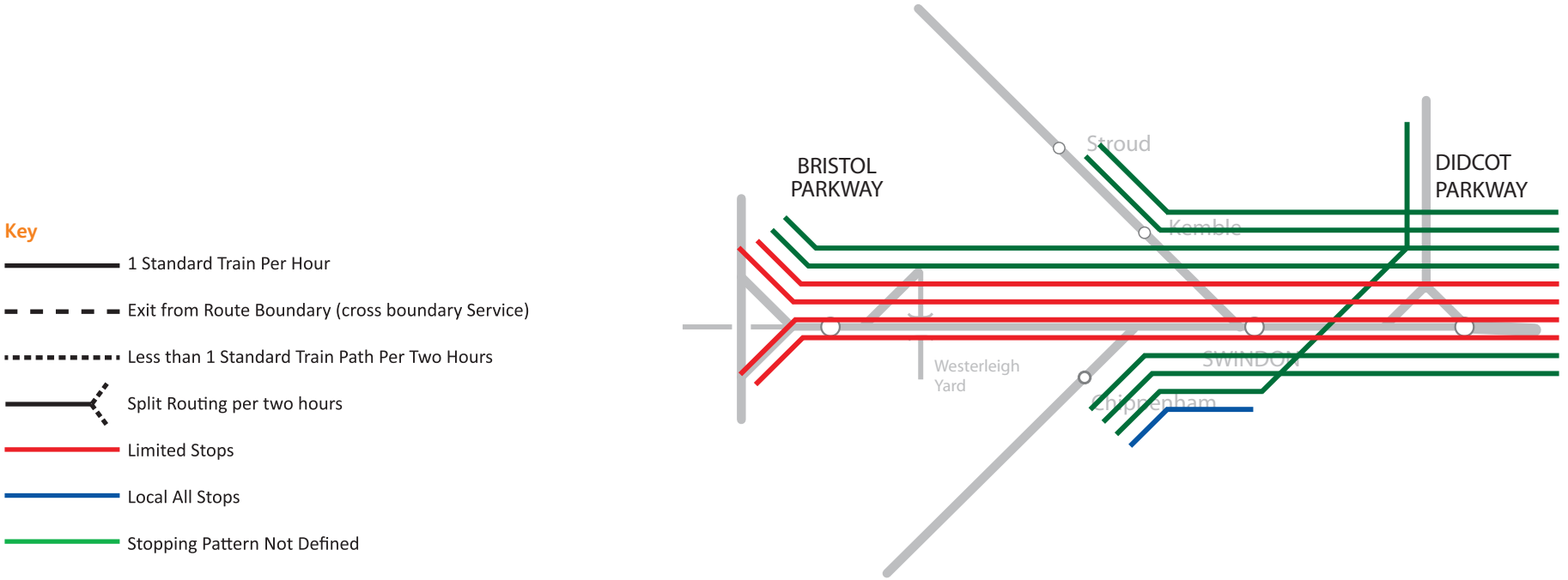
Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity and freight Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 1tph London Paddington – Gloucester
- 2tph London Paddington – Cardiff/Swansea
- 1tph East Midlands – Bristol Temple Meads (via East West Rail and Bath Spa)
- 1tph Swindon – Westbury
- 1tph Swindon – Worcester - North
- 2tph Cardiff – Bristol Parkway – Birmingham and beyond
- 1tph Freight

To accommodate the capacity Conditional Outputs, analysis anticipates that two additional semi-fast services will be required to accommodate rail passenger demand between London Paddington and Swindon. Should these services be implemented, they would be additional to the ITSS for 2043.

Figure 5.37: 2043 Indicative Train Service Specification Didcot Parkway – Bristol Parkway



System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- plain line capacity and traffic volumes between Didcot Parkway and Bristol Parkway
- crossing moves at Foxhall Junction (west of Didcot), where the Relief Lines join the Main Lines to form a two-track section
- crossing moves and platform capacity at Swindon
- crossing moves and junction speeds at Wootton Bassett Junction (west of Swindon), and at Westerleigh Junction (east of Bristol Parkway)
- plain line capacity and quantity of services between Westerleigh Junction and Bristol Parkway arrangement of services by route at Bristol Parkway, and the consequent need for crossing moves at Stoke Gifford Junction, immediately west of Bristol Parkway station
- Bristol Parkway station pedestrian capacity.

Making Best Use of Capacity

The 2019 ITSS represents the best use of existing capacity, and there is very limited scope for further services to be accommodated on the 2019 baseline infrastructure, without impacting on the journey time outputs that are anticipated to be achieved with the use of Super Express Trains on long distance services.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand
  - there is scope for accommodating rail passenger demand through the provision of additional services. This would require increased expenditure so is subject to a value for money assessment and is presented in A9. The additional infrastructure that might be required is presented in I1.
  - additional station capacity would be required at Bristol Parkway to accommodate anticipated rail passenger demand and throughput in the station area. With forecast rail passenger demand and anticipated increases in service provision from 2019, capacity interventions will be required to facilitate passenger throughput at Bristol Parkway Station. Analysis of capacity requirements is being undertaken as part of the CP5 portfolio of works related to the introduction of the Intercity Express Programme
  - freight demand is expected to increase, however it is assumed the growth will be accommodated within the four standard opportunities each hour included for freight in the 2019 ITSS.

To meet these drivers for change, the following choices have been investigated:

Accommodating rail passenger demand

I1: Infrastructure to accommodate additional services between London Paddington and Swindon	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast peak demand between London Paddington and Swindon.
Description	Provision of additional infrastructure in the Swindon area to accommodate two additional high-peak services between London Paddington and Swindon
Indicative Cost	Infrastructure cost not yet assessed. The services could be extended to alternative locations west of Swindon with different costs – see for example Option I2
Indicative Value for Money	High value for money for the operation of the two additional services (the effect of any capital cost is yet to be assessed).
Relates to other options	A1, A9, I2 and I3. See Route Section M for alternative infrastructure options to achieve this output at Chippenham.

Analysis

In order to accommodate the additional passenger demand into London Paddington from Reading, Didcot Parkway and Swindon, additional capacity will be required. The introduction of two additional services between London Paddington and Swindon calling at Didcot Parkway and Reading would provide the additional capacity necessary to meet the capacity Conditional Outputs for Main Line demand into London Paddington until the end of CP6.

It is anticipated that the two additional peak services can be accommodated alongside the 2019 ITSS between Didcot and Reading, however this would utilise existing freight paths. Should freight be required to operate at the same time, additional infrastructure would be required. (see Option I3)

Depending on how these trains were resourced there could be a requirement to provide additional infrastructure to allow them to turn round and stable at the west end of their journey. Two principal choices have been identified where these services could originate and terminate – either Swindon or Chippenham. Chippenham may however have greater value in the future as a location for other trains to terminate from the Bristol direction in line with local aspirations, or to ease the pathing of the East Midlands – Oxford – Bristol services anticipated in the 2043 ITSS.

Longer Term Strategy

In order to accommodate the full forecast increases in demand and the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required between Didcot Parkway and Bristol Parkway.

There are a number of potential choices going forward to deliver the Conditional Outputs. However, in order to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

The following choices set out a range of actions and interventions which seek to address this issue:

- I2: Extension of electric services to Kemble
- I3: Improved planning headways between Didcot Parkway and Bristol Parkway
- I4: Capacity enhancements between Didcot Parkway and Swindon
- I5: Speed improvements at Wootton Bassett Junction
- I6: Capacity enhancements between Westerleigh Junction and Stoke Gifford Junction

Each of the choices is addressed in further detail:

I2: Extension of electric services to Kemble

Additional peak services will be required in CP6 to accommodate demand between London Paddington and Swindon. To allow these services to operate additional infrastructure may be required at Swindon Station or an alternative to enable the peak services to be accommodated alongside freight. See Route Section A: London Paddington to Reading A9: Additional services between London Paddington and Swindon.

An alternative would be to extend one or both of the services from Swindon to Kemble to turn round using existing infrastructure and assist in accommodating future demand on the South Cotswold line. However, in order for this to be achieved it would require the extension of electrification from Swindon to Kemble or use of suitable bi-mode rolling stock. The cost of electrification is likely to exceed the cost of infrastructure at Swindon so would not be justified other than supporting growth in rail passenger demand from Kemble.

However this overall output may be achieved by operation of these services to an alternative location where turnback facilities are or may be made available, such as Chippenham, see Route Section M.

I3: Improved planning headways between Didcot and Bristol Parkway

To accommodate the full 2043 ITSS, planning headways would need to be reduced between Didcot and Bristol Parkway; these costs could be minimised if undertaken in conjunction with the installation of ETCS/signalling renewals.

I4: Capacity enhancements between Didcot and Swindon

To accommodate any growth in services over those anticipated in the 2019 ITSS, analysis has identified that additional infrastructure between Didcot Parkway and Swindon would be required. The anticipated service growth beyond the 2019 baseline is predominantly driven by requirements for passenger services.

At present this is predominantly a two-track railway with a number of loops which are required to be utilised in order to accommodate the 2019 ITSS. To meet both passenger and freight Conditional Outputs on a mixed traffic railway it will be necessary either to provide additional infrastructure or to significantly degrade running times for all services to optimise the use of the available capacity.

The analysis recommends provision of two dynamic loops via an extension of the existing facilities on the Up and Down Main Lines between Wantage Road and Challow. Such dynamic loops would allow freight trains to be passed by faster, long distance passenger services to reduce impact to either passenger or freight journey times. Improvements to passenger and freight performance; the opportunities generated to support freight growth and improved operational flexibility and maintenance access could improve the business case.

I5: Speed Improvements at Wootton Bassett Junction

To improve journey times between London Paddington, Bristol and Wales, the choice exists to reconfigure Wootton Bassett Junction to enable linespeed improvements to be made above the current limit of 75mph. This would support aspirations to improve the linespeed between London Paddington and Bristol Parkway and maximise the opportunities for journey time improvements beyond those which the Intercity Express Programme is currently anticipated to bring. An assessment carried out since the publication of the Draft Route Study suggests that the journey time benefits of the remodelling would be limited in the anticipated 2019 timetable structure, but this should be kept under review. Wootton Bassett Junction is due for renewal in 2036. From a whole-life cost perspective, this offers the preferred opportunity to consider a reconfiguration as an incremental enhancement to the renewal.

I6: Capacity enhancements between Westerleigh Junction and Stoke Gifford Junction

The 2019 baseline infrastructure cannot accommodate the full 2043 ITSS between Westerleigh Junction and Stoke Gifford Junction. An additional crossing move per hour could be accommodated on the 2019 baseline infrastructure at Westerleigh Junction, before additional infrastructure interventions would be required.

A number of choices have been identified to accommodate the 2043 ITSS. These are:

- review the 2043 ITSS or reroute services
- grade separation of Westerleigh Junction and additional infrastructure to Bristol Parkway
- grade separation of Stoke Gifford Junction and additional infrastructure to Westerleigh Junction or a point further north if more economical.

Due to the significant requirements to achieve the 2043 ITSS it is unlikely that a sufficient value for money business case would be achieved.

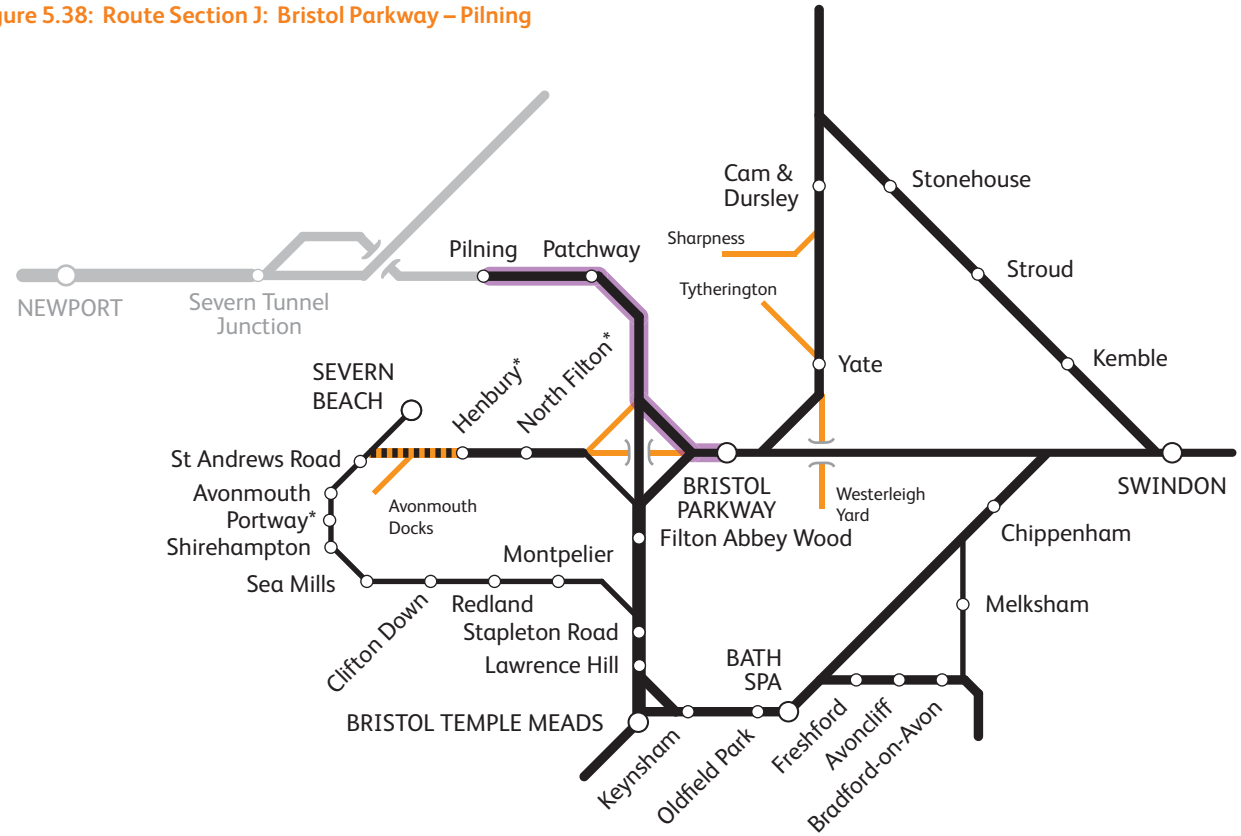
Choices have therefore focussed on the rerouteing of services:

- it is expected that the additional 2tph London Paddington to South Wales services proposed in 2043 would not be accommodated through the Severn Tunnel alongside aspirations for an additional 2tph between Bristol and Cardiff. It may be possible for 1tph each to operate on the 2019 baseline infrastructure with options available to route such additional South Wales to London Paddington services via Gloucester and Kemble rather than Bristol Parkway
- the Cardiff – Bristol Parkway – Birmingham services would be constrained elsewhere on the network, most notably through the Severn Tunnel and between Westerleigh Junction and Abbotswood Junction (south of Worcester) which would require significant infrastructure interventions to accommodate. Thus, it is expected that a better case will exist for these services to run between Cardiff and Gloucester via the direct Lydney route on the South Wales Main Line. See Route Section N Worcester – Bristol Parkway & Gloucester – Swindon
- should alternative routeing options be feasible then the cost of grade separation at Westerleigh Junction is borne solely by the additional 1tph between Bristol and Gloucester and it is likely that this would not achieve a sufficient value for money business case.

Route Section J: Bristol Parkway – Pilning

This Route Section is significant to both the Western and Welsh Route Study areas. It is included here due to the cross-boundary implications of running trains from the Welsh Route through the Severn Tunnel into the Western Route, however the options for this Route Section are presented in the Welsh Route Study.

Figure 5.38: Route Section J: Bristol Parkway – Pilning



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- electrification of the Great Western Main Line from London Paddington to South Wales
- an additional platform at Bristol Parkway and depot facilities at Stoke Gifford.

Anticipated 2019 Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 2tph London Paddington – Cardiff/Swansea
- 2tph between Bristol Temple Meads and Cardiff (not via Bristol Parkway)
- 2tph Freight

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section is:

Figure 5.39	
Reference	**Western Route Study Conditional Output**
CO3	To provide sufficient capacity for passengers travelling in and around Bristol in the peak

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Long Distance Market Study**:

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown in the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other constraints.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts (measured at a point taken west of Patchway) are:

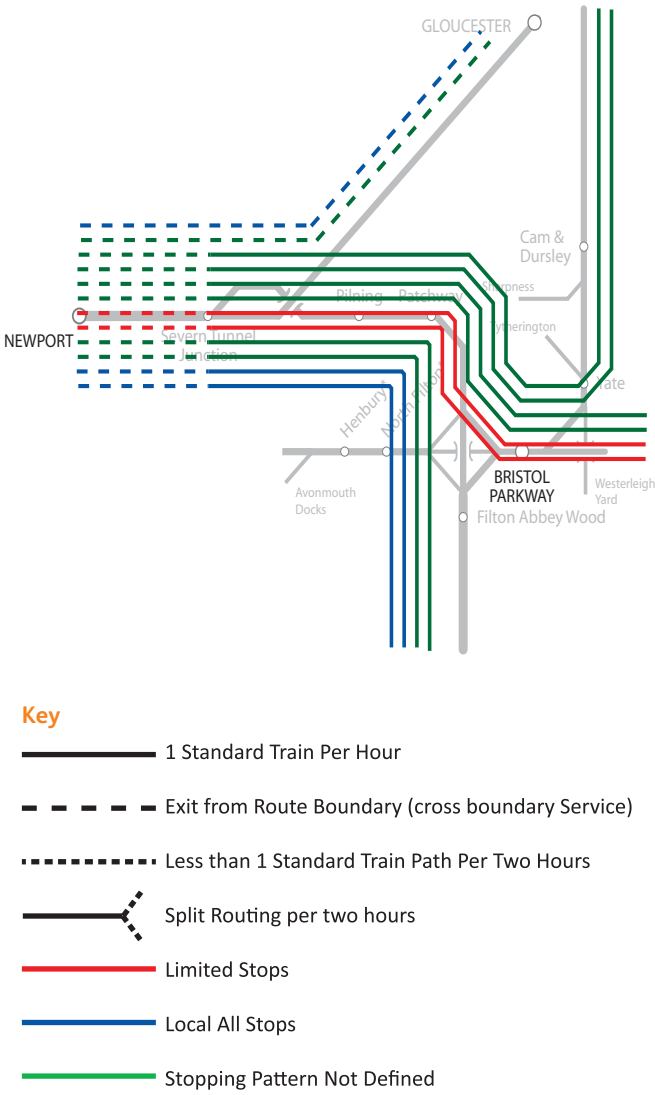
- 0 – 1tph Class 4 (typically intermodal or automotive traffic)
- 0 – 1tph Class 6 (typically 'heavier' traffic).

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Figure 5.40: Interpretation of Passenger Connectivity Conditional Outputs

Reference	Flow (to central London in each case)	Market Study Connectivity Conditional Output	Western Route Study interpretation of service frequency
CO71	London Paddington – Cardiff	3 to 4tph at 160mph	4tph
CO73	London Paddington – Swansea	2 to 3tph at 100mph	2tph
CO06	Bristol – Cardiff	3 to 4tph at 60mph	4tph
CO72	Birmingham – Cardiff	1 to 2 at 80mph	3tph

Figure 5.41: 2043 Indicative Train Service Specification Bristol Parkway – Pilning



Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 2tph London Paddington – Cardiff/Swansea
- 2tph Cardiff – Birmingham via Bristol Parkway
- 2tph Bristol Temple Meads – Cardiff (not via Bristol Parkway).

Changes to the train service specification are reported in both the Western and Welsh Route Studies. The **Welsh Route Study** will consider the feasibility of, and case for, extending or linking trains through the Severn Tunnel; the Western Route Study considers requirements from Bristol Parkway.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- track capacity through the Severn Tunnel.

Use of capacity in this area is also driven by constraints in adjoining areas, for example into Wales and to the North towards Birmingham. Factors that may become constraints if the above are resolved are:

- platform capacity at Bristol Parkway
- arrangement of services by route at Bristol Parkway
- crossing moves at Stoke Gifford Junction, immediately west of Bristol Parkway Station.
- crossing moves at Patchway Junction.

Making Best Use of Capacity

The emerging analysis of the 2019 timetable and performance studies indicates that in 2019 the Route Section will be considerably constrained with minimal capacity to operate any additional train services or modify calling patterns beyond those already assumed.

To make best use of the existing system capacity, the strategy needs to consider optimisation of each train path taking into account choices for rerouteing of services. For example, routeing of additional cross-country services will pose constraints on this Route Section. See Route Section N; Worcester – Bristol Parkway and Gloucester – Swindon for consideration of an alternative specification.

Drivers of Change, and Choices for Funders, in Control Period 6

Demand analysis indicates that the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted rail passenger demand in 2023.

The drivers of change for the Route Section in CP6 have been identified as per the Greater Bristol Area, please refer to Route Section M for further details.

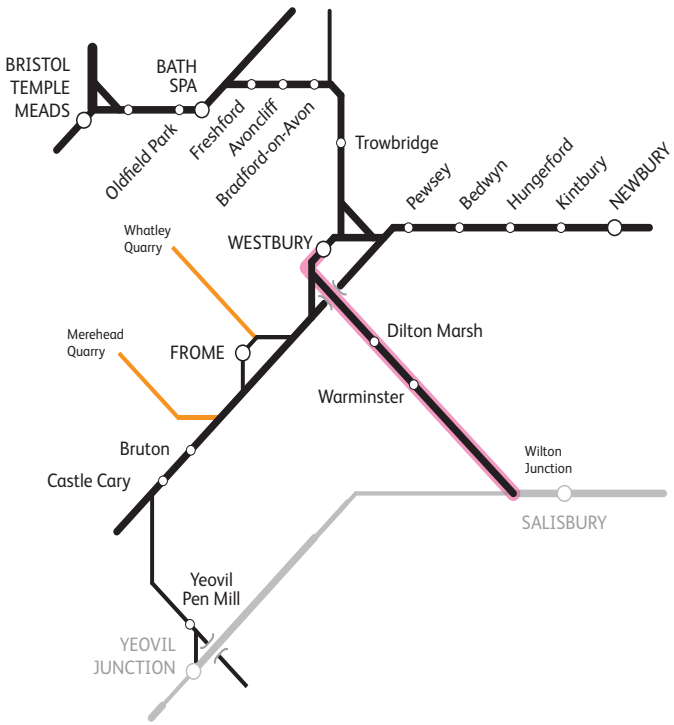
Longer Term Strategy

Demand analysis indicates that the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted rail passenger demand in 2043.

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required between Bristol Parkway and Pilning. For potential choices going forward to deliver the Conditional Outputs please refer to Route Section M: Greater Bristol Area.

Route Section K: Westbury – Salisbury

Figure 5.42 Route Section K: Westbury – Salisbury



Description of the Anticipated 2019 Baseline Infrastructure

There are currently no planned interventions between 2014 and 2019, therefore the infrastructure assumptions for the 2019 baseline remain unchanged from today.

Anticipated 2019 Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1 train per 2 hours Bristol – Weymouth
- 1tph Cardiff/Bristol/Gloucester – the South Coast via Salisbury/ Southampton
- 1 train per 2 hours Bristol/Gloucester – South Coast via Salisbury/ Southampton
- 4 trains per day Bristol – Salisbury (connecting to London Waterloo services at Salisbury)
- 1 freight train per 3 hours (average).

Freight traffic on this section of the route is primarily aggregates traffic originating from the Mendip Quarries at Whatley and Merehead. Whilst most of this traffic runs to various locations in the south east, such as Fareham and Chichester, there is also a flow to Warminster.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Regional Urban Market Study**. The connectivity Conditional Output is to at least maintain the current service level.

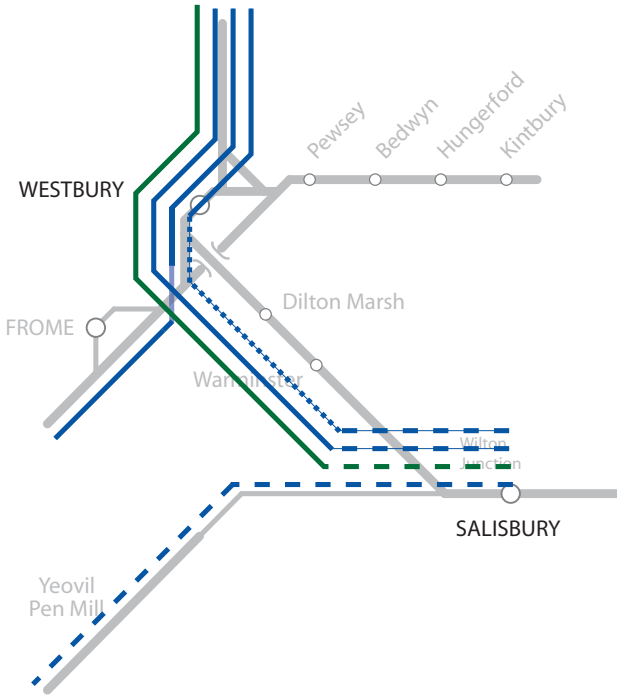
Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts are:

- 6 trains per day Class 6 (typically 'heavier' traffic) (equivalent to approximately one train every 3 hours).

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 Indicative Train Service Specification.

Figure 5.43: 2043 Indicative Train Service Specification Westbury – Salisbury



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- Less than 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 provides for an hourly service between Bristol and Brighton via Westbury. The resulting additional service in the ITSS:

- 1tph Bristol – Brighton.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements has not identified any constraints on the Western Route. However, constraints have been identified in the **Wessex Route Study** for the route beyond Salisbury, please refer to the **Wessex Route Study** for further detail of these constraints.

Making Best Use of Capacity

The emerging analysis of the 2019 timetable and performance studies indicates there is sufficient capacity to operate the service frequency between Westbury and Weymouth. There is also sufficient capacity on the Western Route to accommodate services in the 2019 timetable through to Salisbury and beyond to the south coast.

Drivers of Change, and Choices for Funders, in Control Period 6

Demand analysis confirms that the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted rail passenger demand in 2043.

The linespeeds on this Route Section are lower than the capability of anticipated future rolling stock that will be operated following the rolling stock cascade, this will be reviewed as part of the wider Western Route Journey Time Improvement programme, see Section 5.2.3.

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

Demand analysis confirms that the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted rail passenger demand in 2043.

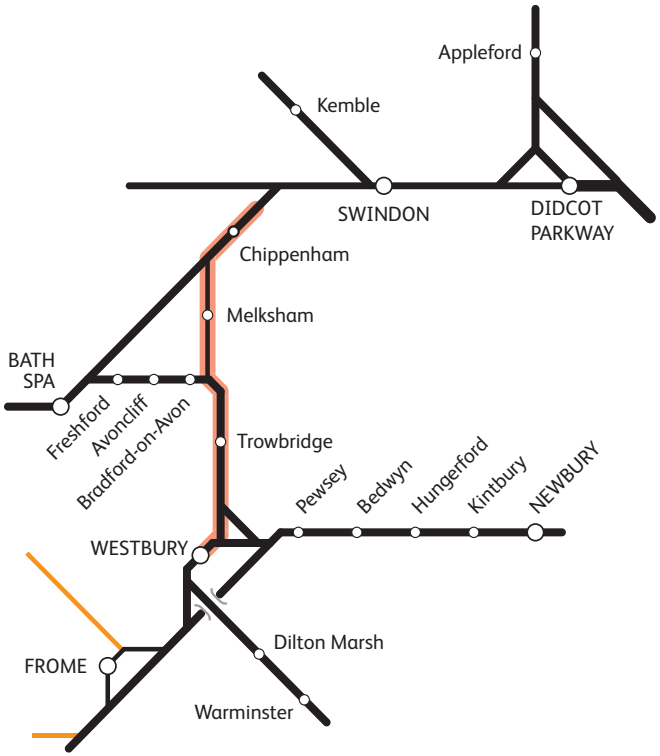
To accommodate the 2043 connectivity Conditional Outputs, an increase in the service level between Bristol and Brighton at a frequency of one train per hour is anticipated over the 2019 baseline service level. This increase in service frequency can be accommodated on the 2019 infrastructure on the Western Route. However, there is insufficient capacity on the Wessex Route to accommodate this service frequency. Please refer to the **Wessex Route Study** for further details on the constraints identified on this corridor.

Linespeed increases should be considered as part of the Journey Time Improvement Programme for this route as the rolling stock cascade programme following the Great Western Modernisation is likely to result in rolling stock with higher speed capability being operated along this corridor.

In order to accommodate the 2043 connectivity Conditional Outputs, an increase in the service level between Westbury and Yeovil Pen Mill is proposed which is an increase over the once every two hours service frequency anticipated in 2019. This increase in service frequency can be accommodated on 2019 infrastructure. Between Yeovil Pen Mill and Weymouth the service frequency would remain as today.

Route Section L: Swindon – Westbury

Figure 5.44: Route Section L: Swindon – Westbury



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- electrification of the Great Western Main Line between London Paddington and South Wales (affecting the route between Swindon and Thingley Junction).

Anticipated 2019 Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1 train per 2 hours Swindon – Westbury via Melksham
- 1 freight train per 3 hours (average).

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding.

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Regional Urban Market Study**. The connectivity Conditional Output is to at least maintain the current service level.

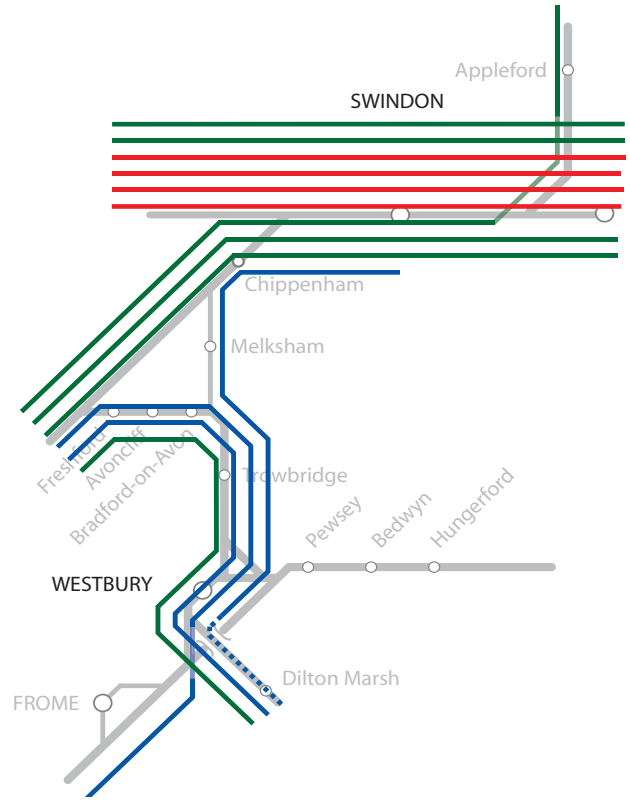
Freight Market Study

Freight Conditional Outputs to accommodate forecast freight demand are:

- 6 trains per day Class 6 (equivalent to approximately one train every 3 hours)

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Figure 5.45: 2043 Indicative Train Service Specification Swindon – Westbury



Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes provision of an hourly service between Swindon and Salisbury via Melksham. As a result, the ITSS includes the following additional service:

- 1 train per 2 hours Swindon – Salisbury via Melksham to give a 1tph service over this section.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- signalling headways
- single line track capacity.

Making Best Use of Capacity

The emerging analysis of the 2019 timetable and performance studies, indicates that the anticipated 2043 ITSS cannot be accommodated on the 2019 baseline infrastructure between Swindon and Westbury.

Demand analysis confirms the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted demand in 2043. The additional service proposed as part of the 2043 ITSS will provide further on-train capacity to support this and improved connectivity.

Drivers of Change, and Choices for Funders, in Control Period 6

Demand analysis confirms the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted demand in 2023.

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

Demand analysis confirms the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted demand in 2043. The additional service proposed as part of the 2043 ITSS will provide further capacity to support this.

To accommodate the 2043 connectivity Conditional Outputs, an increase in the service level to an hourly frequency is proposed between Swindon and Salisbury. This is an increase over the once every two hours service frequency in 2019. In order to accommodate this increase in service frequency, infrastructure interventions would be required to reduce the long signalling headways and provide additional capacity around Melksham plus the provision of an additional unit to facilitate the increased service frequency. It is recommended that cognisance of these requirements is taken at the time of the proposed signalling renewal anticipated in CP7.

This is also an important diversionary route for passenger and freight trains. The provision of additional capacity could therefore support improved resilience of the network.

Route Section M: Greater Bristol Area

Figure 5.46: Route Section M: Greater Bristol Area

Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- resignalling of the Swindon and Bristol area
- electrification of the Great Western Main Line to Bristol Parkway (and South Wales) and Bristol Temple Meads (via Bath).
- introduction of Super Express Trains and capacity and capability improvements required for this including an additional platform at Bristol Parkway and depot facilities at Stoke Gifford
- Bristol Temple Meads Station and Platform Capacity improvements (including two reinstated platforms in the Midland Shed)
- Dr Days Junction to Filton Abbey Wood Capacity Improvements
- infrastructure interventions required to support the rolling stock cascade of the Diesel Multiple Units from the Thames Valley to the West Country
- infrastructure interventions required to support the introduction of MetroWest Phase 1 – restoration of rail services to Portishead and Pill, new stations and turn back facilities at Bathampton
- new station at Portway (on the Severn Beach branch).

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 4tph London Paddington – Bristol Temple Meads (2tph via Bath Spa and 2tph via Bristol Parkway with 1tph extended to Weston-super-Mare)
- 1tph Bristol Temple Meads – Manchester
- 1tph South West England – North East England/Scotland
- 1tph Westbury and the South Coast via Bristol – Gloucester, continuing once every two hours to Great Malvern
- 1tph South Coast –Bristol Temple Meads – Cardiff
- 1tph Cardiff – Taunton (via Bristol Temple Meads)
- 1tph Weston-super-Mare – Bristol Parkway
- 2tph Bristol Temple Meads – Severn Beach (MetroWest Phase 1)
- 1tph Bristol Temple Meads – Portishead (MetroWest Phase 1)
- 1tph Bristol Temple Meads – Bath Spa (MetroWest Phase 1)
- 1 tph Freight.

MetroWest Phase 2 builds upon Phase 1 and aims to introduce passenger services to Henbury, an increase of service frequency to Yate, and a package of new stations from 2021. The West of England Partnership has received a commitment to funding from Government as part of the local Growth Deal. Further details on the scheme, which anticipates implementation during CP6 (subject to funding and a value for money assessment) can be found in Chapter 2.

Significant freight traffic is generated around Bristol, at the major logistics complex at Avonmouth and the Royal Portbury Dock. The terminal at South Liberty Lane, Bristol handles up to six container trains per week from London Gateway and Felixstowe.

The development by the Bristol Port Company to construct a new container terminal at Avonmouth may introduce further freight traffic across the area. The 2019 ITSS includes 1tph Portbury Docks (each way) and 1tph Avonmouth Docks (each way) with occasional paths on other routes.

Network Rail is working with SITA to develop an "Energy from Waste" Power Station on the Severn Beach branch at the old Imperial Chemical Industries (ICI) Severnside site.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section is:

Figure 5.47

Reference	Western Route Study Conditional Output
CO3	To provide sufficient capacity for passengers travelling in and around Bristol in the peak

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Long Distance** and **Regional Urban Market Studies**.

Figure 5.48: Long Distance Market Study Conditional Outputs			
Reference	**Flow**	**Market Study Connectivity Conditional Output**	**Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency**
CO20	London Paddington – Bristol	3 to 4tph at 160mph	4tph
CO27	Bristol – Birmingham	2 to 3tph at 100mph, or 3 to 4tph at 60mph	4tph (4tph direct at Bristol Parkway, 2tph direct at Bristol Temple Meads)
CO28	Bristol – Leeds	1 to 2tph at 80mph	2tph
CO29	Bristol – Manchester	2 to 3tph at 100mph	2tph
CO30	Bristol – Sheffield	1 to 2tph at 80mph	2tph
CO31	Bristol – Brighton	1 to 2tph at 80mph	1tph
CO45	Bath – Birmingham	1 to 2tph at 80mph	2tph (with changes of train)
CO72	Cardiff – Birmingham	2 to 3tph at 100mph	3tph
CO26	Bristol – Swansea	1 to 2tph at 60mph	1tph direct

Figure 5.49: Regional Urban Market Study Conditional Outputs			
Reference	**Flow**	**Market Study Connectivity Conditional Output**	**Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency**
CO4 & CO5	Bristol – Severn Beach	2tph to all stations and better cross-Bristol connectivity	2tph
CO11 & CO12 & CO13	Bristol – Cheltenham/Gloucester	2tph on Gloucester stopping services, peak 2tph service to Yate, better connectivity to Bath Spa	Gloucester stopping services 2tph, Yate 2tph. Improved connectivity to Bath Spa (MetroWest Phase 1)
CO18	Bristol – Bath/Warminster/Chippenham	Oldfield Park off peak frequency to match peak	3tph standard hour service frequency
CO42	Bristol – Filton Abbey Wood/Bristol Temple Meads	Better cross-Bristol connectivity to Filton Abbey Wood	1tph direct and improved connectivity

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown in the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other factors. The Western Route Study (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as below delivering the connectivity outputs in terms of opportunities to travel each hour.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts are:

- 1 freight train path per hour on routes between Bristol Temple Meads and Filton/Stoke Gifford/Swindon/Westbury/Cogload Junction.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

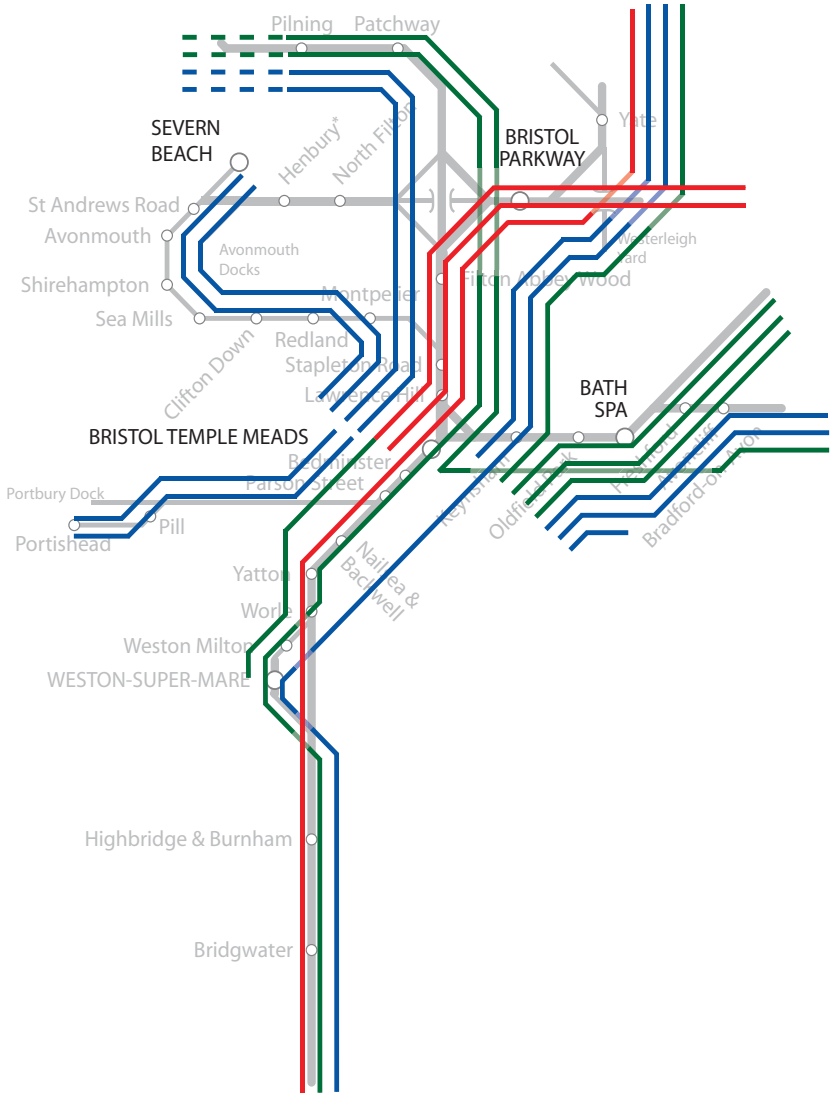
Changes to the Indicative Train Service Specification to 2043

To accommodate the Connectivity Conditional Outputs, the ITSS for 2043 includes the following additional train services:

- 1tph Bristol – Gloucester calling at Yate (MetroWest Phase 2 via extension of the Weston-super-Mare – Bristol Parkway service)
- 2tph Cardiff – Birmingham via Bristol Parkway (continuing to Manchester/Leeds etc)
- 1tph Bristol – Exeter
- 1tph South Coast – Bristol or beyond
- 2tph Bristol – Cardiff (with extensions beyond Bristol)
- 1tph Freight.

By 2043, it is anticipated that additional services may be operated following implementation of the MetroWest Phase 2 proposals which envisage the introduction of passenger services on the Henbury loop line, see Chapter 2.

Figure 5.50: 2043 Indicative Train Service Specification Greater Bristol Area



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- Less than 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- Bristol East Junction capacity and capability
- single line sections - limiting flexibility of paths off routes into Bristol, including the Severn Beach line and the single line between Worle Junction and Weston-super-Mare
- Bristol Temple Meads Station pedestrian capacity.

Making Best Use of Capacity

Analysis of the 2019 timetable and performance studies indicates that in 2019 the Route Section will be considerably constrained with no capacity to operate any additional train services or modify calling patterns beyond those already assumed. The 2019 base is assumed to optimise the use of the baseline capacity and capability in this area.

Whilst the anticipated 2019 ITSS can be accommodated across the layout at Bristol East Junction and within the station area at Bristol Temple Meads, there remain a number of issues:

- extended dwells and journey times
- uneven frequency for some services
- limited flexibility in platform usage
- high performance risk
- no additional capacity for further growth
- inefficient allocation of capacity.

A proposal exists to provide an enhanced layout of the junction improving the capacity, capability and functionality as an incremental enhancement to the planned renewal in CP5. This scheme is being developed to Network Rail's GRIP stage 3. Work continues to identify a funding stream for this enhancement. The efficient delivery of the 2019 baseline is dependent upon the integration of renewals and enhancements at this location.

The enhancement of Bristol East Junction would reduce the need for further infrastructure requirements across the area as conflicts would be resolved at this constraint; supporting flexibility in the timetable and improving capacity utilisation. For example, two trains could be accommodated each hour between Bristol Temple Meads and Severn Beach. However, in order to do this the timetable would need to be fixed on the Severn Beach Line (due to the constraints on crossing points) and there would be limited timetable options at Bristol Temple Meads. An option would be to provide 1tph to Severn Beach and 1tph to Avonmouth which would enable greater flexibility in timetabling at Bristol. This is consistent with the assumptions for MetroWest Phase 1 and may require both platforms at Avonmouth to operate bi-directionally. In order to implement this option (and avoid infrastructure enhancements on the Severn Beach line) the enhanced layout at Bristol East Junction is required.

This issue is also applicable in respect of the single line sections on the route to Weston-super-Mare, with an enhanced Bristol East Junction removing some of the constraints on timetabling services to the south of Bristol. The single line section between Weston-super-Mare and Worle Junction is an additional constraint on the timetable. The 2043 ITSS could be accommodated however, a review of the assumed calling patterns for services between Bristol Temple Meads and Weston-super-Mare would improve the ability to timetable the area.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand:
  - there is scope for accommodating passenger growth by train lengthening or running additional services where capacity permits. The introduction of MetroWest Phase 1 in 2019 is envisaged to provide the additional capacity required to accommodate predicted growth in CP6
  - additional station capacity would be required at Bristol Temple Meads to accommodate anticipated passenger demand and throughput in the station area
  - freight demand is expected to increase on this Route Section, however it is assumed the growth will be accommodated within the standard paths available each hour for freight to run in the off-peak timetable post-2019
  - the provision of additional infrastructure in CP5 (four-tracking between Dr Days Junction and Filton Abbey Wood and additional platforms at Bristol Temple Meads) will assist in providing additional capacity for passenger and freight growth.
- renewals opportunities. The renewal of Bristol East Junction is forecast in CP5. The opportunity exists to align enhancement requirements to minimise passenger disruption and achieve efficient delivery of a capacity enhancement through alignment with the renewals at the lowest Whole Life Cost in CP5. However, should funding be unavailable, the junction enhancement will be prioritised for CP6.

To meet these drivers for change, the following choices have been investigated:

Accommodating rail passenger demand

Demand analysis recommends train lengthening between Cheltenham Spa and Bristol Temple Meads of peak cross- country services anticipated in the 2019 ITSS to at least 5-car formations subject to value for money, affordability and availability of rolling stock. Lengthening busy shoulder peak services to the same length as those arriving in the high peak hour (08:00 and 08:59), for both cross-country and suburban services in the Bristol area would provide sufficient capacity to meet rail passenger demand in CP6.

The additional capacity provided by the proposed new services as part of the West of England's MetroWest Phase 1 is expected to provide sufficient peak capacity to meet demand requirements on the Severn Beach/Avonmouth line, between Bath Spa and Bristol Temple Meads, and on the new Portishead line.

LD1/LD2/LD5a/LD5b: Cross-country train lengthening on the South West to West Midlands axis	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand into Bristol Temple Meads on the cross-country corridor to and from the North where individual train load factors of 100 per cent are predicted. This option will also address capacity requirements throughout the day and beyond the Western Route Study area.
Description	Lengthen selected cross-country services
Indicative Cost	Additional vehicle operating costs, depending on the variation of the option: LD1: Plymouth – Edinburgh/Glasgow route – 18 additional vehicles LD2: Plymouth – Edinburgh/Glasgow route – 8 additional vehicles LD5a: Newton Abbot – Manchester route – 18 additional vehicles LD5b: Newton Abbot – Manchester route – 11 additional vehicles
Indicative Value for Money	LD1 – Low / Medium LD2 – Very high LD5a – Low LD5b – High
Relates to other options	LD1, LD2, LD5a, LD5b. See Appendix D
Analysis The business case also includes the benefits of relieving crowding in West Yorkshire, the East Midlands and West Midlands, on the cross-country services. Options LD1 and LD2 and LD5a and LD5b are variations to address demand on the same routes. See Appendix D for financial and socio-economic appraisal results.	

With forecast rail passenger demand and anticipated increases in service provision from 2019, capacity interventions will be required to facilitate passenger circulation at Bristol Temple Meads Station during CP6. This is further supported by the projected local growth arising from development of the Temple Quarter Enterprise Zone by the West of England Local Enterprise Partnership.

A Masterplan study for Bristol Temple Meads Station and the surrounding area has been developed by Network Rail working in partnership with the West of England Local Enterprise Partnership, Bristol City Council, the Homes & Community Association alongside First Great Western and Historic England.

The Masterplan study identifies a number of options to transform the station area and proposes improvements whilst also aligning and providing linkages to the Temple Quarter Enterprise Zone, the surrounding area and into the city. As part of the proposals, a new interchange facility and new station entrance to the North of the station is identified in addition to an eastern entrance to link the proposed Arena site and former Post Office. Further development work is ongoing.

(CP5) Renewals opportunities

M2: Bristol East Junction	
Conditional Output	Capacity and Connectivity
Timeframe	2019 – 2024 (Control Period 6) (if not completed in CP5)
Purpose	To accommodate additional long distance, local and freight services anticipated for forecast growth
Description	An enhanced renewal in Modern Equivalent Form with associated rationalisation and linespeed improvements to provide the optimum junction layout and support improved operational flexibility, capacity and maintenance.
Indicative Cost	£20m – £50m
Indicative Value for Money	Financially positive (i.e. net reduction in subsidy)
Relates to other options	Capacity provided by MetroWest and Route Section N
Analysis Capacity analysis confirms that the current layout of Bristol East Junction will be a significant constraint in 2019 when additional local and long distance services are introduced. Whilst the quantum of additional services could be accommodated on the current infrastructure, there are likely to be implications of this in terms of capacity utilisation, overall timetable flexibility, resource utilisation, service frequency requirements and performance. The renewal of the junction is forecast for 2015/16 with the development of the enhanced option being progressed in alignment with the resignalling of the Bristol area and the provision of electrification in CP5. However, funding for the enhancement has yet to be identified and should this not be found, the scheme will be prioritised for CP6. The cost for providing the enhancement in CP6 (as opposed to the incremental cost in CP5) is estimated to be between £35m and £75m due to the complexities associated with making physical modifications to an already electrified layout. See Appendix D for financial and socio-economic appraisal.	

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Bristol City Council as part of the West of England Partnership commissioned a study to review the provision of electrification on suburban routes around the Greater Bristol area.

The study, published in March 2015, concluded that the best business case is to follow wider national electrification schemes including those in the Western Route Study. The West of England's Joint Transport Board agreed in March 2015 to push the case for wider South West electrification schemes and new rolling stock as part of a national programme.

Longer Term Strategy

Demand analysis identifies that subject to the provision of additional infrastructure capacity in CP6, sufficient capability will exist to accommodate growth in passenger demand on the suburban and long distance services into Bristol Temple Meads in the peak until 2043.

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required. There are a number of potential choices going forward to deliver the Conditional Outputs however, in order to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

The 2043 ITSS can be accommodated with the enhanced layout proposed at Bristol East Junction. This removes the constraints identified and enables an optimised pattern in this area to make full use of the enhnced junction's capabilities. A structured timetable with service groups platformed consistently could also be constructed.

Route Section N: Worcester – Bristol Parkway and Gloucester – Swindon

Figure 5.51: Route Section N: Worcester – Bristol Parkway and Gloucester – Swindon

Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. They are anticipated to include:

- redoubling of the Swindon to Kemble single line section with improved signalling headways between Kemble and Standish (completed August 2014)
- Bristol Area Signalling Renewals (incorporates part of the Route Section to just north of Yate).

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1tph London Paddington – Cheltenham Spa
- 1tph Bristol – Manchester
- 1tph South West England – North East England / Scotland
- 1tph Cardiff – Nottingham via Birmingham
- 1tph South Wales – Cheltenham Spa
- 1tph Westbury or beyond via Bristol to Gloucester, continuing once every two hours to Great Malvern
- 2tph Freight.

There is a variety of freight traffic, mostly Class 6. Typical examples include coal from Avonmouth Docks to power stations in the Midlands, steel between South Wales and the Midlands and the North East, oil from West Wales to the terminal at Westerleigh. There is some container traffic to South Wales. In addition there are regular flows such as china clay from Cornwall, and nuclear flask traffic from Cumbria to Berkeley and Hinkley Point.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section is:

Figure 5.52	
Reference	**Western Route Study capacity Conditional Output**
CO3	To provide sufficient capacity for passengers travelling in and around Bristol in the peak

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Long Distance** and **Regional Urban Market Studies**.

Figure 5.53: Long Distance Market Study Conditional Outputs

Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
From the Cross-Boundary ITSS	London Paddington – Worcester	2 to 3tph at 100mph	2tph (1tph via Cheltenham)
CO76	London Paddington – Gloucester*	2 to 3tph at 100mph	1tph (and 1tph London to Cheltenham)
CO27	Bristol – Birmingham	2 to 3tph at 100mph, or 3-4tph at 60mph	4tph (4tph direct at Bristol Parkway, 2tph direct at Bristol Temple Meads)
CO28	Bristol – Leeds	1 to 2tph at 80mph	2tph
CO29	Bristol – Manchester	2 to 3tph at 100mph	2tph
CO30	Bristol – Sheffield	1 to 2tph at 80mph	2tph
CO45	Bath – Birmingham	1 to 2tph at 80mph	2tph (via changes)
CO72	Cardiff – Birmingham	2 to 3tph at 100mph	3tph
CO59	Swindon – Birmingham	1 to 2tph at 80mph	1tph

* The Gloucester zone in the **Long Distance Market Study** includes Cheltenham.

Figure 5.54 : Regional Urban Market Study Conditional Outputs			
Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
CO11 & CO12 & CO13	Bristol – Cheltenham/Gloucester	2tph on Gloucester stopping services, peak 2tph service to Yate, better connectivity to Bath Spa	Gloucester stopping services 2tph, Yate 2tph. Improved connectivity to Bath Spa (MetroWest Phase 1)

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown in the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other constraints. The Western Route Study (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as follows delivering the connectivity outputs in terms of opportunities to travel each hour.

- London Paddington to Gloucester

  The Western Route Study interpretation for the connectivity Conditional Outputs is a requirement for two journey opportunities per hour. The Gloucester zone in the **Long Distance Market Study** also includes Cheltenham Spa. The Western Route Study proposes to provide 1tph London Paddington to Gloucester and 1tph London Paddington to Cheltenham Spa (extending to Worcester Foregate Street, see below). This would allow the journey times to/from Cheltenham Spa to be improved by up to 12 minutes in each direction through the potential removal of calls at Gloucester Station. Additional journey opportunities would be available by changing at Gloucester/Birmingham (for Cheltenham Spa), or Cheltenham Spa/Birmingham (for Gloucester) in the context of the significant journey time improvement between Birmingham and London provided by HS2 with additional and faster journey opportunities.

- London Paddington to Worcester

  The Conditional Output is for two journey opportunities per hour. The Cross-Boundary ITSS has choices for an additional service to operate via Oxford or via Cheltenham Spa. The Western Route Study proposes to route the additional service via Cheltenham Spa for a number of reasons:

  - avoids the already congested Didcot – Oxford corridor
  - improves connectivity between Swindon and Worcester
  - is an efficient way of delivering the Conditional Output by extending the London Paddington – Cheltenham Spa service providing a comparable journey time to the other routeing option.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts (at a point between Standish Junction and Gloucester) are:

- 0 – 1tph Class 4 (typically intermodal or automotive traffic)
- 1 – 2tph Class 6 (typically aggregate-type traffic)

Freight flows will be higher between Gloucester and Abbotswood Junction due to traffic to/from South Wales.

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 1tph Bristol – Gloucester
- 2tph Cardiff – Bristol Parkway – Birmingham (continuing north to destinations such as Manchester or Leeds)
- Extension of 1tph London Paddington – Cheltenham to Worcester
- 1tph London Paddington – Gloucester
- 1tph Swindon – north west England via Worcester and Birmingham
- 1tph Freight.

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- plain line capacity between Westerleigh Junction and Standish Junction
- crossing moves at Standish Junction
- crossing moves at Gloucester Yard Junction and Barnwood Junction
- reversing moves at Cheltenham Spa
- plain line capacity between Cheltenham Spa and Abbotswood Junction
- capacity of single lead junction at Abbotswood.

Making Best Use of Capacity

The emerging analysis indicates that in 2019 the Route Section will be considerably constrained with minimal capacity to operate any additional train services, or to modify calling patterns beyond those already assumed without an adverse impact on journey times. Accommodating additional long distance services is particularly challenging due to the speed differential between the fastest and slowest trains on the route.

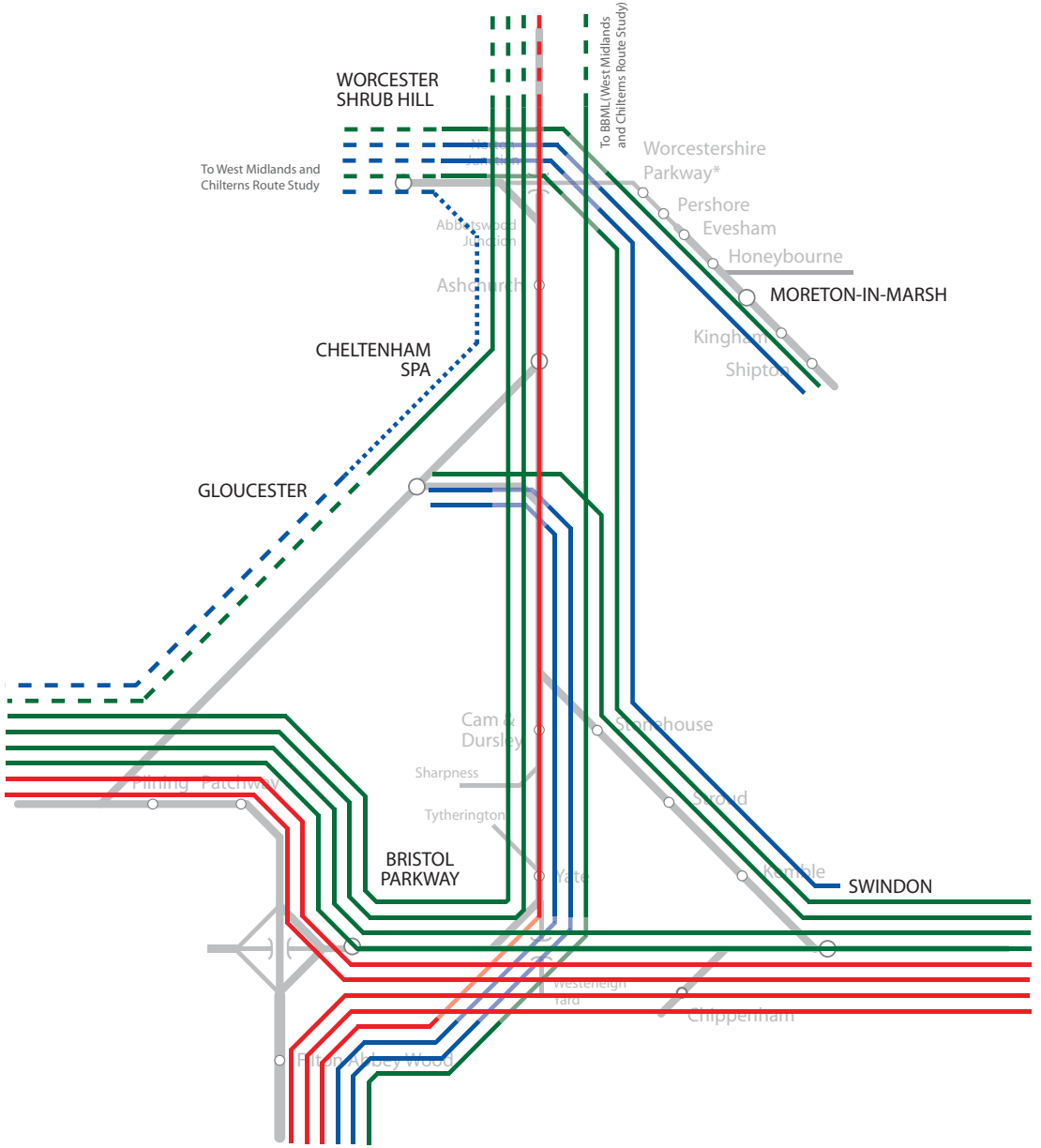
This Route Section is part of a trunk route where there may be capacity available intermediately but not throughout the whole Route Section with particular restrictions at both ends of the route. To this end, up to an additional 3-4tph could be accommodated on current infrastructure when this Route Section is considered in isolation, however the deliverability of these additional services would need to be assessed in the context of the whole network capability.

Additional long distance services might also potentially cause a large increase in freight journey times due to the requirement to loop freight services to enable the long distance passenger services to operate at a higher speed.

Without further infrastructure interventions, the following choices could be made to make best use of existing capacity:

- use of faster rolling stock on the Bristol – Gloucester route. This could be enabled by future electrification and new electric rolling stock
- service changes to reduce or eliminate the reversal of trains at Cheltenham Spa. For example:
  - extension of the South Wales – Cheltenham Spa services to Great Malvern in lieu of trains from Bristol (which could terminate at Gloucester where there are fewer capacity issues)
  - extension of the London Paddington – Cheltenham Spa service to Worcester which would also deliver the Conditional Output for 2tph between London Paddington and Worcester
- a combination of such interventions may provide sufficient capacity to enable an additional train to operate between Westerleigh Junction and Abbotswood Junction each hour, however there would still be constraints across other parts of the network.

Figure 5.55: 2043 Indicative Train Service Specification Worcester – Bristol Parkway and Gloucester – Swindon



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand
  - there is scope for accommodating rail passenger demand by train lengthening and through the provision of additional services. Train lengthening options for the non-London long distance services through this route section is presented in Route Section M: Greater Bristol Area,
  - freight demand is expected to be net neutral in this Route Section during CP6 unless there is significant development at the Port of Bristol, which is currently not committed. In the absence of this development then growth in some commodities (e.g. biomass and intermodal) is expected to be offset by a decline in others (i.e. coal).
- access to HS2 (at Birmingham). The HS2 station at Curzon Street will provide fast services towards London and the North West in Phase 1 which is due to open in 2026. This is likely to lead to an increase in demand on the Bristol to Birmingham corridor due to enhanced journey times to the north making rail more competitive with car for journeys to the North West. In addition, the reduction in journey times between London and Birmingham via HS2 will mean that journeys, for example from London Paddington to Gloucester and Cheltenham Spa, could be faster via Birmingham than via Swindon (although the interchange at Birmingham may limit the number of passengers who choose this route in practice)
- renewals opportunities. The following renewals provide an opportunity to consider the capacity and capability required in these areas as incremental enhancements in CP6:
  - renewal of Abbotswood Junction
  - resignalling of the Worcester area
  - resignalling of the Gloucester area
- funder priorities:
  - electrification of the route is a potential funder priority for CP6. The case for electrification of the route is being reviewed in the refresh of the Network RUS: Electrification Strategy Draft for Consultation.

The following 'choices for funders' have been investigated :

Accommodating rail passenger demand

Demand analysis confirms the anticipated 2019 ITSS would provide sufficient capacity to accommodate predicted demand in 2023. The choice for funders to lengthen peak services to accommodate demand across the route section is presented in Route Section M: Greater Bristol Area Lengthening of non-London long distance services.

Renewals

N1: Enhancement of Abbotswood Junction	
Conditional Output	Connectivity
Timeframe	2019 –2024 (Control Period 6)
Purpose	To accommodate the 2043 ITSS
Description	Provision of an enhanced Junction (a double junction rather than a single lead junction) when renewed.
Indicative Cost	£5m – £15m for a double junction.
Indicative Value for Money	Very High
Relates to other options	None
Analysis Evidence suggests that Abbotswood Junction is a constraint and should be renewed as a double junction (rather than a single lead as at present). This also links to the resignalling of the Worcester area, and might be associated with future infrastructure changes considered in Route Section H. The estimated cost presented above is the full cost of a stand-alone intervention; given that the junction requires renewal in CP6, then the incremental cost will be lower than this.	

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

Demand analysis indicates the anticipated 2019 ITSS provides sufficient capacity to accommodate predicted demand to 2043.

In order to accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions would be required. There are a number of potential choices going forward to deliver the Conditional Outputs, however in order to meet them all there are likely to be significant constraints including deliverability and affordability.

Choices for funders in order to deliver connectivity and capacity improvements on this route will need to be developed in future planning cycles. It is becoming apparent that there is a limit to the capability of the infrastructure and train service to meet future market requirements. In the absence of suitable interventions there are likely to be adverse impacts on journey time, service frequency and performance even if electrification is progressed for this corridor.

For completeness, the Western Route Study considered such interventions as far as Barnt Green within the **West Midlands and Chiltern Route Study** area. The full package of interventions identified to deliver the 2043 ITSS beyond the boundary of the Western Route Study as far as Barnt Green is estimated to cost over £500m with significant constructability issues identified on the section between Bromsgrove and Barnt Green.

Due to the considerable cost of the interventions, a sufficient value for money business case will not be achievable at this stage; however some of the interventions may have a business case in isolation, supported by specific service changes which deliver part of the full 2043 ITSS.

The following choices set out a range of interventions which seek to address this issue.

- N2: Mainline platforms at Gloucester
- N3: Capacity improvements between Gloucester and Cheltenham
- N4: Capacity improvements at Standish Junction
- N5: Capacity improvements between Standish and Haresfield
- N6 Capacity improvements between Charfield and Ashchurch - Eckington.

Each of the choices is addressed in further detail:

N2: Mainline platforms at Gloucester	
Conditional Output	Capacity
Timeframe	Longer Term, however there may be a case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	• would enable more main line services to call at Gloucester without incurring a journey time penalty as at present • reduces timetable conflicts across the area
Description	Provision of an additional two-island station providing four platform faces on the Main Line.
Indicative Cost	• £50m – £100m • cost of passive provision not known
Relates to other options	All other options in this Route Section N

Analysis

The Gloucester Station area is complex and offers opportunities for rationalisation when resignalling takes place in CP6. There are also opportunities to consider alternative ways to serve rail passenger demand in the Gloucester area.

Gloucester Station is located off the Bristol to Birmingham Main Line. Currently, to serve Gloucester Station trains need to leave and rejoin the Main Line; the crossing moves at Gloucester Yard Junction and Barnwood Junction impose a limit on the capacity which would otherwise be available and extend journey times. This means that a number of services on the Bristol – Birmingham axis do not call at Gloucester due to the reversal requirements and additional journey time which this entails. London Paddington/Swindon – Cheltenham Spa services do call at Gloucester, and incur a journey time penalty of approximately 10-12 minutes as a result. However, Gloucester Station is well sited for the city centre and bus station, facilitating access on foot.

An option exists to provide additional platforms for Gloucester on the Main Line. This could be in the area of the triangle of railway lines east of Gloucester Station. If additional services were to be provided on the Bristol – Birmingham axis then this would allow those trains to call at Gloucester without incurring the reversal/journey time penalty. The costed option is a two-island design, providing four platform faces in total. This is a relatively expensive option due to the cost of providing new island platforms, realigning track and providing footbridges and associated infrastructure.

Other, more local train services could continue to serve the existing Gloucester Station for the pedestrian connectivity.

The case for the platforms is dependent on additional services on the Bristol – Birmingham axis, which would be difficult to accommodate on the 2019 infrastructure at each end of the route.

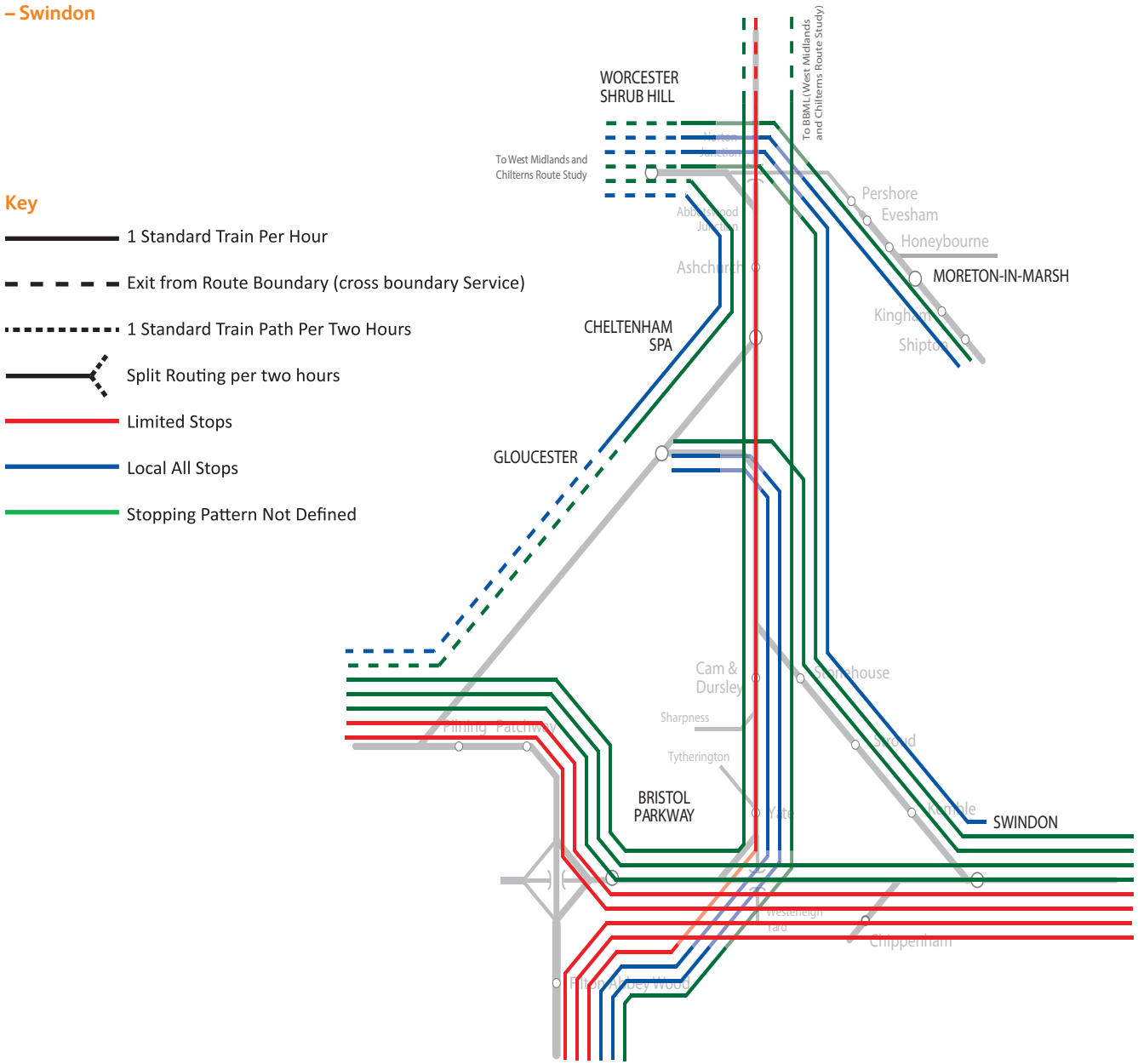
N3: Capacity improvements between Gloucester and Cheltenham	
Conditional Output	Connectivity
Timeframe	Longer Term, however there may be a case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	To accommodate the 2043 ITSS
Description	Provision of four tracking between Barnwood Junction and Cheltenham Spa Station using the available four track formation, and extending this by a distance of approximately 5 miles, thus providing a regulating and dynamic passing capability.
Indicative Cost	• £50m – £100m • Cost of passive provision not known
Relates to other options	• Gloucester Mainline Platforms (N2) • Charfield Loops (N6) • Ashchurch-Eckington Loops (N6) • Standish Junction Capacity improvements and Haresfield Loops (N4 & N5)
Analysis Within current Network Rail ownership there is land available which previously accommodated four tracks between Barnwood Junction and Cheltenham Spa. This option would not fully alleviate the need for dynamic loops at Charfield, or Ashchurch – Eckington, but it is a more cost effective and lower-risk proposition. It would therefore appear prudent to retain the ability to provide loops between Gloucester and Cheltenham in the future.	

N4: Capacity improvements of Standish Junction	
Conditional Output	Connectivity
Timeframe	Longer Term, however there may be a case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	To accommodate the 2043 ITSS
Description	Capacity improvements at Standish Junction to remove timetable conflicts due to the crossing moves at the junction.
Indicative Cost	• £35m – £75m • Cost of passive provision not known
Relates to other options	None
Analysis Increased number of trains on the Kemble and Charfield routes would drive the need for grade separation. The costed option consists of grade separation from the Stonehouse direction over the lines to Bristol to reconnect with the line towards Gloucester. It would therefore appear prudent to retain the ability to provide grade separation at Standish Junction in the future.	

N5: Capacity Improvements between Standish and Haresfield	
Conditional Output	Connectivity
Timeframe	Longer Term, however there may be a case for passive provision in 2019 – 2024 (Control Period 6)
Purpose	To accommodate the 2043 ITSS
Description	Provision of dynamic loops from Standish Junction to the M5 motorway bridge at Haresfield (approximately 2¼ miles). With suitable connecting crossovers, this provides a regulating point for trains to/from either the Kemble or Charfield routes and assists with timetabling.
Indicative Cost	• £20m – £50m • Cost of passive provision not known
Relates to other options	N4 Capacity improvements of Standish Junction
Analysis Within current Network Rail ownership there is land available which previously accommodated four tracks, between Standish Junction and Tuffley Junction (south of Gloucester). The track bed narrows to a two track width where it crosses over the M5 motorway at Haresfield, south of Gloucester which would limit the length of loop possible without the potentially significant cost of a double track railway bridge over a 6-lane motorway. This option would not fully alleviate the need for loops at Charfield, or Ashchurch – Eckington (see N8), but it is a more cost effective and lower-risk proposition. It would therefore appear prudent to retain the ability to provide loops between Gloucester and Cheltenham in the future.	

N6: Capacity Improvements at Charfield and between Ashchurch – Eckington	
Conditional Output	Connectivity
Timeframe	Longer Term
Purpose	To accommodate the 2043 ITSS
Description	Four-tracking to provide a dynamic passing capability
Indicative Cost	• Charfield: £75m – £175m • Ashchurch-Eckington: £100m – £250m
Relates to other options	N3 Capacity improvements between Gloucester and Cheltenham
Analysis Dynamic loops at Charfield (south of Cam & Dursley), and between Ashchurch and Eckington (south of Abbotswood Junction) would provide capacity to accommodate the 2043 ITSS by providing sections of four-track long enough to allow faster trains to overtake slower trains while not requiring the slower trains to come to a stand. The cost is high due to the need to acquire land and to build embankments or cuttings through the terrain to provide a suitable formation. It is also likely that some level crossings would need to be closed were the loops to be provided. The **West Midlands and Chilterns Route Study** will investigate and report on alternative routeing strategies which could reduce the need for such interventions. Such loops would require land outside the current railway boundary, which would require a Development Consent Order to be sought and granted which is a significant risk to delivery.	

Figure 5.56: Alternative 2043 Indicative Train Service Specification Worcester – Bristol Parkway and Gloucester – Swindon



Consideration of Alternative Specification

In the Draft for Consultation, it was identified that the full set of interventions that would be needed to accommodate the 2043 ITSS is likely to be unaffordable and represent poor value for money. Since then, the Route Study has considered an alternative specification with the aim of finding a reduced set of interventions which could deliver some or all of the Conditional Outputs.

As some of the services are cross-boundary in nature, this specification was agreed with the **Welsh** and **West Midlands and Chilterns Route Studies**, and with the Cross Boundary Working Group (see Chapter 4 for details).

The relevant part of the alternative specification is presented in Figure 5.57.

The alternative specification removes one Cardiff – Bristol Parkway – Birmingham service compared with the 2043 ITSS. It also routes some services via Worcester to Birmingham Snow Hill to avoid constraints at the Lickey Incline and at Bromsgrove (in the **West Midlands and Chilterns Route Study** area).

Taking a network-wide view shows a reduced cost to the industry for the alternative specification compared with the 2043 ITSS. Constraints identified by the **Welsh** and **West Midlands and Chilterns Route Studies** are relieved by this alternative specification, however there is no reduction in the interventions that would be required on the Western Route.

Analysis using multiple timetable approaches shows that 3-4 additional 'local' services can be accommodated between Standish Junction and Abbotswood Junction without infrastructure interventions, however additional cross-boundary paths covering the whole route are not available.

There is no driver to increase capacity on this Route Section during CP6, however electrification is anticipated to be a funder priority. Thus it is desirable to identify future requirements so that appropriate provision may be made during any works to electrify the railway. It is intended to continue development work outside the Route Study to ensure that all requirements are captured, to explore further alternative specifications, and to identify an affordable and value for money set of interventions.

Route Section O: Exeter Area

Figure 5.57: Route Section O: Exeter area

Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today's infrastructure. This includes:

- new stations at Cranbrook, Edginswell and Marsh Barton.

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 2tph London Paddington – Exeter or beyond
- 1tph London Waterloo – Exeter
- 1-2tph South West – Bristol and the North
- 1tph Paignton – Exmouth
- 1tph Barnstaple – Exmouth
- 0-1tph Freight.

Devon County Council's Devon Metro proposal includes the introduction of a number of new stations as well as increases and modifications to the existing service structure. Options being reviewed with the train operator as part of its recent Direct Award include concentrating the 2tph Exmouth service to operate to Paignton, while ensuring appropriate connectivity across Exeter for the Barnstaple service see Chapter 2 Baseline for more details.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Output, identified as a priority to the Western Route Study and relevant to this Route Section is:

Figure 5.58 Reference	Western Route Study capacity Conditional Output
CO4	To provide sufficient capacity for passengers travelling in and around Exeter in the peak

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the **Long Distance** and **Regional Urban Market Studies**.

Figure 5.59: Long Distance Market Study Conditional Outputs

Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
CO103	London Paddington – Exeter	2 to 3tph at 100mph	3tph

Figure 5.60: Regional Urban Market Study Conditional Outputs			
Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
CO85	Exeter St Davids – Plymouth	1tph at 80mph, or 2tph at 45mph	3tph
CO88	Exeter St Davids – Plymouth/Paignton/ Newton Abbot	Reduce journey time	2tph Exeter to Paignton, 3tph Exeter to Plymouth, 6tph Exeter to Newton Abbot
CO91	Exeter St Davids – Barnstaple	Improve end to end journey time	1tph
CO93	Exeter St Davids – Exmouth	Reduce journey time	2tph
CO94	London Paddington – Bath	2 to 3tph at 100mph	2tph
CO96	Exeter St Davids – Taunton	Reduce journey time and improve connectivity with Exeter Central	2 to 3tph Exeter to Taunton, 4tph Exeter St Davids to Exeter Central
CO98	Exeter St Davids – Truro	1 to 2tph at 80mph	2tph
CO104	Plymouth – Exeter	1 to 2tph at 80mph	3tph
CO108	Plymouth – Exeter/Paignton/Newton Abbot	Improve connectivity between Plymouth and Torbay	3tph Plymouth to Exeter, 3tph Plymouth to Newton Abbot, improved connectivity at Newton Abbot for Plymouth to Torbay

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown in the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other constraints. The Western Route Study (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as follows, delivering the connectivity outputs in terms of opportunities to travel each hour.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts (measured at a point taken south of Cogload Junction) are:

- 0 - 1tph Class 4 (typically intermodal or automotive traffic)
- 0 - 1tph Class 6 (typically 'heavier' traffic).

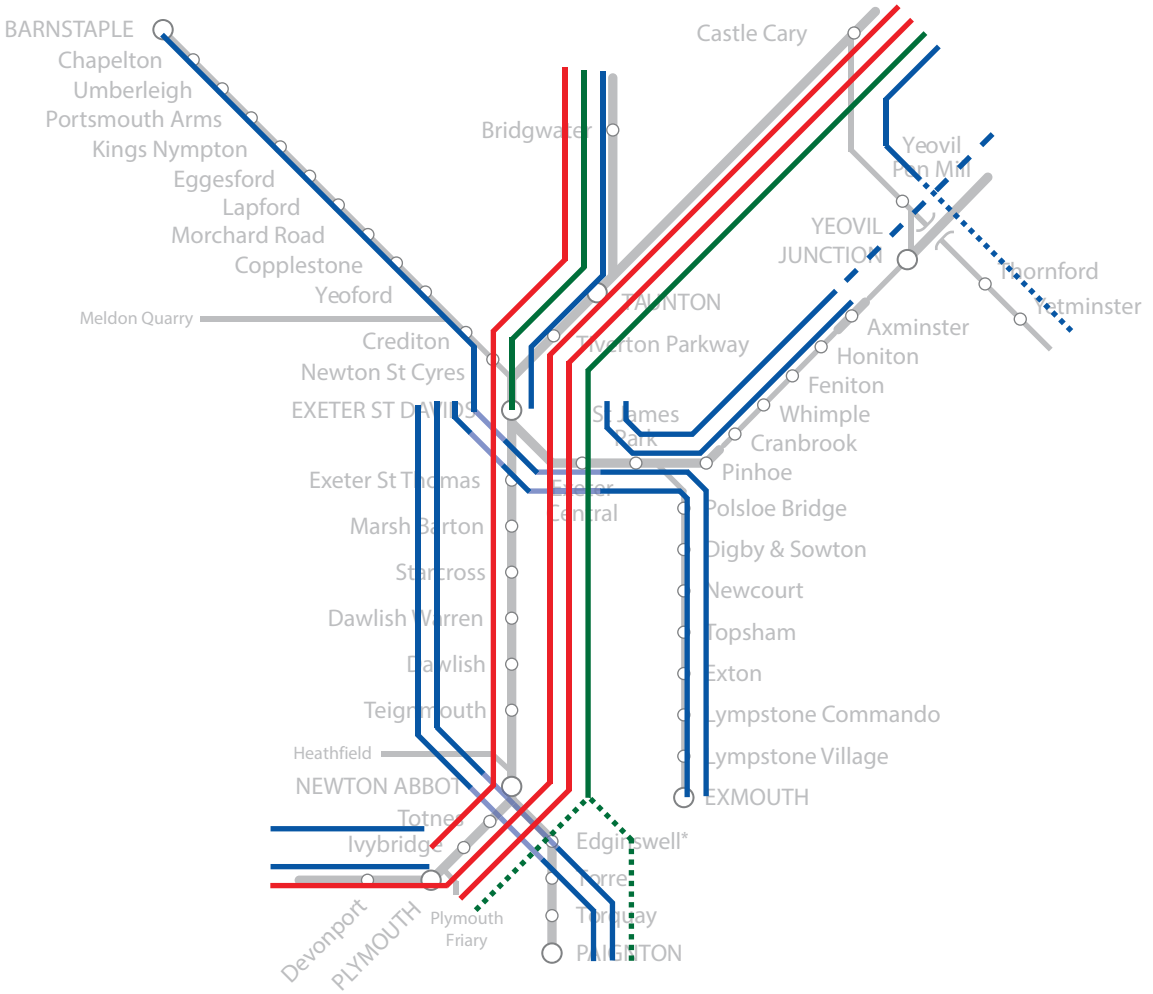
Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 ITSS.

Changes to the Indicative Train Service Specification to 2043

To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional services:

- 1tph London Paddington – Exeter (via Westbury/Castle Cary) or beyond
- 1tph North/Bristol/Birmingham – Exeter/Plymouth/Paignton
- 1tph Exmouth – Paignton
- 1tph Freight.

Figure 5.61: 2043 Indicative Train Service Specification Exeter Area



Key

- 1 Standard Train Per Hour
- Exit from Route Boundary (cross boundary Service)
- Less than 1 Standard Train Path Per Two Hours
- Split Routing per two hours
- Limited Stops
- Local All Stops
- Stopping Pattern Not Defined

System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, identifies the following emerging constraints:

- the non-standard pattern of long distance services, combined with the requirement for a standard half hourly pattern for local services
- the single line sections on the Barnstaple and Exmouth Branches and between Axminster and Pinhoe on the cross-boundary route to Salisbury (**Wessex Route Study** area)
- speed mix of services between Cogload Junction and Exeter St Davids, and from Exeter St Davids to Newton Abbot
- platform capacity at Paignton
- junction capability at Newton Abbot West, Cowley Bridge and Exmouth Junctions
- planning headways between Exeter St Davids and Plymouth, and on the Paignton line.

Making Best Use of Capacity

The emerging analysis from a number of studies indicates that this area will be considerably constrained.

Implementation of the Devon Metro proposals will require trade-offs across services and/or additional infrastructure. For example, in general there are up to five service opportunities per hour between Exeter St Davids and Newton Abbot when service mix and wider constraints are taken into consideration. These opportunities must accommodate local stopping, freight and long distance service requirements.

There are a number of opportunities to enable additional local services to operate on existing infrastructure in each hour:

- develop a standardised pattern for long distance services to allow the introduction of even service patterns for the local services. A clear opportunity exists to develop this further as the proposed IEP service specification is developed and implemented during CP5
- accelerate (e.g. through the use of faster rolling stock or by modifying calling patterns) slower services to allow more efficient use of network capacity.

Drivers of Change, and Choices for Funders, in Control Period 6

To identify the drivers of change for the Route Section in CP6, the longer term requirements have been prioritised, using the agreed prioritisation criteria for the LTPP:

- accommodating passenger and freight demand:
  - there is scope for accommodating passenger growth by train lengthening and running additional services. Both methods of intervention will require increased expenditure so are subject to a value for money assessment
  - lengthening existing services or delivery of Devon Metro proposals will provide additional capacity required to accommodate predicted growth in CP6
  - freight demand is expected to remain relatively constant in CP6, therefore there will be trade-offs for use of capacity in each hour for standard freight opportunities or passenger service opportunities
- renewals opportunities. Cogload Junction is due for renewal in CP6; any requirements for passive provision of additional capability will be considered through the development process.

To meet these drivers for change, the following choices have been investigated:

Accommodating rail passenger demand

Demand analysis indicates that commuter demand into Exeter will exceed capacity proposed in the 2019 ITSS for arrivals in the morning high peak on the Exmouth and South West (from Yeovil) lines.

Standing is expected to occur on the Barnstaple corridor into Exeter, however the data made available to the Western Route Study indicates that this will still be within total capacity and for less than 20 minutes' journey time.

The Route Study investigates alternative options O1 and O2 to provide sufficient capacity on the Exmouth corridor, including train lengthening or a third, peak train to start at Exmouth or Topsham. This would provide additional capacity for commuters into Exeter; however both options could not be accommodated on 2019 infrastructure so investment would be required.

For the Yeovil corridor, additional capacity would be provided as part of Devon County Council's proposed 'Devon Metro' with an additional train per hour to be provided between Exeter St Davids and Axminster. This would provide 2tph from Axminster and would also accommodate the on-train crowding forecast on this corridor in the peak during CP6, see Option O3: Capacity Improvements Exeter St Davids – Axminster.

See also Route Section M: Non-London long distance train lengthening.

O1: Train Lengthening on the Exmouth Line	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand on the corridor from Exmouth to Exeter
Description	Lengthen the Exmouth – Barnstaple peak service
Indicative Cost	Platform lengthening is likely to be required at specific stations to accommodate 5-car trains
Indicative Value for Money	Poor
Relates to other options	O2 – Additional peak service on the Exmouth line

Analysis

The average load factor on the peak services from Exmouth to Exeter is expected to exceed 100 per cent at the critical load point at St James' Park. Lengthening from 4 to 5-cars would reduce this load factor to below 100 per cent of total capacity.

The analysis is based on the Market Studies' growth forecasts that do not include demand generated by further schemes, i.e. only background growth is included. The additional demand generated by new stations at Cranbrook, Marsh Barton and Edginswell have been estimated and incorporated into the analysis.

More detailed appraisal results are presented in Appendix D.

O2: Additional Peak Train on the Exmouth Line	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand on the corridor from Exmouth to Exeter
Description	Provide an additional peak service and associated infrastructure interventions
Indicative Cost	This option is likely to require additional infrastructure. This has not been costed as both the capital and operating costs of Option O1 will be lower than this Option O2.
Indicative Value for Money	Not assessed
Relates to other options	O1 – Train lengthening on the Exmouth Line
Analysis The average load factor on the peak services from Exmouth to Exeter is expected to exceed 100 per cent at the critical load point at St James' Park. Provision of an additional peak service would reduce this load factor to below 100 per cent of total capacity.	

O3: Capacity Improvements Exeter St Davids – Axminster	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast peak demand between Exeter and Yeovil
Description	• Provision of an additional 3-car service between Exeter St Davids and Axminster to create a 2tph service • Provision of a new loop at Whimple would be required
Indicative Cost	• Infrastructure cost for new loop £5m – £15m • Additional vehicle operating costs
Indicative Value for Money	Poor (2-car scenario, was also tested, improving the value for money slightly to low value for money)
Relates to other options	O4 - as above but including Diversionary Capability
Analysis Demand analysis identifies that by 2023, there will be on-train crowding between Yeovil and Exeter. To avoid excessive train lengthening on the London Waterloo services, the choice to provide a second train per hour between Exeter St Davids and Axminster has been considered. This would provide capacity to meet demand requirements and aligns with aspirations to increase the service frequency on this route by the local authorities and forms part of the Devon Metro proposal. With the opening of a new station at Cranbrook, it is anticipated that demand growth will continue to rise. More detailed appraisal results are presented in Appendix D.	

O4: Capacity Improvements Exeter St Davids – Axminster plus Diversionary Requirements	
Conditional Output	Capacity and Diversionary Capability
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast peak demand between Exeter and Yeovil and provide a sustainable diversionary route for services to London Paddington via Yeovil Junction
Description	• Provision of an additional service between Exeter St Davids and Axminster to create a 2tph service (provision of a new loop at Whimple would be required) • To accommodate an hourly diversionary service between Exeter and Castle Cary (via Yeovil Junction) (note this would take the path of the additional local service when required to operate)
Indicative Cost	• Infrastructure costs £75m – £175m including the costs for Option O3 • Additional vehicle operating costs
Indicative Value for Money	High
Relates to other options	O3 - Capacity Improvements Exeter St Davids – Axminster
Analysis Work as part of the resilience workstream and **Wessex Route Study** has assessed requirements to support an hourly diversionary service via Yeovil when the GWML may be restricted by, for example, engineering access or severe weather. The provision of a diversionary route drives further infrastructure interventions. When assessing the value for money business case of the scheme, benefits from capacity and connectivity have been captured alongside the diversionary benefits. The result presented also includes diversionary benefits as a result of unexpected closures, such as flooding (estimated from historic data). These benefits may not be attributable to this option should other resilience schemes be successfully implemented. More detailed appraisal results are presented in Appendix D.	

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

By 2043 on-train crowding is predicted on peak services into Exeter from Barnstaple. Lengthening of the Barnstaple services to beyond 4-cars would be required in order to provide sufficient capacity, plus further lengthening on the Exmouth corridor to accommodate 2043 predicted demand.

The proposed Devon Metro 2tph service level would provide additional capacity from Axminster and Paignton that would be sufficient for 2043 and this level of service is reflected in the 2043 ITSS.

To accommodate the connectivity Conditional Outputs as represented in the 2043 ITSS, further interventions will be required. There are a number of potential choices to deliver the Conditional Outputs. However, to meet them all there are likely to be significant constraints including deliverability and affordability. A choice for funders is likely to involve trade-offs between journey time, service frequency and performance.

Analysis has identified that the following infrastructure or equivalent would be required to operate the full 2043 ITSS:

- improve planning headways between Exeter St Davids, and Plymouth and on the Paignton line to enable greater flexibility in the timetabling of services
- provision of a four-track railway for part of the route section between Exeter St Davids and Newton Abbot
- junction improvements at Cowley Bridge
- infrastructure to reduce possible conflicts, for example at Newton Abbot or Exeter St Davids to remove the need for crossing moves, and/or more flexibility for timing long distance services
- at Paignton, provision of either –
  - an additional platform, or
  - a reduction in turnaround times for services using the Goodrington facility to turn back, or
  - a flexing of stopping patterns and journey times for local services alongside bi-directional signalling capability for both platforms.

The provision of a four track railway for part of the Route Section between Exeter St Davids and Newton Abbot would be difficult to accommodate along the current coastal route. However, should capacity for a four track railway be required by 2043 to deliver the full 2043 ITSS, this could be provided through a combination of the existing two-track formation and a new two-track railway as investigated under the West of Exeter Route Resilience Study. However, this is one choice that will be reviewed as further work is undertaken to consider the resilience requirements over future control periods up to 2043.

West of Exeter Route Resilience Study

The catastrophic destruction of the Dawlish sea wall due to exceptional weather conditions in early February 2014 prompted a study of the resilience of the route into Devon and Cornwall. The study assessed options for improving the resilience of the existing railway. It appraises alternative scenarios in the event of the Dawlish coastal route being unavailable because of severe weather events or maintenance requirements.

The study evaluated:

- the cost effectiveness and value for money of options to deliver improvements to the existing route and sustainable alternative routes
- the opportunities to deliver improved journey times between Exeter St Davids and Newton Abbot
- the constructability and resilience of each option assumes the existing route is fully restored and operational.

Options identified and assessed:

- Option 1 – Maintaining the existing railway with the current maintenance regime between Exeter St Davids and Newton Abbot
- Option 2 – Further strengthening of the existing railway between Exeter St Davids and Newton Abbot. Early estimates suggest this could cost between £398 million and £659 million. This would be spread over four Control Periods with a series of trigger and hold points to reflect funding availability, spend profile and achieved level of resilience
- Option 3 – Alternative Route A: Reconstruction of the former London & South Western Railway route from Exeter to Plymouth via Okehampton in the form of a double track railway for the whole length of the route at an estimated cost of £875 million
- Option 4 – Alternative Route B: A new double track railway on the alignment of the former Teign Valley route from Exeter to Newton Abbot at an estimated cost of £470 million. (There is doubt as to whether a resilient railway is practical on this route due to flood plains)
- Option 5 – Alternative Route C. This incorporated five sub-options (C1 to C5) to provide potential new direct routes between Exeter and Newton Abbot at an estimated cost between £1.49 billion and £3.10 billion. The five alternative routes capture all reasonable alignments capable of a 125mph linespeed and all routes mostly traverse open country at the north end and in tunnel at the south end.

Each option has also been reviewed in terms of capability and journey time improvements.

Journey time:

- Options 1 and 2 have no impact on journey time
- Options 3 (via Okehampton) and 4 (via Teign Valley) result in journey times in excess of current journey times via the coastal route. Option 3 would add between 14 and 20 minutes to the duration of through journeys to Cornwall
- Option 4 is likely to add around seven minutes, suggesting that these routes would only be used by long distance trains when the current route is closed.

  These would therefore not meet the Market Studies Generalised Journey Time Conditional Output
- Option 5, Alternative (tunnelled) Routes C1, C2, C3 and C4 each offer a journey time benefit to through passengers ranging between three and six minutes. Alternative Route C5 makes little difference to journey time.

Capability:

- all options would be used by all types of diesel rolling stock for passenger and freight
- all options provide varying levels of notional additional capacity, which enable the connectivity Conditional Outputs to be accommodated
- Options 4 and 5 support future electrification without a requirement to further modify structures along the new route.

The options are assumed to be feasible to build and operate, safe to operate and maintain, resilient against environmental threats, and capable of accommodating all or most train services that are likely to run in the future. A successful option must also offer value for money. A value for money assessment has been undertaken on each of the options to provide an alternative line. The results are presented in Figure 5.62.

Figure 5.62: Benefit Cost Ratio for Alternative Route Options		
Option	**Estimated cost at 2014 cost base including contingency (£m)**	**BCR**
Option 1	0.8 per annum + 5 every 5 years	N/A
Option 2	398 - 659	N/A
Option 3	875	0.14
Option 4	470	0.29
Option 5 - (C1)	3,100	0.08
Option 5 - (C2)	2,510	0.12
Option 5 - (C3)	2,250	0.13
Option 5 - (C4)	1,560	0.17
Option 5 - (C5)	1, 490	0.15

Four sensitivity tests were conducted in order to understand the impact of any changes in the underlying assumptions incorporating the outputs from the Western Route Study and to see if these would influence the value for money case.

i. Enhanced timetable test

An enhanced timetable scenario was derived for an increase in frequencies, mainly along the coastal route. This scenario included capacity for nearly double the number of trains and accommodates the 2043 connectivity Conditional Outputs.

ii. Reduced capital cost test

The effect of a substantial reduction of 50 per cent in the cost of each option was tested.

iii. Longer closure of the coastal route test

The effect of assuming a longer than average duration of closure of the existing route - an annual 10 per cent chance of the route being shut for 40 days - was tested. The central case assumed an annual 10 per cent chance of the route being shut for 15 days.

iv. Optimistic revenue and capital cost test

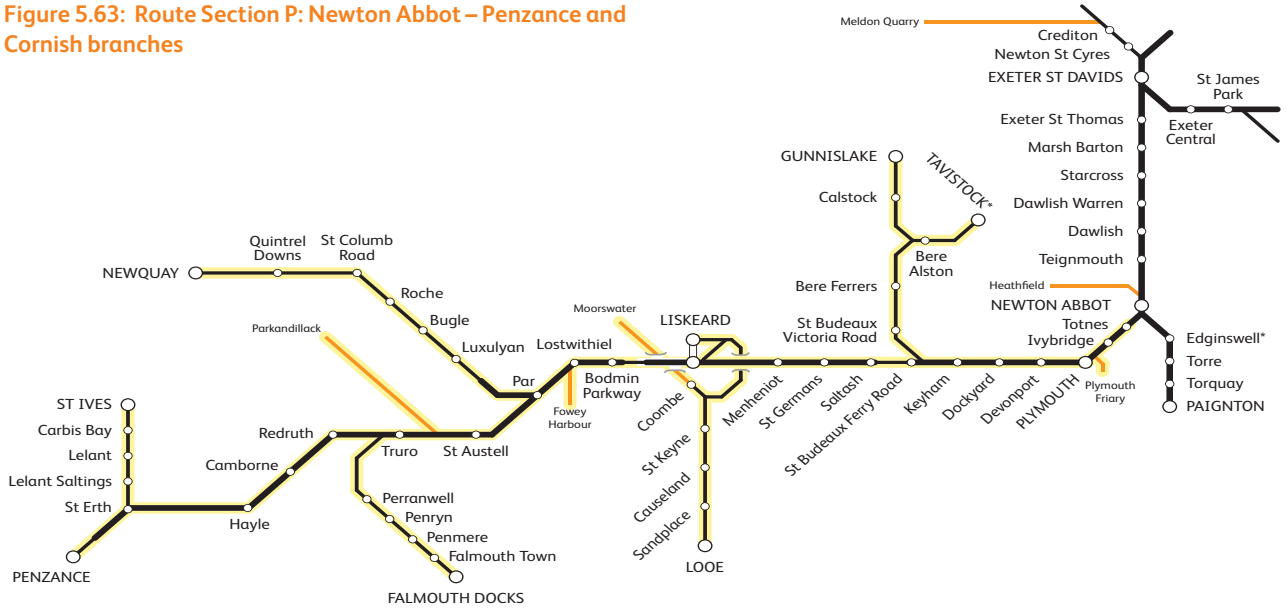
A reduction of 50 per cent in the capital cost outlay and increase in certain revenue and unpriced benefits of 100 per cent were made. The revenue and unpriced benefits were attributable to the operation of the option timetable (compared to the existing situation).

The results indicate that, from a transport economic appraisal point of view, all the alternative route options represent poor value for money. This remains true under a range of sensitivity tests. Apart from those listed above, this appraisal has not taken account of wider social and economic benefits that might have been forgone during the closure of the railway in February 2014. Stakeholders continue to gather research to help quantify the size of these wider impacts, and to understand the extent to which they might contribute towards enhancing any business case for an additional or alternative route.

The full West of Exeter Route Resilience Study can be found on Network Rail's website.

Route Section P: Newton Abbot – Penzance and Cornish Branches

Figure 5.63: Route Section P: Newton Abbot – Penzance and Cornish branches



Description of the Anticipated 2019 Baseline Infrastructure

The investment projects expected to be implemented between 2014 and 2019 mean that the infrastructure assumptions for the baseline differ from today. They are anticipated to include:

- reinstatement of the Bere Alston to Tavistock line for passenger services and a new station at Tavistock
- resignalling between Totnes and Penzance.

Anticipated 2019 Baseline Service Patterns

The principal off-peak services anticipated in the 2019 Indicative Train Service Specification (ITSS) are as follows (tph = trains per hour, each direction):

- 1tph London Paddington – Plymouth/Penzance
- 1tph Plymouth – Penzance
- 1tph Plymouth – Tavistock
- a service between Bere Alston and Gunnislake, connecting into and out of the Tavistock service
- 1 train per two hours Liskeard to Looe
- 7 trains per day Par – Newquay. During the peak season, there is one direct service per day in each direction to/from London Paddington (two on Saturdays) and three direct trains per day on Saturdays from Plymouth
- 2tph Truro – Falmouth
- 2tph St Erth – St Ives
- 1tph Freight.

The current Main Line passenger service patterns in the Devon and Cornwall area are irregular west of Plymouth. Long Distance High Speed services from London Paddington and the North serve Plymouth each hour with some services extending to Penzance. The Main Line is also served by services from Cardiff, Bristol, Exeter and Plymouth serving stations to Penzance.

Capacity and Connectivity Conditional Outputs the Route Study seeks to accommodate

These Conditional Outputs are aspirations for the industry to deliver in the long term subject to value for money, deliverability and affordability. Equally, the Conditional Outputs will need to be deliverable – technologically, operationally and physically.

Capacity

Defined as capacity to accommodate forecast passenger demand and minimise on-train crowding. The capacity Conditional Outputs, identified as a priority to the Western Route Study and relevant to this Route Section is:

Figure 5.64	
Reference	Western Route Study capacity Conditional Output
CO6	To provide sufficient capacity for passengers travelling in Devon and Cornwall

Connectivity

In terms of passenger services the connectivity Conditional Outputs applicable to this Route Section are defined by the Long Distance and Regional Urban Market Studies.

Figure 5.65: Long Distance Market Study Conditional Outputs			
Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
CO114	London Paddington – Plymouth	2 to 3tph at 100mph	2tph
CO123	London Paddington – Penzance	1 to 2tph at 80mph	1tph
CO113	Plymouth – Truro	1 to 2tph at 80mph	2tph
CO121	Truro – Exeter	1 to 2tph at 80mph	2tph
CO104	Plymouth – Exeter	1 to 2tph at 80mph	3-4tph

Figure 5.66 : Regional Urban Market Study Conditional Outputs			
Reference	Flow	Market Study Connectivity Conditional Output	Western Route Study (or Cross-Boundary ITSS) interpretation of service frequency
CO110	Plymouth – Penzance	Reduce journey time	2tph
CO116	Truro Main Line	Reduce journey time	2tph
CO119	Truro Branch Line	Reduce journey time	2tph
CO104	Plymouth – Exeter	Journey Time Improvement	3-4tph
CO108	Connectivity at Newton Abbot (Plymouth – Paignton)	Journey Time Improvement	Increased frequency on both legs of journey

Interpretation of Passenger Connectivity Conditional Outputs

The Western Route Study interpretation for the connectivity Conditional Outputs is as shown on the 2043 ITSS. Note this is only one possible interpretation, and is unconstrained by network capacity or other constraints. The Western Route Study (or Cross-Boundary ITSS where appropriate) has interpreted the Conditional Outputs as follows delivering the connectivity outputs in terms of opportunities to travel each hour.

Freight Market Study

The Freight Conditional Outputs are to accommodate forecast freight demand. The 2043 demand forecasts are:

- 1tph combined Class 4 path west of Exeter (typically intermodal or automotive traffic and Class 6 (typically 'heavier' traffic))

Please see Chapter 3 for more details on interpretation of Conditional Outputs and construction of the Western Route Study 2043 Indicative Train Service Specification.

Changes to the Indicative Train Service Specification to 2043

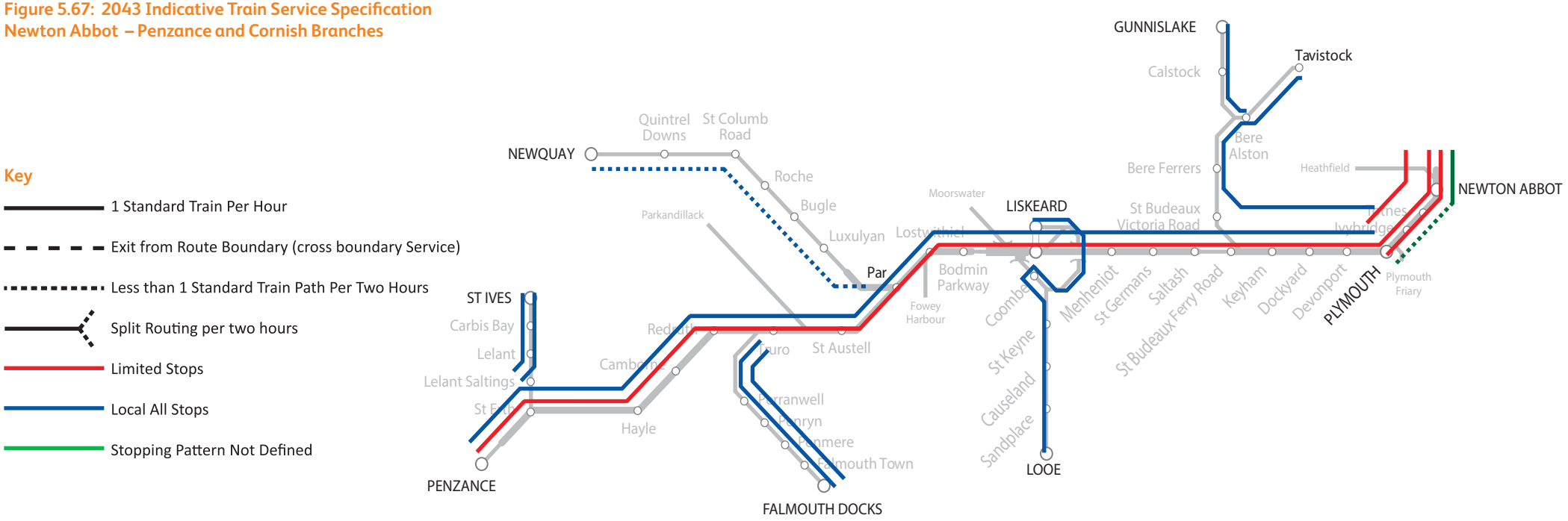
To accommodate the connectivity Conditional Outputs, the ITSS for 2043 includes the following additional service:

- 1tph Plymouth – Penzance.

An additional hourly service between Plymouth and Penzance will provide a 2tph service level. This improves the frequency and regularity of services for stations on the Main Line between Plymouth and Penzance and improves Main Line and Branch Line connectivity, therefore improving the Generalised Journey Time to Branch Line locations from Main Line stations.

There are no anticipated changes required to meet freight demand.

Figure 5.67: 2043 Indicative Train Service Specification Newton Abbot – Penzance and Cornish Branches



System Capability Constraints

Developing the 2019 ITSS towards the 2043 service level requirements, has not identified any further constraints. It is assumed that the planning headways are reduced in CP5 by the proposed accelerated resignalling between Totnes (exclusive) and Penzance which would provide the infrastructure capability to operate 2tph on the Main Line. See Chapter 2 for further details.

Making Best Use of Capacity

This Route Section is currently constrained by the long signalling headways specifically between Totnes and Plymouth, Saltash and Liskeard, and west of Truro. However, the accelerated resignalling proposal will provide sufficient capacity to operate the service frequencies proposed.

Drivers of Change, and Choices for Funders, in Control Period 6

No specific drivers for change have been identified in CP6 subject to the accelerated resignalling in CP5 being implemented.

The linespeeds on the Route Section are low due to the nature of the curvature of the infrastructure; journey time improvements will be investigated and implemented, where possible, subject to a value for money assessment and this will be reviewed as part of the wider Western Route Journey Time Improvement programme see Section 5.3.2.

In 2023, demand analysis indicates that morning peak services between Truro and Falmouth are forecast to require additional capacity to avoid crowded conditions with services anticipated to have an estimated 89 per cent load factor. Choices to meet this demand are presented in options P1 and P2.

The seasonal variation in passenger demand for this part of the network is an important consideration and is discussed in more detail in Section 5.3.2, as part of the tourism Conditional Output.

P1: Train Lengthening on the Falmouth Line	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand on the corridor from Falmouth Docks to Truro
Description	Lengthen high peak services from 2 to 3-car
Indicative Cost	Platform lengthening is likely to be required at Falmouth Town to accommodate 3-car trains
Indicative Value for Money	Low
Relates to other options	P2 – Additional peak train on the Falmouth line
Analysis The average load factor on the peak services from Falmouth to Truro is expected to exceed 100 per cent at the critical load point at Truro. Lengthening from 2 to 3-cars would reduce this load factor to below 100 per cent of total capacity. The analysis is based on the Market Studies' growth forecasts which do not include demand generated by further schemes, i.e. only background growth is included.	

P2: Additional Peak Train on the Falmouth Line	
Conditional Output	Capacity
Timeframe	2019 – 2024 (Control Period 6)
Purpose	To accommodate forecast 2023 peak demand on the corridor from Falmouth Docks to Truro
Description	To provide an additional peak train Falmouth Docks – Truro and the infrastructure required to accommodate this
Indicative Cost	A capital cost has not been calculated as Option P1 is likely to provide better value means to achieve the same output
Indicative Value for Money	Not calculated but likely to be Poor
Relates to other options	P1 – Train Lengthening on the Falmouth Line

Analysis

The average load factor on the peak services from Falmouth to Truro is expected to exceed 100 per cent at the critical load point at Truro.

Operation of an additional peak train could reduce this load factor to below 100 per cent of total capacity.

Capability analysis shows that additional infrastructure would be required. Currently the line operates as Single Line Working between Penwithers Junction and Penryn, and between Penryn and Falmouth Docks. An additional tph on the branch would require additional passing loops in the following locations (with appropriate signalling control):

- Perrenwell
- Penmere and Falmouth Town (~1mile between the stations, likely require double track throughout).

The option is likely to require signalling enhancements between Truro and Penwithers Junction e.g. headway reduction.

The analysis is based on the Market Studies' growth forecasts which do not include demand generated by further schemes, i.e. only background growth is included.

Option P1 is likely to present better value for money as both capital and operating costs would be lower.

Electrification

The strategic case for electrification of the route will be reported on in the refresh of the **Network RUS: Electrification** Draft for Consultation due to be published in 2015.

Longer Term Strategy

By 2043, additional capacity will be required between Truro and Falmouth.

In order to accommodate the 2043 Conditional Outputs an increase in service level on the Main Line will be implemented to provide 2tph between Plymouth and Penzance. With this anticipated ITSS, the services on the Cornish Main Line and the remaining branches are assumed to have sufficient capacity to accommodate morning peak demand forecasts in 2043.

The seasonal variation in passenger demand for this part of the network is an important consideration but difficult to predict. Consideration of alternative solutions to meet the Conditional Outputs should be assessed in line with the Network RUS: Alternative Solutions.

5.3.2 Other Conditional Outputs

Not all of the Market Studies' Conditional Outputs have been quantified as they either do not directly relate to connectivity or are too bespoke for numerical analysis to be undertaken. However, these outputs still require articulation as they are likely to contribute to a successful outcome of the strategic goals and may enable the positive impact of the connectivity and capacity based Conditional Outputs. The other Conditional Outputs are:

- improved access to long distance gateways (HS2 and Airports)
- better connectivity for the leisure market at the weekends
- better capacity for the leisure market at the weekends and week day evenings
- improved access to higher education establishments and social infrastructure
- improved passenger satisfaction
- improved local access to the rail network to cater for demand
- connectivity and capacity for tourist attractions outside of the region's urban centres.

Airports Strategy

The independent Airports Commission chaired by Sir Howard Davies published its final report on the 1 July 2015, setting out its recommendations for maintaining the UK's status as an international hub for aviation. In December 2013 the Commission shortlisted three schemes for further consideration, two at Heathrow and one at Gatwick.

The report contains a range of recommendations which Government will now consider. The Secretary of State is expected to provide clear direction on the Government's plans in the autumn. Should Government decide to take forward any recommendations made by the Airports Commission, then we will work with the DfT and the preferred airport developer to develop the rail component of the surface access strategy and review the Conditional Outputs as appropriate.

Better connectivity for the leisure market at weekends

The busiest time for leisure travel is often at weekends, which coincides with significant railway engineering activities timed to minimise disruption to commuting and business passengers. There is a choice for funders to provide the same level of connectivty as illustrated on the 2043 ITSS at the weekend. This involves consideration of trade-offs between connectivty, engineering regimes and assessment of affordability and value for money.

Better capacity for the leisure market at weekends and weekday evenings

The busiest times for travel to/from urban retail and tourism centres are often at weekends and during weekday evenings. This is in contrast to the typical weekday peak for commuting and business travel, when the highest levels of train service frequency and capacity are provided. There is a choice for funders to provide the same level of capacity at the weekend as the rest of the week subject to demand requirements.

Where the number of trains operated remains the same throughout the day, and at weekends, then the train operating companies could have sufficient rolling stock available to deploy to meet demand outside the traditional week day peaks. This involves consideration of trade-offs between connectivity, engineering regimes and assessment of affordability and value for money.

Improved access to higher education establishments and social infrastructure

In some regions demand for travel in these markets is strong and the Route Study considers the potential impact on rail passenger demand and the level of service provision that could be required to accommodate it. As presented in Chapter 3, locations across the area where connectivity is key include Oxford, Bath, Bristol, Exeter, Plymouth, Truro and Falmouth. The 2019 and 2043 ITSS anticipate an increase in service frequencies that would support the provision of improved capacity and connectivity to such establishments across the route.

Improved passenger satisfaction

Two important aspects of passenger satisfaction are Generalised Journey Time (composed of in-vehicle time, waiting time and interchange penalty) and capacity (sufficient space to sit or stand). These are considered in detail in the Route Study through the connectivity and capacity Conditional Outputs.

Opportunities to improve journey times and station capacity have also been reviewed.

Journey Times

The Western Route Journey Time Improvement Programme is reviewing opportunities to reduce journey times via a change in calling patterns, rolling stock and/or linespeed improvements. The Western Route Study scope area has been assessed by Route Section and opportunities on each Route Section for journey time benefits assessed. This has been undertaken using a combination of different pre-GRIP methods, depending on context. Typically these include:

- Route Runner: An Excel spreadsheet tool that calculates journey times based on rolling stock performance characteristics and calling patterns and identifies the target linespeed increases and the potential benefits available
- Third Way Analysis: Desktop review of track geometry to identify the scale of intervention required (or possible) to achieve linespeed increases
- Timetable Analysis: Analysis of the benefits that can be realised within the timetable structure or the improvements possible through changes in calling patterns.

The outputs of the programme will be assessed for implementation and funding streams in CP5, CP6 and the longer term and where possible aligned with renewals or other enhancements.

For schemes that have been reviewed but have no value for money opportunities presently identified, then the analysis will be maintained in order that it can be reviewed should circumstances change. Where schemes have been analysed to sufficient depth such that the scale of opportunity is well defined, then CP5 Passenger Journey Improvement funds will be sought to allow development of the scheme to progress. This will include a detailed review of requirements, cost and value for money assessment.

The Western Route Journey Time Improvement Programme will continue following publication of the Western Route Study. It is informed by the indicative train service specification and options developed as part of the Western Route Study.

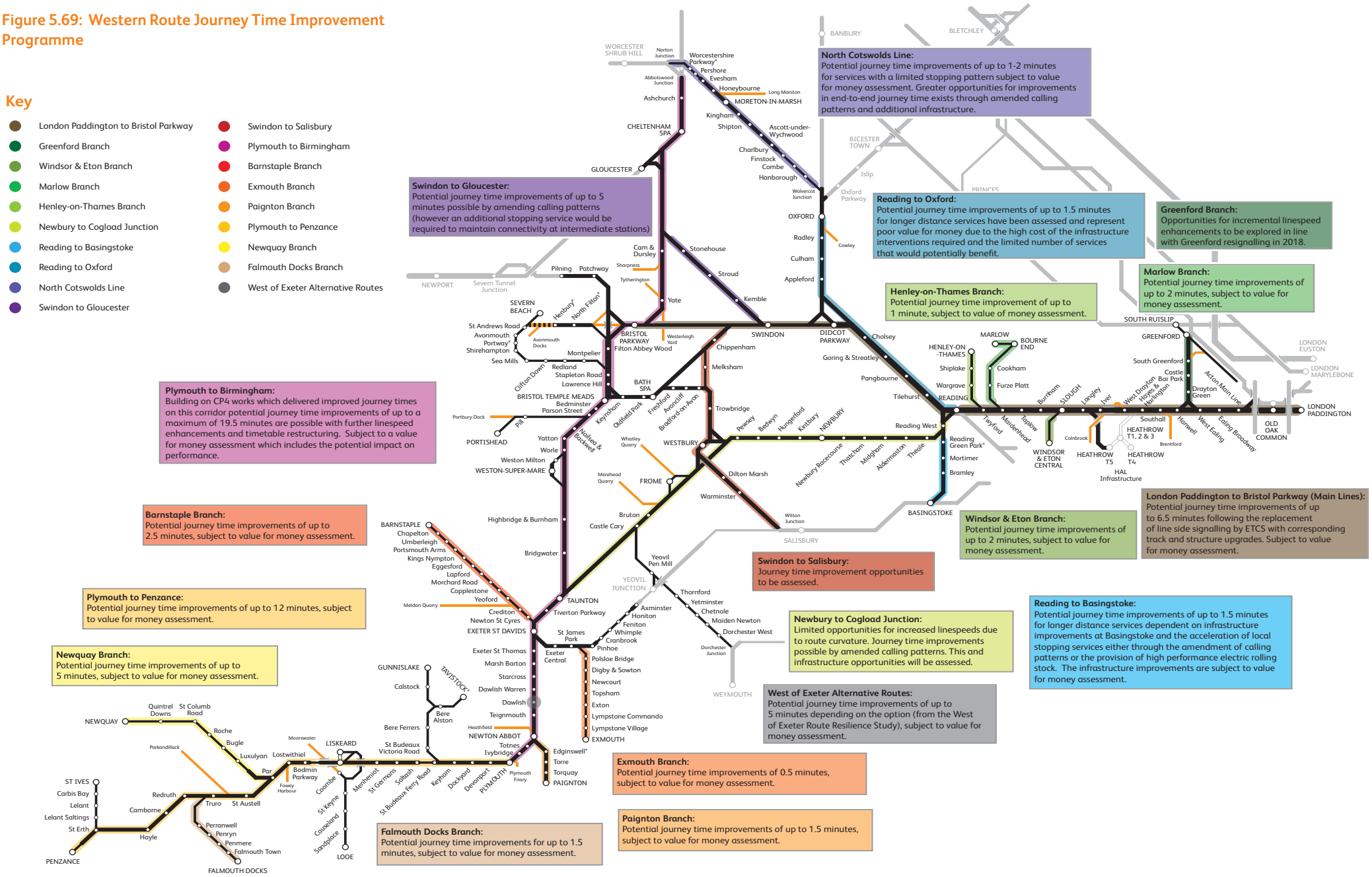
Figure 5.68 presents possible timetable improvements for long distance services with new dedicated long distance trains.

Figure 5.69 presents a summary of potential opportunities for journey time improvements subject to value for money assessments and funding.

Figure 5.69: Estimated journey time improvements from the December 2018 timetable (courtesy of First Great Western)

Journey	2013		December 2018		Improvement	
	Fastest	Typical	Fastest	Typical	Fastest	Typical
London Paddington to Bristol Temple Meads	96 mins (1hr 36 min)	105 mins (1hr 45 min)	79 mins (via BPW) (1hr 19 min)	90 mins (1hr 30 min)	17 mins (18%)	15 min (14%)
London Paddington to Cardiff Central	119 mins (1hr 59min)	127 mins (2hr 7 min)	105 mins (1hr 45 min)	113 mins (1hr 53 min)	14 mins (11%)	14 mins (11%)
London Paddington to Cheltenham	126 mins (2hr 6 min)	130 mins (2hr 10 min)	115 mins (1hr 55 min)	120 mins (2 hrs)	11 mins (9%)	15 mins (7%)
London Paddington to Hereford	183 mins (3hrs 3 min)	190 mins (3hrs 10 min)	176 mins (2hr 54 min)	180 mins (3 hrs)	7 mins (3%)	10 mins (5%)

Figure 5.69: Western Route Journey Time Improvement Programme



Station Capacity

Station capacity is an important factor to be considered as part of the Long Term Planning Process (LTPP). Stations form an integral part of passengers' journeys. If sufficient capacity is not provided then safety can be compromised and walk times and inconvenience could be caused due to congestion. Providing sufficient space at stations is a crucial enabler to ensuring passenger satisfaction, minimising dwell times and running longer or higher capacity rolling stock in addition to continuing to attract demand and provide a high performing railway.

An important part of increasing capacity on the Western Route is addressing any current or anticipated station congestion.

Process

In order to generate a station capacity based scenario, a review of current station capacity was undertaken. A Station Capacity Working Group was established with representatives from First Great Western (as Station Facility Operator across the route) to incorporate their knowledge from operating the stations on a day-to-day basis.

In parallel with this, a review of ticket data was undertaken to identify the stations with the highest boarding/alighting numbers for individual train services during peak times of the day. Station capacity analysis is predominantly based on the busiest 15-minute periods of the day for train boarding and alighting. If a station has sufficient capacity to accommodate the busiest periods then this should be sufficient for all other times of day.

For the purposes of this assessment a total boarding/alighting (churn) figure of 100 for the busiest train service at each particular station was used to select stations to create a shortlist (it should be noted that outputs from ticket data are indicative only, and are used as a means to identify overall patterns and trends rather than provide detailed information on individual train services).

This information was used to identify potential future capacity issues based on forecast passenger demand and potential infrastructure and operational interventions. Opportunities to improve station capacity were identified at a high level, which can be analysed as part of a more detailed station capacity assessment if required. This information needs to be revisited and updated during subsequent Control Periods.

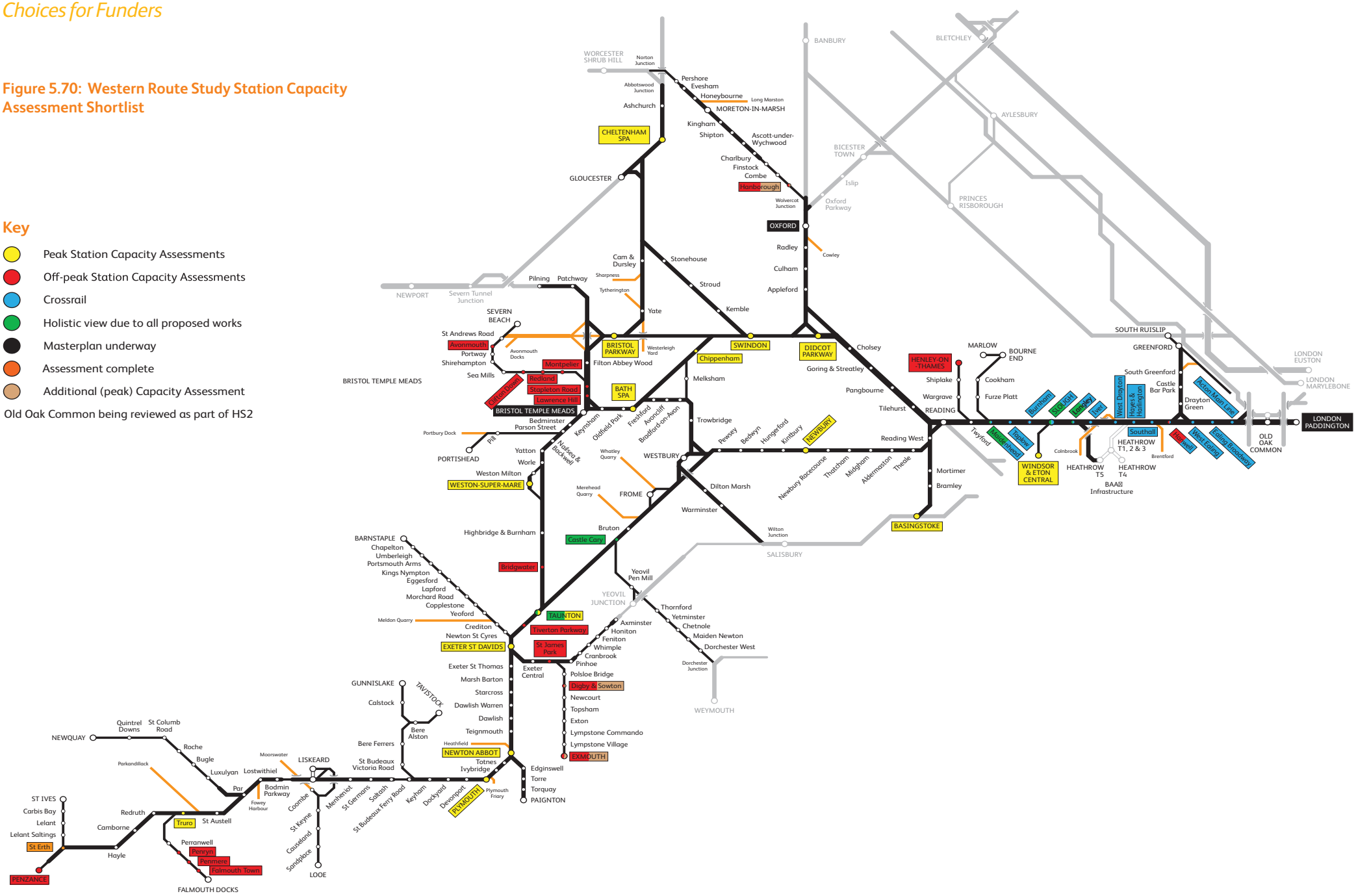
The shortlist developed by these two different processes was combined to create one overall list. Overlaps were identified between the two lists, with a large proportion of stations appearing on both. A final shortlist of stations was developed and agreed, following which, a programme of site visits and station capacity assessments was undertaken and assessments made with regards to current and future capacity requirements. They are highlighted in Figure 5.70.

Figure 5.70: Western Route Study Station Capacity Assessment Shortlist

Key

- Peak Station Capacity Assessments
- Off-peak Station Capacity Assessments
- Crossrail
- Holistic view due to all proposed works
- Masterplan underway
- Assessment complete
- Additional (peak) Capacity Assessment

Old Oak Common being reviewed as part of HS2



Assessment Shortlist

A number of stations were excluded from this process because they have already been identified as having existing capacity constraints or are being assessed as part of recent or current projects. These are:

- London Paddington (Masterplan and redevelopment proposals underway)
- future Crossrail stations between London Paddington and Maidenhead
- Reading Area Station Redevelopment, completed 2015
- Oxford Masterplan (Masterplan study completed)
- Bristol Temple Meads Masterplan, (Masterplan study completed)
- St Erth Station Capacity Assessment, completed August 2013.

Outputs

In addition to the agreed shortlist:

Bristol Parkway Station has been identified as potentially requiring capacity interventions in CP6 to accommodate growth in demand forecast with the introduction of additional long distance and local services. A station capacity assessment is being undertaken as part of the Intercity Express Programme (IEP).

Bath Spa and **Newbury** Stations are recommended for a review into potential way-finding measures, such as improved signage to stairs and lifts, PA announcements, layout of furniture, and segregation of stairs that could be employed more efficiently to manage passenger flows during peak periods.

The following areas have been identified for further review should train lengthening be implemented or demand growth exceed current forecasts:

- Henley-on-Thames
- The Exmouth Branch – Exmouth, Digby and Sowton, Polsloe Bridge and St James Park recommended for review as part of Devon Metro
- The Falmouth Branch – Truro, Penryn, Penmere and Falmouth Town
- Severn Beach Line – Avonmouth, Clifton Down, Redland, Montpelier, Stapleton Road and Lawrence Hill. This is also recommended for review as part of the MetroWest Phase 1 project.

It is recommended that platform lengthening be considered at **Hanborough** to maintain existing train dwell times and to minimise adverse impacts on performance. Its role as a railhead for North West Oxfordshire has led to potential issues with the busier services given the relatively short platform length and the time available for passengers to board.

A number of CP5 schemes are planned at stations across the route, in addition to third party schemes in development. Although these may not have been identified as specifically requiring capacity enhancements, it is recommended that station capacity requirements are considered to ensure sufficient provision is made for future growth.

In addition to the stations with known capacity constraints there are those that, depending on the choices selected to meet the Conditional Outputs, are likely to reach capacity in future years. It is important that these stations are also identified as part of the LTPP and are considered to be reviewed as part of this process.

A summary matrix has been developed to consolidate the outputs from the station capacity assessments and this is presented in Figure 5.71. The results are based on high-level assessments conducted as part of this work. More detailed passenger assessments should be conducted before any decisions can be made on the specifics of any proposed interventions. This is to ensure that the full extent of any capacity issue is identified before solutions are developed.

A limited number of issues have been identified that require interventions in CP5; these are predominantly covered by the projects already in place. However, where smaller interventions such as Access for All (AfA), National Stations Improvement Programme (NSIP) and renewal schemes are planned, it is recommended that a collective strategy for the area be developed.

Improved local access to the rail network to cater for demand

Good connectivity and accessibility to rail stations is important in attracting passengers to travel by rail. Key to this is the provision of car parking, walking and cycling routes and cycle storage facilities and an interchange with other transport modes, such as taxis and buses. There are existing mechanisms in place that review these requirements through work within the rail industry and in collaboration with wider stakeholders, such as local authorities and Local Enterprise Partnerships.

Connectivity and capacity for tourist attractions outside the region's urban centres

Provision of a frequent, regular service throughout the week and at weekends, as well as services that operate sufficiently early and late in the day to enable a full day trip is required to maintain and improve attractiveness to such destinations. The 2019 and 2043 ITSSs anticipate an increase in service frequency which could support the provision of improved capacity and connectivity to such establishments across the route.

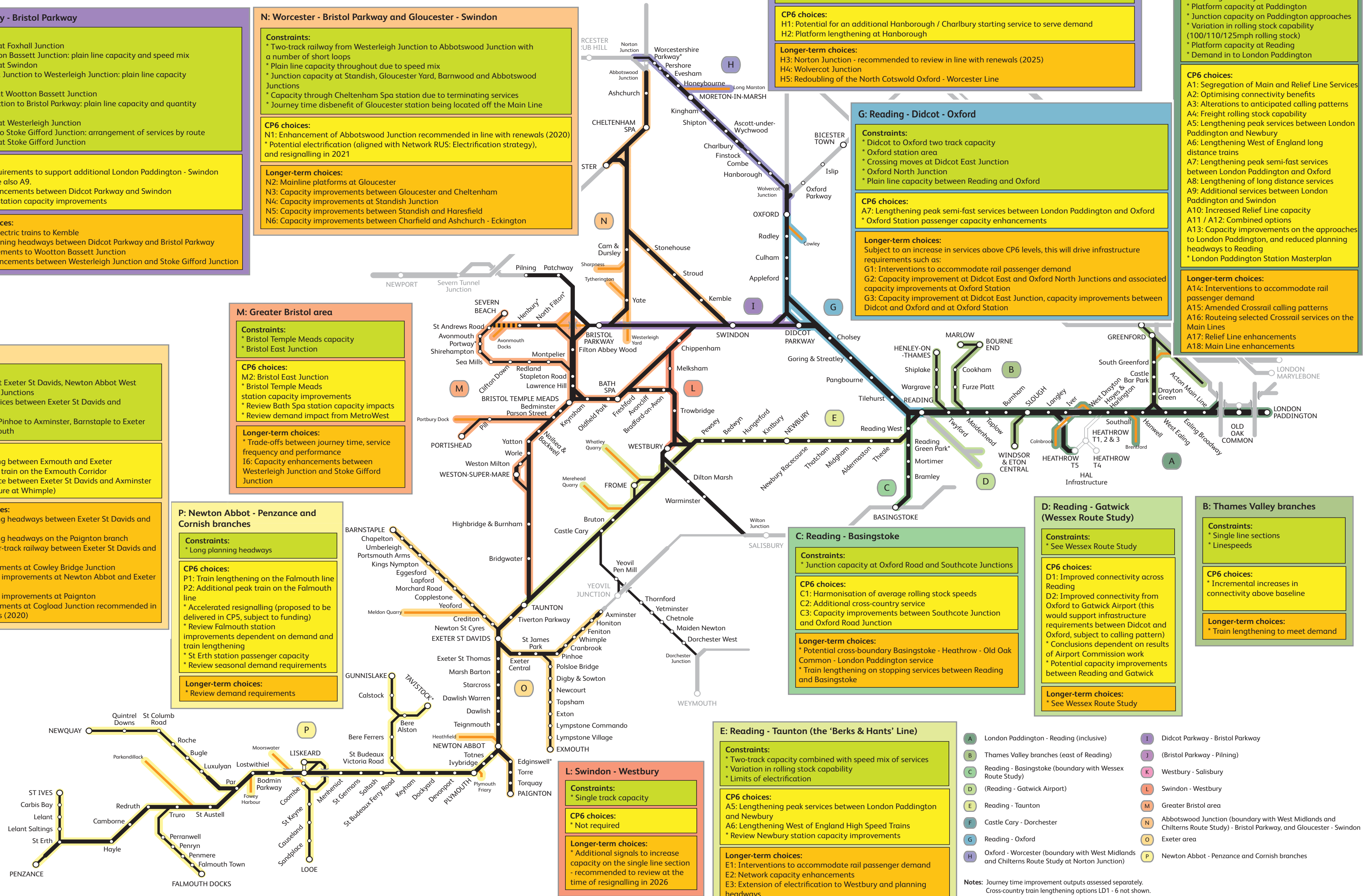
5.4 Summary

This chapter has assessed each Route Section and provided details on the anticipated 2019 baseline infrastructure and service specification; Conditional Outputs that are required to be accommodated and any constraints or choices to achieve this. A view of the longer-term strategy for 2043 has been undertaken, with a prioritised view of requirements in the context of CP6. Figure 5.72 presents the Route Study strategy per Route Section for CP6 and 2043.

The following chapter summarises the outline Western Route strategy prioritised for Control Period 6.

Figure 5.71: Station summary matrix			
Station capacity enhancement recommended			
Consult with existing CP5 project			
Look into soft measures			
Review during later Control Periods			
Locations	**2019 (including planned CP5 schemes)**	**2023**	**2043**
Basingstoke	Pending link with Wessex Route Study		
Bath Spa			
Bristol Parkway	New platform as part of IEP		
Cheltenham Spa	CP5 AfA; Third Party NSIP proposal		
Chippenham	Third Party Masterplan proposals		
Didcot Parkway	Third Party station area and car park aspirations		
Exeter St Davids			
Newbury	Wider station area development proposals		
Newton Abbot	CP5 footbridge renewals; Third Party footbridge extension proposals		
Plymouth	Third Party wider station area development proposals		
Swindon	Third Party aspirations to improve connectivity to the north		
Taunton	Area Masterplan produced		
Truro	CP5 footbridge renewals		
Weston-super-Mare	CP5 AfA scheme		
Windsor & Eton Central	Impact of Crossrail at Slough		
Bridgwater			
Exmouth Branch (St James Park, Digby & Sowton, Polsloe Bridge, Exmouth)	Devon Metro		
Falmouth Branch (Penryn, Penmere, Falmouth Town)			
Hanborough			
Hanwell			
Henley-on-Thames			
Penzance			
Severn Beach Branch (Avonmouth, Clifton Down, Redcliffe, Montpelier, Stapleton Road, Lawrence Hill)	MetroWest Phase 1		
Tiverton Parkway			

Figure 5.72: Route Study Strategy for CP6 and Longer Term



I: Didcot Parkway - Bristol Parkway

Constraints:
* Crossing moves at Foxhall Junction
* Didcot to Wootton Bassett Junction: plain line capacity and speed mix
* Crossing moves at Swindon
* Wootton Bassett Junction to Westerleigh Junction: plain line capacity and speed mix
* Junction speed at Wootton Bassett Junction
* Westerleigh Junction to Bristol Parkway: plain line capacity and quantity of services
* Crossing moves at Westerleigh Junction
* Bristol Parkway to Stoke Gifford Junction: arrangement of services by route
* Crossing moves at Stoke Gifford Junction

CP6 choices:
I1: Capability requirements to support additional London Paddington - Swindon peak services. See also A9.
I4: Capacity enhancements between Didcot Parkway and Swindon
* Bristol Parkway station capacity improvements

Longer-term choices:
I2: Extension of electric trains to Kemble
I3: Improved planning headways between Didcot Parkway and Bristol Parkway
I5: Speed improvements to Wootton Bassett Junction
I6: Capacity enhancements between Westerleigh Junction and Stoke Gifford Junction

N: Worcester - Bristol Parkway and Gloucester - Swindon

Constraints:
* Two-track railway from Westerleigh Junction to Abbotswood Junction with a number of short loops
* Plain line capacity throughout due to speed mix
* Junction capacity at Standish, Gloucester Yard, Barnwood and Abbotswood Junctions
* Capacity through Cheltenham Spa station due to terminating services
* Journey time disbenefit of Gloucester station being located off the Main Line

CP6 choices:
N1: Enhancement of Abbotswood Junction recommended in line with renewals (2020)
* Potential electrification (aligned with Network RUS: Electrification strategy), and resignalling in 2021

Longer-term choices:
N2: Mainline platforms at Gloucester
N3: Capacity improvements between Gloucester and Cheltenham
N4: Capacity improvements at Standish Junction
N5: Capacity improvements between Standish and Haresfield
N6: Capacity improvements between Charfield and Ashchurch - Eckington

H: Oxford - Worcester

Constraints:
* Single line capacity

CP6 choices:
H1: Potential for an additional Hanborough / Charlbury starting service to serve demand
H2: Platform lengthening at Hanborough

Longer-term choices:
H3: Norton Junction - recommended to review in line with renewals (2025)
H4: Wolvercot Junction
H5: Redoubling of the North Cotswold Oxford - Worcester Line

A: London Paddington - Reading

Constraints:
* Planning headways
* Platform capacity at Paddington
* Junction capacity on Paddington approaches
* Variation in rolling stock capability (100/110/125mph rolling stock)
* Platform capacity at Reading
* Demand in to London Paddington

CP6 choices:
A1: Segregation of Main and Relief Line Services
A2: Optimising connectivity benefits
A3: Alterations to anticipated calling patterns
A4: Freight rolling stock capability
A5: Lengthening peak services between London Paddington and Newbury
A6: Lengthening West of England long distance trains
A7: Lengthening peak semi-fast services between London Paddington and Oxford
A8: Lengthening of long distance services
A9: Additional services between London Paddington and Swindon
A10: Increased Relief Line capacity
A11 / A12: Combined options
A13: Capacity improvements on the approaches to London Paddington, and reduced planning headways to Reading
* London Paddington Station Masterplan

Longer-term choices:
A14: Interventions to accommodate rail passenger demand
A15: Amended Crossrail calling patterns
A16: Routeing selected Crossrail services on the Main Lines
A17: Relief Line enhancements
A18: Main Line enhancements

G: Reading - Didcot - Oxford

Constraints:
* Didcot to Oxford two track capacity
* Oxford station area
* Crossing moves at Didcot East Junction
* Oxford North Junction
* Plain line capacity between Reading and Oxford

CP6 choices:
A7: Lengthening peak semi-fast services between London Paddington and Oxford
* Oxford Station passenger capacity enhancements

Longer-term choices:
Subject to an increase in services above CP6 levels, this will drive infrastructure requirements such as:
G1: Interventions to accommodate rail passenger demand
G2: Capacity improvement at Didcot East and Oxford North Junctions and associated capacity improvements at Oxford Station
G3: Capacity improvement at Didcot East Junction, capacity improvements between Didcot and Oxford and at Oxford Station

M: Greater Bristol area

Constraints:
* Bristol Temple Meads capacity
* Bristol East Junction

CP6 choices:
M2: Bristol East Junction
* Bristol Temple Meads station capacity improvements
* Review Bath Spa station capacity impacts
* Review demand impact from MetroWest

Longer-term choices:
* Trade-offs between journey time, service frequency and performance
I6: Capacity enhancements between Westerleigh Junction and Stoke Gifford Junction

O: Exeter area

Constraints:
* Crossing moves at Exeter St Davids, Newton Abbot West and Cowley Bridge Junctions
* Speed mix of services between Exeter St Davids and Newton Abbot
* Single lines from Pinhoe to Axminster, Barnstaple to Exeter and Exeter to Exmouth

CP6 choices:
O1: Train lengthening between Exmouth and Exeter
O2: Additional peak train on the Exmouth Corridor
O3: Additional service between Exeter St Davids and Axminster (requires infrastructure at Whimple)

Longer-term choices:
* Improved planning headways between Exeter St Davids and Plymouth
* Improved planning headways on the Paignton branch
* Provision of a four-track railway between Exeter St Davids and Newton Abbot
* Capacity improvements at Cowley Bridge Junction
* Network capacity improvements at Newton Abbot and Exeter St Davids
* Network capacity improvements at Paignton
* Capacity improvements at Cogload Junction recommended in line with renewals (2020)

P: Newton Abbot - Penzance and Cornish branches

Constraints:
* Long planning headways

CP6 choices:
P1: Train lengthening on the Falmouth line
P2: Additional peak train on the Falmouth line
* Accelerated resignalling (proposed to be delivered in CP5, subject to funding)
* Review Falmouth station improvements dependent on demand and train lengthening
* St Erth station passenger capacity
* Review seasonal demand requirements

Longer-term choices:
* Review demand requirements

L: Swindon - Westbury

Constraints:
* Single track capacity

CP6 choices:
* Not required

Longer-term choices:
* Additional signals to increase capacity on the single line section - recommended to review at the time of resignalling in 2026

E: Reading - Taunton (the 'Berks & Hants' Line)

Constraints:
* Two-track capacity combined with speed mix of services
* Variation in rolling stock capability
* Limits of electrification

CP6 choices:
A5: Lengthening peak services between London Paddington and Newbury
A6: Lengthening West of England High Speed Trains
* Review Newbury station capacity improvements

Longer-term choices:
E1: Interventions to accommodate rail passenger demand
E2: Network capacity enhancements
E3: Extension of electrification to Westbury and planning headways

C: Reading - Basingstoke

Constraints:
* Junction capacity at Oxford Road and Southcote Junctions

CP6 choices:
C1: Harmonisation of average rolling stock speeds
C2: Additional cross-country service
C3: Capacity improvements between Southcote Junction and Oxford Road Junction

Longer-term choices:
* Potential cross-boundary Basingstoke - Heathrow - Old Oak Common - London Paddington service
* Train lengthening on stopping services between Reading and Basingstoke

D: Reading - Gatwick (Wessex Route Study)

Constraints:
* See Wessex Route Study

CP6 choices:
D1: Improved connectivity across Reading
D2: Improved connectivity from Oxford to Gatwick Airport (this would support infrastructure requirements between Didcot and Oxford, subject to calling pattern)
* Conclusions dependent on results of Airport Commission work
* Potential capacity improvements between Reading and Gatwick

Longer-term choices:
* See Wessex Route Study

B: Thames Valley branches

Constraints:
* Single line sections
* Linespeeds

CP6 choices:
* Incremental increases in connectivity above baseline

Longer-term choices:
* Train lengthening to meet demand

A London Paddington - Reading (inclusive)	I Didcot Parkway - Bristol Parkway
B Thames Valley branches (east of Reading)	J (Bristol Parkway - Pilning)
C Reading - Basingstoke (boundary with Wessex Route Study)	K Westbury - Salisbury
D (Reading - Gatwick Airport)	L Swindon - Westbury
E Reading - Taunton	M Greater Bristol area
F Castle Cary - Dorchester	N Abbotswood Junction (boundary with West Midlands and Chilterns Route Study) - Bristol Parkway, and Gloucester - Swindon
G Reading - Oxford	O Exeter area
H Oxford - Worcester (boundary with West Midlands and Chilterns Route Study at Norton Junction)	P Newton Abbot - Penzance and Cornish branches

Notes: Journey time improvement outputs assessed separately.
Cross-country train lengthening options LD1 - 6 not shown.

06 Control Period 6 – Outline Strategy

In this chapter, the Western Route Study presents a number of choices and potential investment priorities which have been identified by the rail industry for the next Control Period (CP6, 2019 – 2024), and seeks to inform funders of the implications for industry outputs, value for money and affordability.

6.1 Introduction

To identify the drivers of change for CP6, the longer-term requirements have been identified and prioritised using the agreed prioritisation criteria for the Long Term Planning Process (LTPP). All of the CP6 investment choices identified meet one (or more) of the following agreed criteria in order to deliver the Conditional Outputs:

- investments which are required to provide sufficient capacity for the forecast level of passenger or freight demand at the end of CP6, where this investment is also consistent with the longer-term strategy for the route
- opportunities where Conditional Outputs (or some part of the capital works necessary to deliver Conditional Outputs over a longer period of time) can be delivered most efficiently and provide the lowest Whole Life Cost option for delivery during CP6, for example in conjunction with the planned renewal of life-expired assets
- investments which reduce rail industry costs (for example, further network electrification, or the provision of new 'turnback' facilities) enabling the rail industry to reduce its operational costs
- other investments which reflect funders' priorities
- investing in better connectivity to High Speed Two (HS2).

To meet these drivers of change, the following CP6 choices for funders have been investigated as part of the Western Route Study. These are presented below in accordance with the prioritisation criteria they address. Further details on each choice can be found in Chapter 5.

6.2 Accommodating Demand

6.2.1 Rail Passenger Demand

The following choices have been identified to accommodate rail passenger demand in CP6.

Route Section A: London Paddington to Reading:

- A1a: Separation of Main and Relief Line passenger services

Long distance capacity and connectivity requirements could be accommodated through optimisation of network capacity on the busiest part of the Route Section immediately out of London Paddington through functional separation of the railway into dedicated Main and Relief Lines for long distance non-stop and intermediate calling services.

- A1b: Options to serve Heathrow Airport by Relief Lines services only

Optimising Main Line passenger capacity could be achieved through the utilisation of paths for long distance services rather than dedicated airport services. This supports the principle of maximising the passenger capacity on the Main Lines by allowing longer trains to operate which carry more passengers, particularly in the peak periods.

- A2: Optimising service provision and connectivity with anticipated future network developments

Anticipated future developments such as electrification and new service offerings (via East West Rail) offer the opportunity to introduce new direct journey opportunities to locations on this Route Section including Heathrow Airport, through linking of services.

- A3: Alterations to anticipated calling patterns

Optimised use of on-train capacity to accommodate rail passenger demand through alterations to the stopping patterns anticipated in the 2019 Indicative Train Service Specification (ITSS). This could be achieved via additional peak calls at stations such as Reading, Newbury, Didcot Parkway and Swindon. Although this could provide additional capacity, it is not sufficient on its own to accommodate all predicted rail passenger demand in CP6, and such extended journey times for long distance passengers would be inconsistent with the reduced journey times anticipated by the Intercity Express Programme.

- A4: Improving freight rolling stock capability

In order to enable current Class 7 freight paths to be substituted with faster Class 6 (60mph) paths carrying the same tonnage, consideration could be given to upgraded or new freight rolling stock thereby reducing the speed differential between passenger and freight services on the Relief Lines east of Reading.

- A5: Lengthen morning and evening high peak services between London Paddington and Newbury from the anticipated 8-car train formation in the 2019 ITSS to 12-car trains or
- A6: Lengthen the morning and evening high peak West of England long distance services from an 8-car to 9-car train
- A7: Lengthen the morning and evening high-peak semi-fast services between London Paddington and Oxford from the anticipated 8-car train formation in the 2019 ITSS to 12-car trains
- A8: Lengthen Super Express Trains to 11/12-car
- A9: Provide two additional morning and evening high peak 12-car services between London Paddington and Swindon calling at Reading and Didcot Parkway
- A10: Assessment of capacity and capability requirements for Relief Line services to meet emerging rail passenger demand
- A11/A12: Combination of Options of A3, A5, A6, A7 and A8/9.

To provide the necessary additional capacity between London Paddington and Reading one or more of the choices identified above will be required. However, a number of combined options have been assessed which could support the provision of additional capacity. These are presented in Figures 6.1 and 6.2 as further choices.

Figure 6.1: Option A11 - Combined Option 1

A11		High Peak On Train Departure average Load Factors[1] at key stations at 2023			
Combined Option 1		Newbury	Swindon/Didcot	Tilehurst	Reading
A3	Changes to service pattern	63%	56% / 73%	76%	88%
A5	Newbury train lengthening				
A7	Oxford train lengthening				
A9	Additional 2tph London Paddington – Swindon				

Figure 6.2: Option A12 - Combined Option 1

A12		High Peak On Train Departure average Load Factors[2] at key stations at 2023			
Combined Option 2		Newbury	Swindon/Didcot	Tilehurst	Reading
A3	Changes to service pattern	86%	56% / 73%	76%	89%
A6	West of England lengthening to 9-car				
A7	Oxford train lengthening				
A9	Additional 2tph London Paddington – Swindon				

1 Load factor is defined as the proportion of on-train capacity being taken, expressed as a percentage. Capacity is defined as the number of standard class seats plus standing allowance when appropriate

Choices identified to accommodate forecast rail passenger demand and/or the connectivity Conditional Outputs on the other Western Route Study Route Sections in CP6 are as follows:

- B Thames Valley Branches
  - incremental increases in connectivity above baseline are available on the Henley-on-Thames line
- C Reading to Basingstoke:
  - LD3/LD4/LD6/LD7 Train lengthening on non-London long distance services (from Southampton/Reading to the North) to accommodate forecast peak demand into Reading
- D Reading to Gatwick Airport:
  - D1 and D2 Improved connectivity across Reading and between Oxford and Gatwick Airport. To accommodate forecast demand and provide improved connectivity from the west of Reading to Gatwick Airport. This would provide additional capacity, connectivity and journey time improvements
- H Oxford to Worcester:
  - H1 Should growth in rail passenger demand exceed that forecast then interventions may be required. These could be in the form of train lengthening or through the provision of additional peak services. These could be accommodated at the eastern end of the route, utilising the existing turn back capability at Charlbury and/or Moreton-in-Marsh. There is also the potential for an additional Hanborough/Charlbury service to more economically serve rail passenger demand, noting that this may however drive a requirement for infrastructure interventions
- I Didcot Parkway to Bristol Parkway:
  - I1 Additional services between London Paddington and Swindon (as presented in A9) might require additional infrastructure capacity at Swindon or Chippenham stations
  - I4 Capacity enhancements between Didcot and Swindon.

Any growth beyond those services anticipated in the 2019 ITSS will drive requirements for additional infrastructure between Didcot Parkway and Swindon. Analysis recommends provision of two dynamic loops via an extension of the existing facility alongside the Up and Down Main Lines between Wantage Road and Challow

- M Greater Bristol Area:
  - LD1/LD2/LD5a/LD5b Non-London long distance train lengthening between Cheltenham Spa, Bristol Temple Meads and Taunton: Lengthen selected services (e.g. between Plymouth and Edinburgh/Glasgow) throughout the day to accommodate demand
- O Exeter Area
  - O1 Lengthen the peak services on the Exmouth corridor from the anticipated 2019 length of 3/4-cars to 5-cars
  - O3 Capacity Improvements between Exeter St Davids and Axminster. Provide an additional service between Exeter St Davids and Axminster to create a 2tph service frequency providing sufficient capacity to accommodate forecast rail passenger demand into Exeter. A new loop at Whimple would be required to deliver this increased service frequency
  - O4 Capacity Improvements Exeter St Davids – Axminster plus diversionary capabilities. As Option O3 above with the addition of the capability to accommodate an hourly diverted long distance service noting this would take the path of the additional local service when required
- P Newton Abbot to Penzance and Cornish branches
  - P1 Train lengthening on the Falmouth line - Lengthen the peak services on the Falmouth line from the anticipated 2019 length of 2-cars to 3-cars

6.2.2 Station Capacity

A number of stations have been highlighted as having existing capacity constraints, or are being assessed as part of recent or current projects in Control Period 5 (CP5, 2014-2019). These include:

- London Paddington (Masterplan and redevelopment proposals underway)

- stations to be served by Crossrail between London Paddington and Reading (completion by December 2019)
- Reading Station Area Redevelopment (completed 2015)
- Oxford Station (Masterplan study completed 2014)
- Bristol Parkway Station (Additional platform and associated station requirements as part of the Intercity Express Programme)
- Bristol Temple Meads Station (Masterplan study completed 2014)
- St Erth Station (Station Capacity Assessment completed August 2013).

As a result, the Western Route Study has not undertaken any further Station Capacity Analysis at these stations but incorporates the identified stations as priorities for CP6. Should capacity at any of these stations not be addressed during CP5, they remain a priority for investment in CP6.

Elsewhere on the Western Route, it is anticipated that a review will be required at a number of other stations during CP6 in order to accommodate the predicted growth in rail passenger demand. Hanborough Station has been identified for platform lengthening to be investigated. Newbury and Bath Spa Stations have been recommended for further investigation into wayfinding measures to more efficiently manage pedestrian flows within the stations. Stations on the branch lines to Severn Beach, Exmouth and Falmouth should be reviewed if train lengthening is implemented. Consideration also needs to be given to the anticipated changes in service specification proposed as part of MetroWest and Devon Metro which may drive further growth in rail passenger demand above that already predicted.

Figure 6.3 presents the station investment priorities for CP6.

At this early stage of development, the level of investment required has not been assessed. More specific costs will be developed to better inform funders' choices for CP6, where relevant

Figure 6.3: Station investment priorities for CP6

Station	CP6 investment priority
London Paddington	Alignment with Masterplan and redevelopment proposals.
Crossrail stations	Review post-Crossrail to assess the impact of service changes and demand growth.
Oxford	Oxford Station area as presented in the Masterplan, which includes passive provision for a fourth through platform.
Hanborough	Platform lengthening should be considered to reduce the impact on performance of increasing numbers of passengers boarding and alighting.
Newbury	Review potential soft measures such as improved signage, public announcements, position of station furniture, and segregation of passenger flows on stairs that could be employed to manage passenger flows during peak periods.
Bath Spa	Review potential soft measures such as improved signage, public announcements, position of station furniture, and segregation of passenger flows on stairs that could be employed to manage passenger flows during peak periods.
Bristol Parkway	Station improvements to accommodate predicted rail passenger demand as a result of the additional services anticipated.
Bristol Temple Meads	Station improvements to accommodate predicted rail passenger demand as a result of the additional services anticipated. Ensure alignment with the Enterprise Zone and Station Masterplan proposals.
Severn Beach Line	Avonmouth, Clifton Down, Redland, Montpelier, Stapleton Road and Lawrence Hill, subject to train lengthening requirements. Recommended for review as part of MetroWest Phase 1.
Exmouth Branch	Exmouth, Digby & Sowton, Polsloe Bridge, Lympstone and St James Park, subject to train lengthening requirements. Recommended for review as part of Devon Metro.
Falmouth Branch	Falmouth Town, subject to train lengthening requirements.
St Erth	Platform widening to accommodate forecast increase in rail passenger demand.

6.2.3 Freight Demand

Freight demand has been forecast in the Freight Market Study (FMS) for 2023, 2033 and 2043. To accommodate the demand forecast in 2043, the Western Route Study anticipates the following interventions as being required to accommodate an increase in freight services:

- C Reading to Basingstoke:
  - C3 Capacity enhancements between Southcote Junction and Oxford Road Junction. Grade separation of Southcote Junction and provision of a third, bi-directional line. A line of route analysis is being undertaken in conjunction with the **Wessex** and **West Midlands and Chilterns Route Studies** by the **Network RUS: Freight** to assess requirements between Southampton and the West Coast Main Line to accommodate predicted freight growth along this core corridor of the Strategic Freight Network (SFN) and to maintain a high performing and operationally resilient railway
- I Didcot Parkway to Bristol Parkway:
  - I4 Capacity enhancements between Didcot and Swindon.

    At present this is predominantly a two-track railway with a number of loops which are required to be utilised in order to accommodate the 2019 ITSS. To meet both passenger and freight Conditional Outputs on a mixed traffic railway it will be necessary either to provide additional infrastructure

    Analysis recommends provision of two dynamic loops via an extension of the existing facilities on the Up and Down Main Lines between Wantage Road and Challow to provide additional capacity for freight. Such dynamic loops would allow freight trains to be passed by faster, long distance services and avoid any negative impact to either passenger or freight journey times
- N Worcester – Bristol Parkway and Gloucester – Swindon:
  - N1 Enhancement of Abbotswood Junction. To remove the capacity constraint identified at Abbotswood Junction, an assessment should be made to renew the layout as a double junction (rather than a single lead as at present) when renewed in CP6. This also links to the resignalling of the Worcester area, and may be associated with future infrastructure changes considered in Chapter 5, Route Section H.

6.3 Renewal Opportunities for Incremental Enhancement at Reduced Whole Life Cost

Renewals of various asset types are anticipated in CP6 or CP7, including:

- signalling (conventional)
- signalling (European Train Control System, ETCS)
- junctions.

Such renewals present the opportunity to consider incremental enhancements to increase capacity or capability to accommodate the 2043 Conditional Outputs. If enhancements were aligned with a planned renewal strategy then better value for money outcomes can be achieved.

Signalling renewals are anticipated within the following geographical areas:

- Gloucester area (circa 2021)
- Worcester area (circa 2023)
- Westbury area (circa 2026)
- Exeter area (circa 2026).

Resignalling between Totnes and Penzance (known as Cornwall Resignalling) is anticipated to take place during CP5, subject to the provision of third party funding and a viable business case as presented in Route Section P: Newton Abbot to Penzance and Cornish branches.

As part of these resignalling schemes and future transition to ETCS, the Western Route Study has identified that a reduction in planning headways would be beneficial in order to accommodate the capacity and connectivity Conditional Outputs between the following locations:

- London Paddington and Reading (A13)
- Reading and Oxford (G4)
- Didcot Parkway and Bristol Parkway (I4)
- Reading and Taunton (E5, Southcote Junction and Westbury)
- Newton Abbot and Plymouth (P1), an element of which is expected to take place during the accelerated resignalling in CP5 (west of Totnes).

Consideration of these requirements, and provision of any necessary additional signals, should be made during the resignalling schemes.

Choices for funders driven by renewal opportunities in CP6 (or early CP7) are as follows:

- an improved layout on the approach to London Paddington incorporating grade separation at Ladbroke Grove Junction as presented in Route Section A: London Paddington to Reading A13
- Bristol East Junction (anticipated to take place during CP5 subject to funding) as presented in Route Section M: Greater Bristol Area M2
- enhancement of Abbotswood Junction (south east of Worcester) as presented in Route Section N: Worcester – Bristol Parkway and Gloucester – Swindon N1
- Cornwall Resignalling (anticipated to take place during CP5 subject to third party funding and a viable business case).

Consideration of longer-term requirements is also recommended at the time of renewal, in order to not preclude any future interventions that may be required. This has been identified specifically for Route Section N: Worcester – Bristol Parkway and Gloucester – Swindon, and Route Section E: Reading – Taunton.

- N2 to N6 provision for longer-term capacity interventions such as four-tracking from Cheltenham Spa to Standish Junction; Main Line platforms at Gloucester and capacity improvements at Standish Junction when the area is resignalled in CP6
- E7 Potential for enhanced capacity between Cogload Junction and Taunton when Cogload Junction is renewed.

In addition, the opportunity to integrate long term requirements for both infrastructure and train service provision should be given particular consideration in respect of work between London Paddington and Slough notably in connection with the Western Rail Link to Heathrow (see A17/A18).

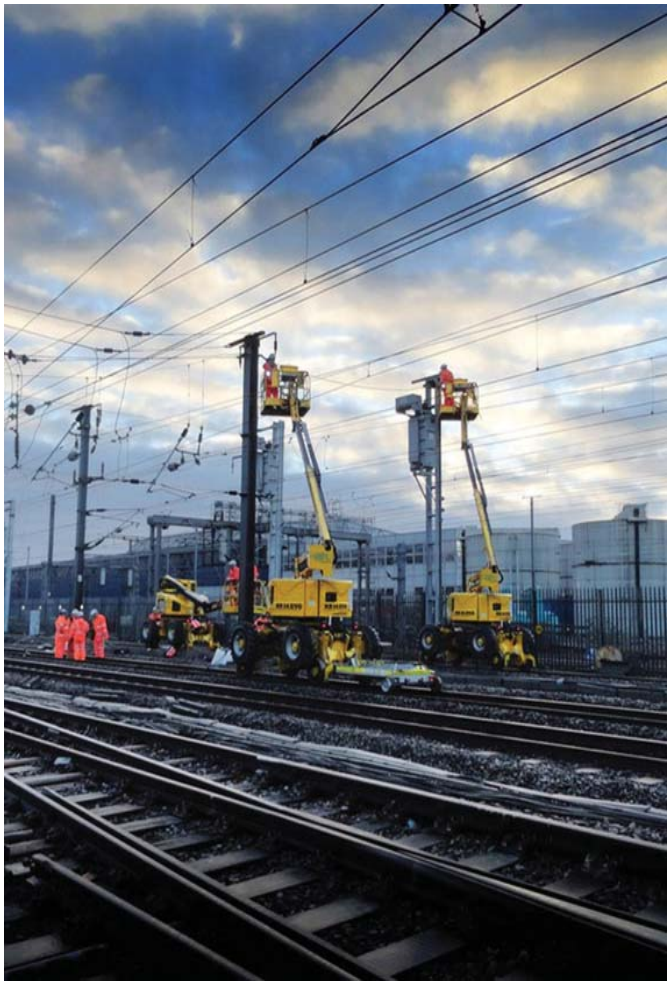
6.4 Investing to Reduce Costs (including Electrification)

The strategic case for further electrification will be presented in the refresh of the **Network RUS: Electrification**.

The potential for implementation of electrification is improved by the proposed resignalling of the Gloucester area in CP6, which will provide the necessary signalling immunisation which is a prerequisite for electrification.

Electrification west of Bristol Temple Meads and in the wider Bristol conurbation could enable a more efficient delivery of local and long distance service provision across the greater Bristol area and should be considered in line with the West of England Partnership's 'West of England Electrification Study'.

As above, cognisance of longer-term requirements is also essential at the time of electrification, in order to make necessary provision for any identified future interventions.



6.5 Funder Priorities

Government priorities for CP6 will be published in the next High Level Output Specification as part of the industry funding process. For the purposes of the Western Route Study, existing Government priorities, and those raised as likely Government priorities for CP6, are highlighted. Known priorities include:

- investing in better connectivity to High Speed Two (HS2)
- Western Rail Link to Heathrow (WRLtH)
- electrification of the Bristol – Birmingham corridor (see Options N2 to N6).

Other priorities identified as part of the Western Route Study include:

- improved access to airports from catchments not currently served by direct trains (see Options D1 and D2).

6.6 Access to HS2

HS2 Phase 1 is incorporated within the baseline of the Western Route Study and is anticipated to open during 2026; this includes new stations at Old Oak Common and Birmingham Curzon Street.

6.6.1 Old Oak Common

It is currently anticipated that the station at Old Oak Common will be served by all passenger trains to and from London Paddington. An opportunity exists to provide connectivity from the **Wessex Route Study** area for example from Basingstoke to London Paddington via Old Oak Common. This could also provide improved connectivity to Heathrow Airport via the Western Rail Link to Heathrow.

During Control Periods 6 and 7, choices for improving connectivity include:

- C2 Basingstoke – Heathrow Airport – Old Oak Common – London Paddington service
- D1 Improved connectivity across Reading. Choices include linking either 2tph Basingstoke – Reading, 2tph Oxford (or beyond including from East West Rail) or 2tph from the Newbury corridor with 2tph Reading – Gatwick to provide through connectivity from these areas to Gatwick Airport.

6.6.2 Birmingham Curzon Street

Also included within HS2 Phase 1 is the opening of a new station at Birmingham Curzon Street, providing access to high-speed train services to London. This is expected to have a significant impact on rail passenger demand within the Western Route Study area for travel towards Birmingham from stations such as Cheltenham Spa and Gloucester.

Relevant CP6 choices improving access to Birmingham include:

- Option M2 Bristol East Junction
- Option N1 Enhancement of Abbotswood Junction.

6.7 Journey Times

Opportunities to improve journey times will continue to be assessed as part of the Western Route Journey Time Improvement Programme. The outputs of the programme will be assessed for implementation and funding streams that may be available in CP5, CP6 and the longer-term, subject to value for money assessments, and where possible aligned with renewals or other enhancements.

6.8 Next Steps

Given the significance of key Route Sections across the Western Route Study area, and the influence of future service specifications on the interventions that may be required, the early development of a number of Route Sections has been prioritised to further inform requirements for CP6. This also reflects the significant challenge of the Western Route Study with the uncertainties presented in the anticipated 2019 baseline.

The choices presented in Chapter 5 for the following Route Sections have been prioritised for development to Network Rail's GRIP (Governance for Railway Investment Projects) stage 2:

- Route Section A: London Paddington – Reading
- Route Section G: Reading – Oxford
- Route Section I: Didcot Parkway – Bristol Parkway (specifically focussing on the section between Didcot and Swindon)
- Route Sections F and O: Castle Cary – Exeter.

Since the publication of the Draft for Consultation, development work has commenced to progress these schemes to GRIP 2 utilising Network Rail's GRIP process. These initial feasibility studies will clarify the requirements of the proposals in terms of scope, cost and value for money assessments; the outputs of which will be used to inform the industry's planning input for CP6 which commences with the Initial Industry Plan in September 2016.

For Route Section C: Reading – Basingstoke, the **Network RUS: Freight** has commenced a line of route analysis in conjunction with the **Wessex** and **West Midlands and Chiltern Route Studies** to assess requirements between Basingstoke and the West Coast Main Line.

6.9 Longer Term Strategy

The choices listed in this chapter are a subset of those which would be required to accommodate the capacity and connectivity Conditional Outputs, and all other Conditional Outputs, in 2043. The choices presented here are prioritised because they meet at least one of the criteria for inclusion in CP6, for example the requirement to accommodate growth in passenger and freight demand in CP6. Please refer to the previous Chapter 5 where the full set of choices is provided.

6.10 Summary

This chapter has highlighted the prioritised choices presented to funders for consideration for the next funding cycle (Control Period 6).

The following chapter presents the consultation process and a summary of responses received.

07 Consultation

This section outlines the consultation that has been undertaken to inform the development of the Western Route Study.

7.1 Development of the process

Network Rail has taken a collaborative and consultative approach to the development of the Long Term Planning Process (LTPP). The Western Route Study has been a key part of this process.

As a new approach to industry planning, it has been important to develop a process that allows an opportunity for all interested stakeholders, both within and outside the rail industry, to contribute if they wish to influence the rail industry's plans for the future.

7.2 Western Route Study – Stakeholder Groups

The Western Route Study has been developed with the close involvement of a wide range of stakeholders. This has sought to ensure that the work has been subject to comment and review by an informed audience of key stakeholders throughout.

Consultation and guidance has been extensive and held at a number of levels, using the groups set out in the governance structure outlined in Chapter 1. The four key groups guiding the development of the work have been:

- Rail Industry Planning Group (RIPG)
- Western Route Study Programme Board
- Western Route Study Working Group
- Western Route Study Regional Working Groups.

The study was discussed at a number of Regional Working Group meetings held across the Route where Local Authority, Local Enterprise Partnerships and other interested stakeholders were briefed on the work, and feedback was received. These groups were an important opportunity for participants to raise any queries they may have and inform their own organisations to assist in focusing the responses received as part of the consultation process.

In addition, these groups have been complemented by Wider Stakeholder events, Technical Working Groups and one-to-one discussions with individual group members to guide and develop the work.

7.3 Consultation Process

The Western Route Study Draft for Consultation was published on the Network Rail website on 10 October 2014. A 90-day consultation period on the document closed on 9 January 2015.

During the consultation period, additional analysis has been undertaken. This is incorporated into the final document. The various Route Study forums have continued to convene during the consultation period, and further meetings have been held with all groups following the consultation period to determine and share the outputs of the further work and the final strategy.

7.4 Consultation Responses

In total, 162 responses were received from stakeholders, and these have been categorised as shown in Figure 7.1. The consultation responses are published on the Network Rail website alongside this study.

Figure 7. 1: Responses by type of responder

Responder Type		Number of Responses	Percentage of Responses in each category
Western Route Study Board and Working Group	Industry Representatives	9	5.6%
	Government Representatives	2	1.2%
Regional Working Groups	Thames Valley	8	5.0%
	West of England	7	4.3%
	Peninsula	8	5.0%
Transport Industry (non-rail)		2	1.2%
Campaign, User Groups and Community Rail Partnerships		48	29.6%
Individual Responses	Members of Parliament	6	3.7%
	Members of the Public	46	28.4%
Other Non-Rail Industry Responses		26	16.0%
Total		162	100%

7.5 Key themes in the consultation responses

The responses Network Rail received were well considered and, in many cases, comprehensive. As a result, it is difficult to provide a précis of each individual response. Inevitably in a consultation process, it can be the case that consultee suggestions are potentially helpful but then also contradict other responses. Some of the common themes from the responses received are summarised below. Some responses included constructive suggestions and requests for clarification, which have been reviewed and addressed within this Western Route Study.

Some of the clarification requests concerned the relationship of the Western Route Study with those Route Studies with adjoining boundaries (Welsh, Wessex, Sussex and West Midlands and Chilterns) and with the nationwide issues of electrification and rolling stock strategies. As a result, the study has clarified in Chapters 4 and 1 respectively how the studies relate to each other.

A high proportion of respondents expressed support for the approach taken by the Industry in developing the Long Term Planning Process and the Route Study. Industry and Government organisation respondents particularly expressed their support for the level of stakeholder engagement that was undertaken as part of the Western Route Study process and the collaborative approach taken. The responses also noted support for the process of Control Period 6 (CP6, 2019-2024) prioritisation and the longer-term context, with stakeholders confirming their support for the choices for funders described in the document. Respondees were positive about the Route Study document, outlining that it is a clear, concise document with a sufficient level of detail for the reader to gain understanding. Many also outlined their support for the enhancement schemes in CP5, as listed in the Baseline.

The Department for Transport noted in their consultation response that the draft study has sought to accommodate a series of Conditional Outputs derived from the various Market Studies. It also noted that whilst the need for recommendations of the studies is focused on meeting forecast demand growth is recognised, a degree in the level of flexibility in relation to the Conditional Outputs should be applied. This recommended flexibility in the accommodation of the Conditional Outputs has been reviewed and exercised specfically on Route Section N: Bristol – Birmingham.

The service specification for this corridor has been reviewed and a reduced service specification agreed by the Western Route Study Working Group and the Cross-Boundary Working Group to ensure alignment with the **Welsh** and **West Midlands and Chilterns Route Studies**.

Requests were received for clarification on several topics within the Western Route Study Draft for Consultation including future rolling stock strategy, demand forecasts for the South West Peninsula area, and the impact of the maintenance strategy for CP5. A review of demand forecasting for the South West Peninsula was undertaken in consultation with the Regional Working Group and an alternative methodology developed. This is presented in Chapter 3.

The Working Group and Board members raised the necessity of a suitable maintenance and resilience strategy in their consultation responses, noting that the current maintenance access and working arrangements are likely to alter markedly. They also raised that the expectation of a six and a half day operating railway should be assumed in the future further restricting maintenance access to late evenings and Sunday mornings. Further work is underway for developing the maintenance strategy for CP5 and the latest information available is presented in Chapter 2.

Responses also requested further detail regarding the performance implications of the choices for funders, and a greater level of detail regarding the resilience requirements across the route. This will be addressed further in the individual studies as the choices for funders are developed.

The Western Route Study Working Group and Board members also raised concern in their consultation responses regarding capacity on the Great Western Main Line and the optimisation of this. The responses noted the necessity for the network to provide sufficient capability to operate the anticipated 2019 timetable at a high performance level whilst also having capacity available to accommodate further service level increments to meet the anticipated range of market demands.

Optimisation of connectivity across the Western Route Study scope area was raised outlining that providing appropriate connectivity options at key points across the route will aid the maximisation of value and benefit. This was raised with particular relevance to Reading Station for running trains through Reading as opposed to terminating services there. This is presented in Chapter 5, Route Section A: London Paddington – Reading.

Further electrification beyond what is proposed for implementation during CP5 was also an area of concern highlighted by respondees, particularly with regard to electrification west of Newbury on the Berks & Hants line and possible alternative options to serve stations between Newbury and Bedwyn should electrification not extend beyond Newbury. This has been revised with further consideration presented in Chapter 5.

Stakeholders in the South West registered their concern that the demand forecasts for the region appeared too low, noting that forecast levels of on-train crowding on the Barnstaple and Severn Beach lines appeared to understate the current situation. It was also suggested that the document did not contain sufficient analysis regarding seasonality of demand and its impact. As a result, we have undertaken capacity case studies to understand demand requirements. These are presented further in Chapter 3 and Appendix C.

A number of respondents raised concerns regarding the potential choice for funders as described in Route Section G: Reading – Oxford, with the proposal for grade separation to remove conflicts caused by crossing moves at Oxford North Junction, to the north of Oxford Station. This has been noted and will inform further studies of development.

Additionally, respondents also raised their concern in respect of the Henley-on-Thames branch line in Route Section B, noting their objection to any reduction in the level of service at Wargrave Station to permit a higher frequency service at other stations on the branch line.

The Western Route Study Working Group wishes to offer thanks to those individuals and organisations that have taken the time to read the Western Route Study and provided considered responses.

7.6 Next Steps

The Western Route Study will become established 60 days after publication unless the ORR issues a notice of objection within this period.

7.7 Planning for Control Period 6 and beyond

As detailed in Chapter 1 the output from both this and other Route Studies will present the case for continuing investment in the rail sector to Governments.

The Route Studies will inform plans for Control Period 6, the period from 2019 – 2024. The outputs will be used to inform the Initial Industry Plan in September 2016 and to update the Network and Route Specifications published on the Network Rail website.

Appendix A
Western Flood Resilience Programme

Western Flood Resilience Programme					
Site name ***Between stations***	**Proposal**	**Expected Outcome**	**Influencing Factors**	**Estimated Cost**	**Delivery Date / Progress**
Cowley Bridge Junction *Tiverton Parkway – Exeter St Davids*	Upgrading culvert. Removal of three weirs. Alterations to Staffords Bridge and earth bank weir. Raised location boxes.	Reduced frequency of flooding. Reduced damage to track and reduced closure time.	Third Party land. Environment Agency and stakeholder agreement. Wider flood plain management (Staffords Bridge). Track access requirements for blockade works.	£14m	2016 - 18 (delivered for raised location boxes)
Chipping Sodbury *Swindon – Bristol Parkway*	Water pumping and storage scheme. Surface water interception drains and permanent cross-track pumps.	Reduced closure time.	Electrification proposals. Land owner, Water Board and Environment Agency agreement.	£4m	Staged to 2016 PART DELIVERED POSITIVE RESULTS
Hinksey *Didcot Parkway – Oxford*	Track lift through Red Bridge. New culvert. Installation of elevated signalling and distribution cabinets through Oxford Area Resignalling.	Reduced track flooding and signalling failures due to flooding.	Track access for blockade works. Track Renewals Supply Chain delivery capacity. Electrification Project. Planning consent for culvert. Environment Agency and stakeholder agreement.	£16.27m	2016
Whiteball Tunnel South *Taunton – Tiverton Parkway*	Crest drain and enhanced capacity earthwork and track drainage.	Reduced track flooding. In severe weather trains continue to Tiverton Parkway in the short term.	Confirmation of works required to track drainage. Outfall location and consent.	£1.4m	Completed
Athelney – Cogload *Castle Cary – Cogload*	Crest drain and cross-track drain at Lyng Overbridge.	Reduced closure time, Climate Change adaption.	Landowner relationships. Location of property and other assets/wider flood plain issues.	£0.350m	2015 PART DELIVERED
Hele & Bradninch *Tiverton Parkway – Exeter St Davids*	Highway works. Sustainable drainage. Flood plain clearance. Track raising.	Reduced frequency of flooding. Reduced closure time. Mitigation against flooding.	Track access. Third Party land access. Environment Agency and stakeholder agreement.	£1.4m	2016 - 17
Flax Bourton *Bristol Temple Meads – Weston-super-Mare*	New crest drain to intercept runoff flows. New cross drains. Possible enhancement to track drainage.	Reduced track flooding.	Suitability of local streams for outfall. Track access for cross drains.	£2.0m	2015 PART DELIVERED
Patchway Up Tunnel *Bristol – Newport/Cardiff*	New and enhanced capacity track drainage system (collector and carrier drains) from Pilning portal to outfall.	Reduced track flooding.	Electrification proposals for track lowering. Track access. Outfall level.	£1.5m	2015 - 16
Exeter Diversionary Route *Exeter Central – Yeovil*	Earthworks strengthening at Honiton and Crewkerne. Resilience improvements around River Axe at Broom Level Crossing.	Increased availability of diversionary route in extreme weather.	Track access.	£3.0m	2015 PART DELIVERED
Catchment instrumentation and flood prediction system	Installation of rainfall, river flow and groundwater level monitoring in critical catchments around Cowley Bridge Junction and Chipping Sodbury.	Advanced warning of flooding to enable tactical response. Data to inform resilience option design.	Timely interpretation of data. Selection of key locations.	£0.2m	2015 - 16 (delivered for Cowley Bridge Junction)
Total				**£44.12m**	

Appendix B
Rolling stock assumptions

Rolling stock assumptions				
Name	Class, example	Description	Assumed capacity	Typical location/service assumed to operate in 2019 ITSS
2-car DMU	Class 150	Diesel Multiple Unit with two carriages	Seats: 148 Seats + standing: 203	Local stopping services in Devon and Cornwall
2-car DMU	Class 158	Diesel Multiple Unit with two carriages	Seats: 138 Seats + standing: 214	Local stopping services across Exeter between Bristol and Penzance
2-car DMU	Class 165	Diesel Multiple Unit with two carriages	Seats: 148 Seats + standing: 196	Greenford branch
3-car DMU	Class 16x*	Diesel Multiple Unit with three carriages	Seats: 282 Seats + standing: 375	Reading to Redhill and Gatwick Airport, Reading to Basingstoke and suburban stopping services across Bristol
3-car DMU	Class 158	Diesel Multiple Unit with three carriages	Seats: 209 Seats + standing: 323	Barnstaple to Exmouth
4-car DMU	Class 150	Two Class 150 DMUs coupled to form a train of four carriages	Seats: 296 Seats + standing: 406	Paignton to Exmouth
5-car DMU	Class 16x*	Two Class 16x DMUs coupled to form a train of five carriages	Seats: 470 Seats + standing: 625	Suburban stopping service across Bristol
2+8 HST	HST	High Speed Train formed of two locomotives and eight carriages	Seats: 465 Seats + standing: 507	London Paddington to Plymouth/Penzance
EMU	Varied	Generic Electric Multiple Unit	One vehicle: Seats: 60 Seats + standing: 96	London Paddington to Oxford/Newbury and Thames Valley Branches
8-car EMU	Class 458	Electric Multiple Unit with eight carriages	Seats: 522 Seats + standing: 984	London Waterloo to Reading
4-car DEMU	Class 220	Diesel-Electric Multiple Unit with four carriages	Seats: 170 Seats + standing: 204	Long distance services from West/South West to Birmingham and the North
5-car DEMU	Class 221	Diesel-Electric Multiple Unit with five carriages	Seats: 232 Seats + standing: 278	Long distance services from Cornwall/Bristol/Basingstoke to Birmingham and the North
9-car	SET	Super Express Train - Electric Multiple Unit with nine carriages	Seats: 627 Seats + standing: 752	London Paddington to Bristol Temple Meads and Wales
10-car bi-mode	SET	Super Express Train - two Electric Multiple Units with five carriages fitted with diesel engines to operate on routes without electrification coupled together to form a train with ten carriages	Seats: 630 Seats + standing: 756	London Paddington to Hereford via Oxford, London Paddington to Cheltenham via Kemble

* Class 16x indicates either a Class 165 or 166

Total seated capacity is assumed standard class only

The rolling stock assumptions presented were used for passenger demand analysis to broadly represent capacity that is anticipated to be provided in 2019.

Appendix C: Devon and Cornwall Passenger Growth Case Studies

Section 1: Exmouth – Exeter historic growth case study

Section 2: Truro – Falmouth Docks historic growth case study

Section 3: Seasonal demand forecasts discussion

Section 4: Cornish branch line loading data:

- **4 (a)** Liskeard – Looe
- **4 (b)** St Erth – St Ives
- **4 (c)** Par – Newquay

Section 5: Non-London long distance analysis:

Detailed analysis of demand is presented, which supplements that presented in Chapter 3. Options to accommodate forecast passenger demand are presented in Chapter 5.

Section 1: Exmouth – Exeter historic growth case study

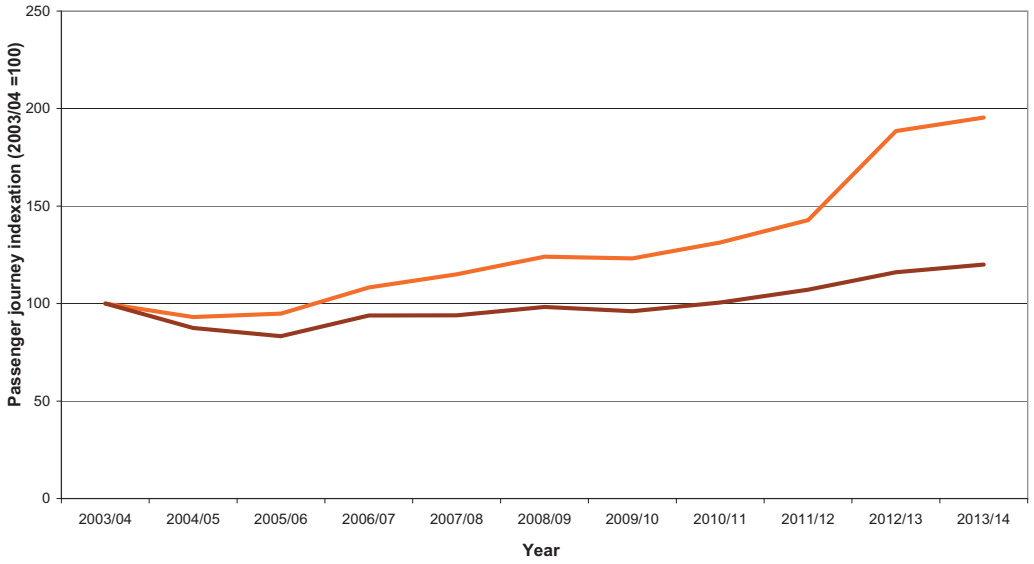
The Exmouth to Exeter St Davids line serves suburban demand into Exeter from several communities, including the large town of Exmouth, and rapidly growing residential and employment areas in the east of Exeter. Digby & Sowton also attracts commuters from across the city and other routes.

The line is busy throughout the year with commuting and retail trips particularly during autumn and winter months supplemented by additional leisure trips during summer months. Other specific demand drivers include sporting events with both Exeter Central's (Chiefs Rugby ground) and Exeter City (football ground) served by the branch, and long distance trips to and from the line.

Between 2003/04 and 2013/14 demand on the Exmouth to Exeter corridor has almost doubled, while demand from Exmouth to Exeter city centre stations has increased by 20 per cent over the same period, providing an average growth rate of 2.8 per cent per annum. Rail interventions including increased capacity have stimulated growth on the corridor, and this is thought to explain circa 20 per cent of the demand growth. Ticket sales data also shows that there is significant increase in demand to and from Digby & Sowton and other smaller stations on the route. Figure C1 shows the historic growth rate on the corridor.

After taking into account rail interventions, growth on this corridor has been higher than other corridors to Bristol, Exeter and Plymouth. A sensitivity test of higher demand growth of 1 to 2 per cent per year is recommended to be used for capacity analysis.

Figure C1: Exeter to Exmouth rail demand growth

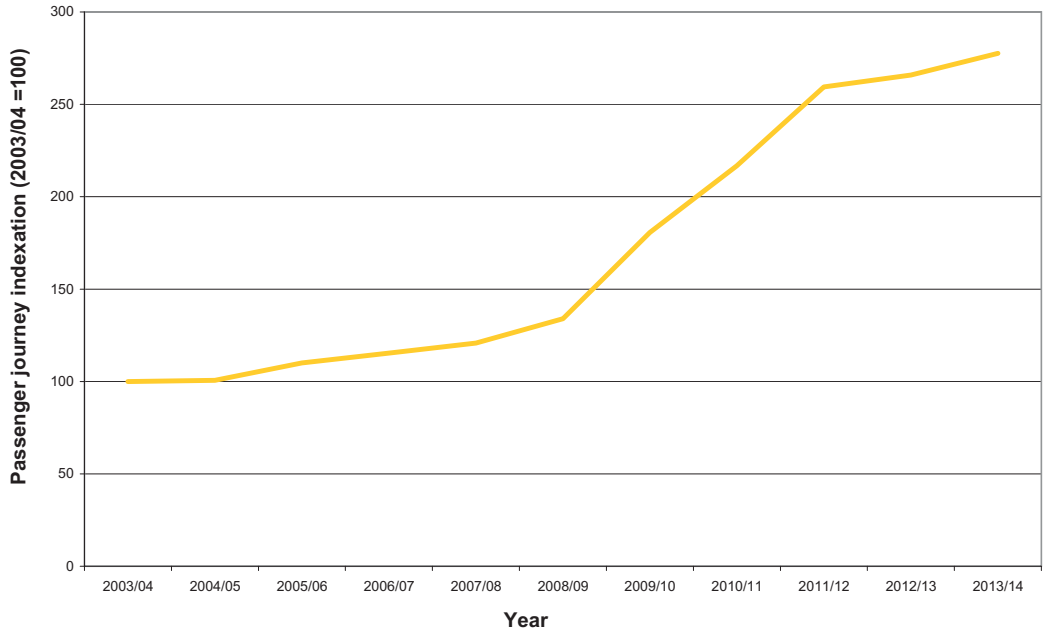


Section 2: Truro – Falmouth historic growth case study

Between 2003/04 and 2013/14 demand on the Truro - Falmouth line has increased by circa 160 per cent with the highest growth observed between 2008/09 and 2011/12. In the summer of 2009, completion of rail infrastructure enhancements on the corridor enabled rail service frequency to increase from one train per hour to two trains per hour which has helped to stimulate demand significantly. This is evident by a 90 per cent increase in demand between 2008/09 and 2011/12, with demand growth reducing after 2011/12.

Demand increased at an average rate of 3.3 per cent per annum after 2011/12. By using Passenger Demand Forecasting Handbook (PDFH) guidance, it is estimated that the improved timetable (journey time and service frequency) contributed to a 50 per cent increase in demand. The provision of half-hourly services throughout the day has also increased demand for season tickets by commuters. Figure C2 shows the demand growth on the Truro – Falmouth line.

Figure C2: Truro to Falmouth rail demand



Section 3: Seasonal rail demand forecasts

For the purpose of the Western Route Study, seasonal demand has been identified as demand that significantly fluctuates in the summer months, predominantly driven by leisure and tourism. This section discusses the high level forecasting approach applied to the seasonal branch lines, identified as St Erth - St Ives, Liskeard - Looe and Par - Newquay, that all show a significant peak in demand over the summer months. The importance of accommodating this demand to support the local economies and meeting the rail industry's strategic goals has been discussed in Section 3.3.6, Leisure Demand.

The **Long Distance Market Study** (LDMS) developed forecasts for the long distance market; defined as the market for rail travel over distances greater than 50 miles, where the majority of the journeys are made for the purposes of business or leisure.

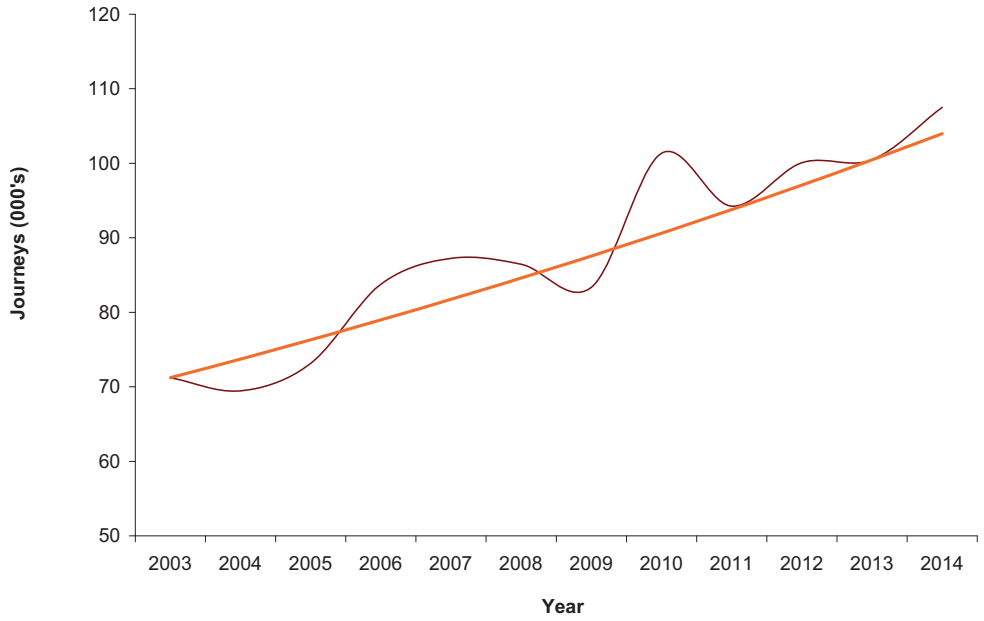
The long distance model was developed in two stages:

- An estimation of the propensity to travel at the origin and destination town/city; and
- Rail's market share.

For more detail on the long distance market and forecasting methodology, please see **The Long Distance Market Study**.

The LDMS forecasts do not capture the increase in local (shorter distance) journeys in the summer months. Therefore a combination of the long distance forecasts and a look at historic growth in the summer months has been assessed and used to model future demand. The historic growth of summer journeys on the seasonal branch lines, presented in Figure C3 indicates an average growth rate of 3 per cent per annum.

Figure C3: Three month summer passenger demand on Looe, St Ives and Newquay branch lines



Section 4: Cornish branch line loading data

Source data is a combination of passenger counts provided by the Devon and Cornwall Rail Partnership and the train operators.

The following presents a comparison of current and forecast loading data against anticipated capacity for each of the three routes, on various days of the week:

- Liskeard – Looe
  - Weekdays and Saturdays
- St Erth – St Ives
  - Weekdays (no data available for Saturdays)
- Par – Newquay
  - Weekdays, Saturdays and Sundays.

Commentary on these figures is provided in Section 3.3.6.1.

4 (a) Liskeard – Looe

Figure C4: Liskeard to Looe loading data for a weekday during the summer season

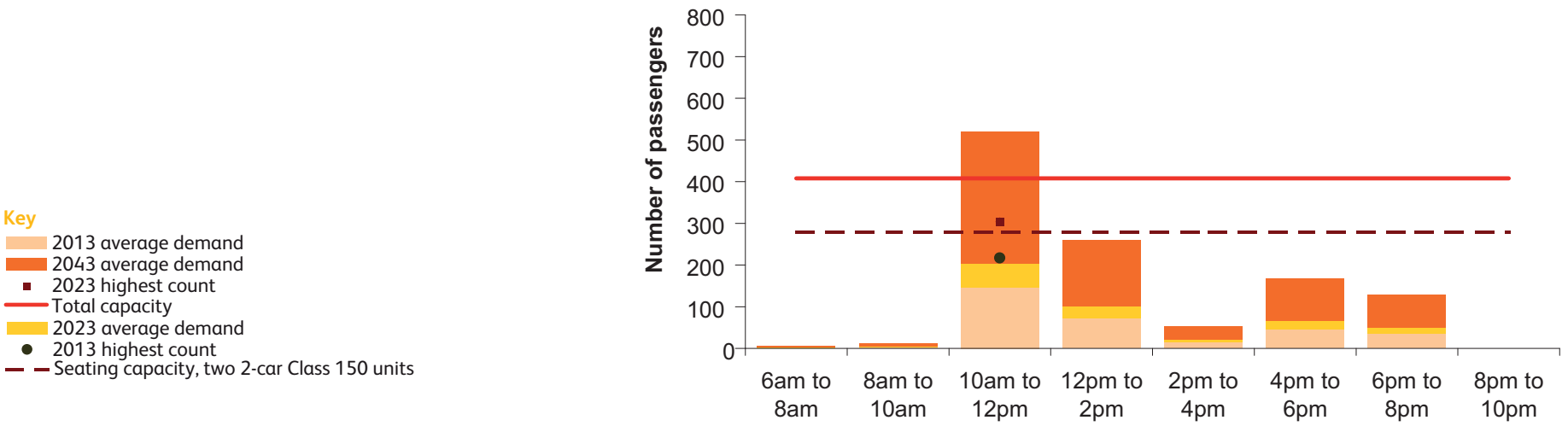


Figure C5: Looe to Liskeard branch loading data for a weekday during the summer season

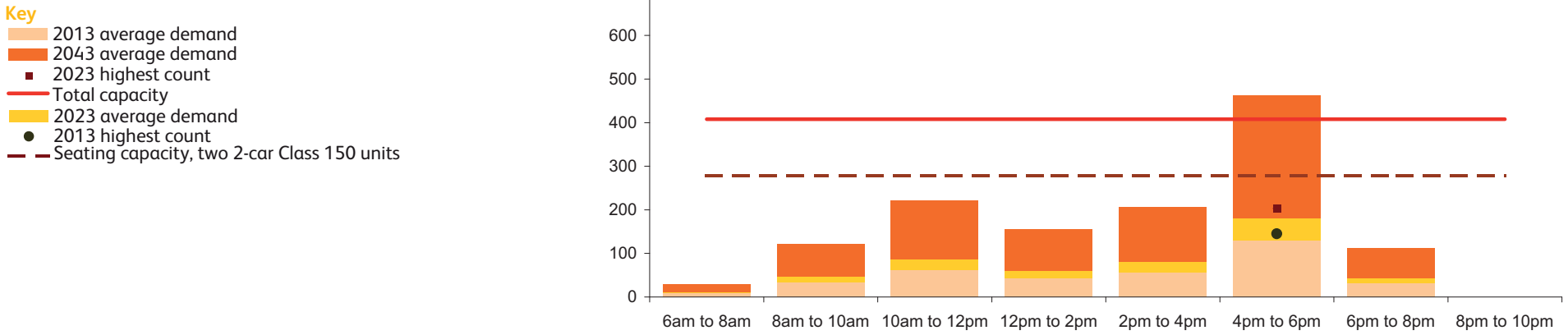


Figure C6: Liskeard to Looe branch loading data for a Saturday during the summer season

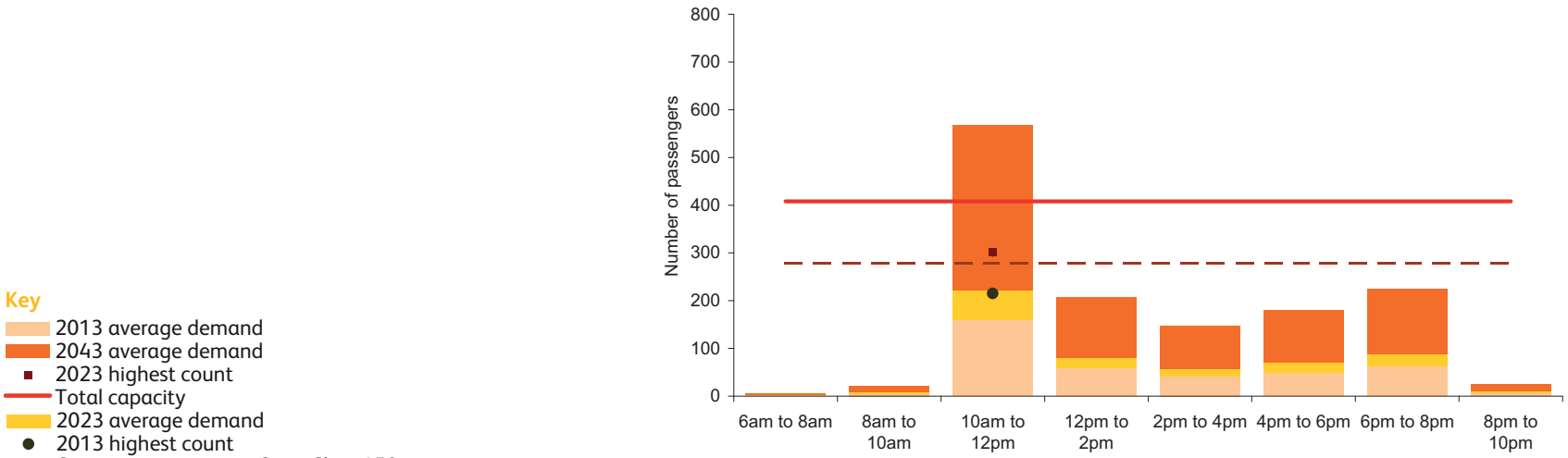
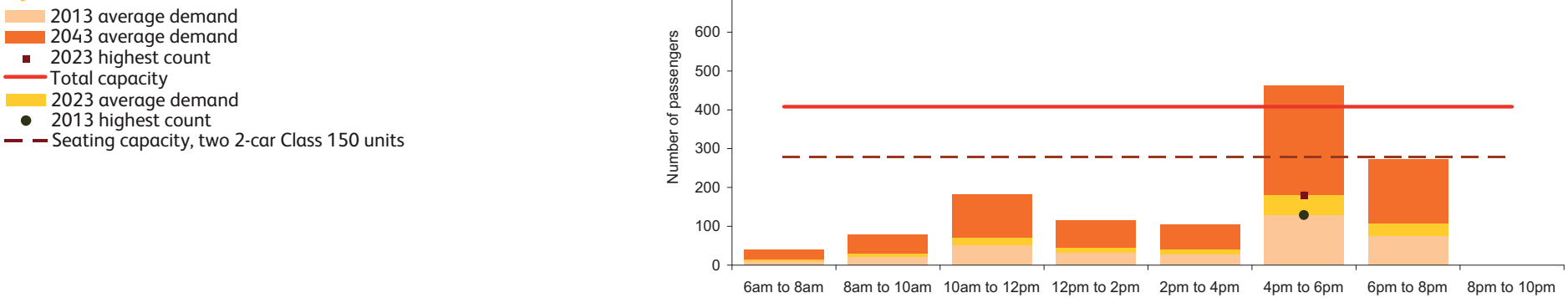


Figure C7: Looe to Liskeard loading data for a Saturday during the summer season



4(b) St Erth to St Ives

Figure C8: St Erth to St Ives loading data for a weekday during the summer season

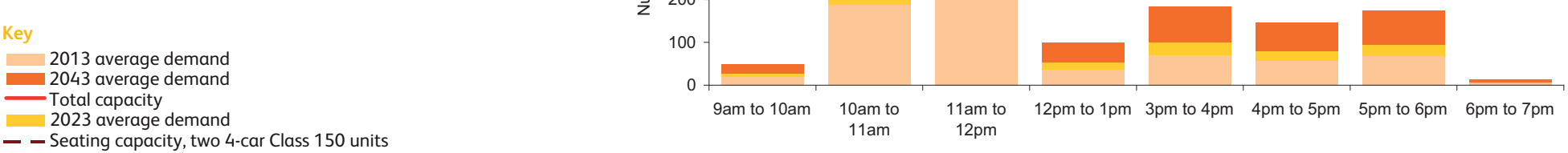
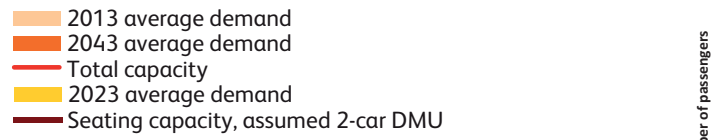


Figure C9: Par to Newquay loading data for a weekday during the summer season



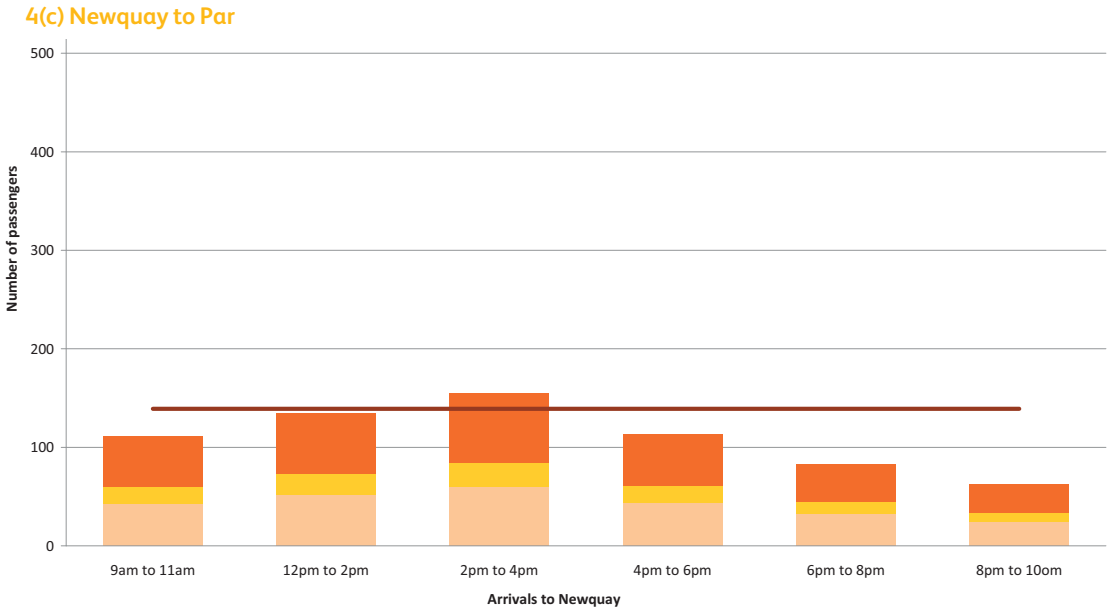
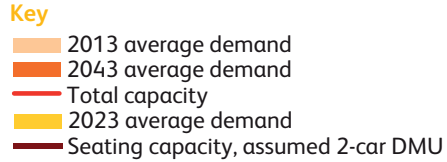


Figure C10: Newquay to Par loading data for a weekday during the summer season



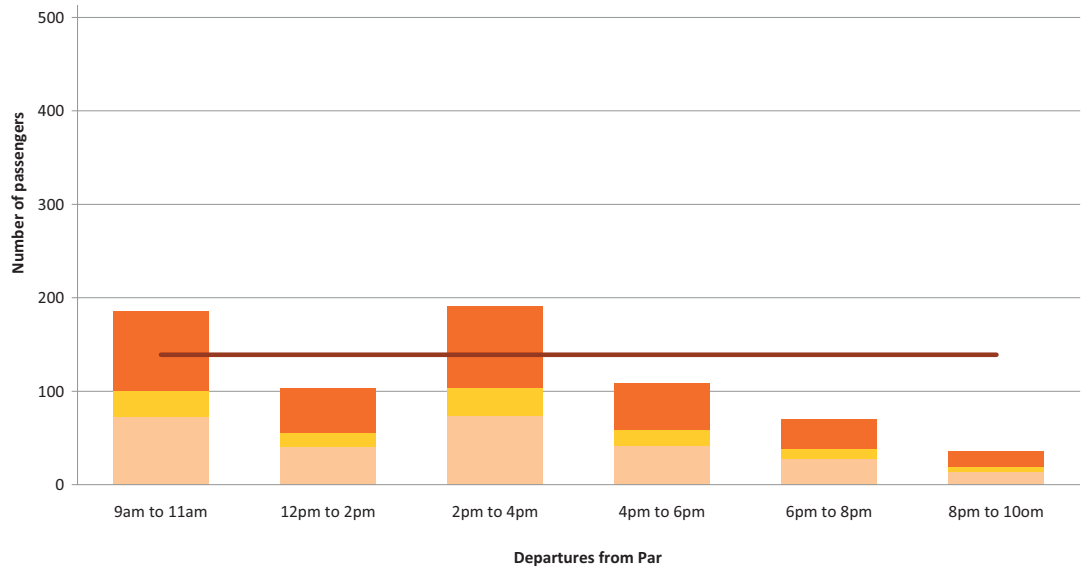


Figure C11: Par to Newquay loading data for a Saturday during the summer season

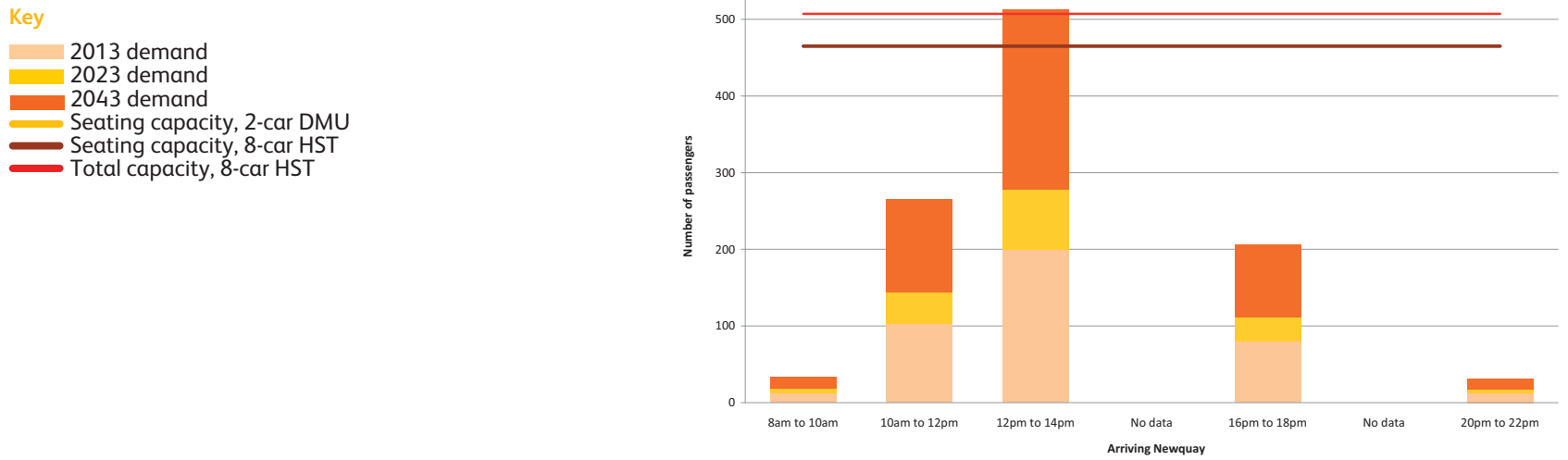


Figure C12: Newquay to Par loading data for a Saturday during the summer season

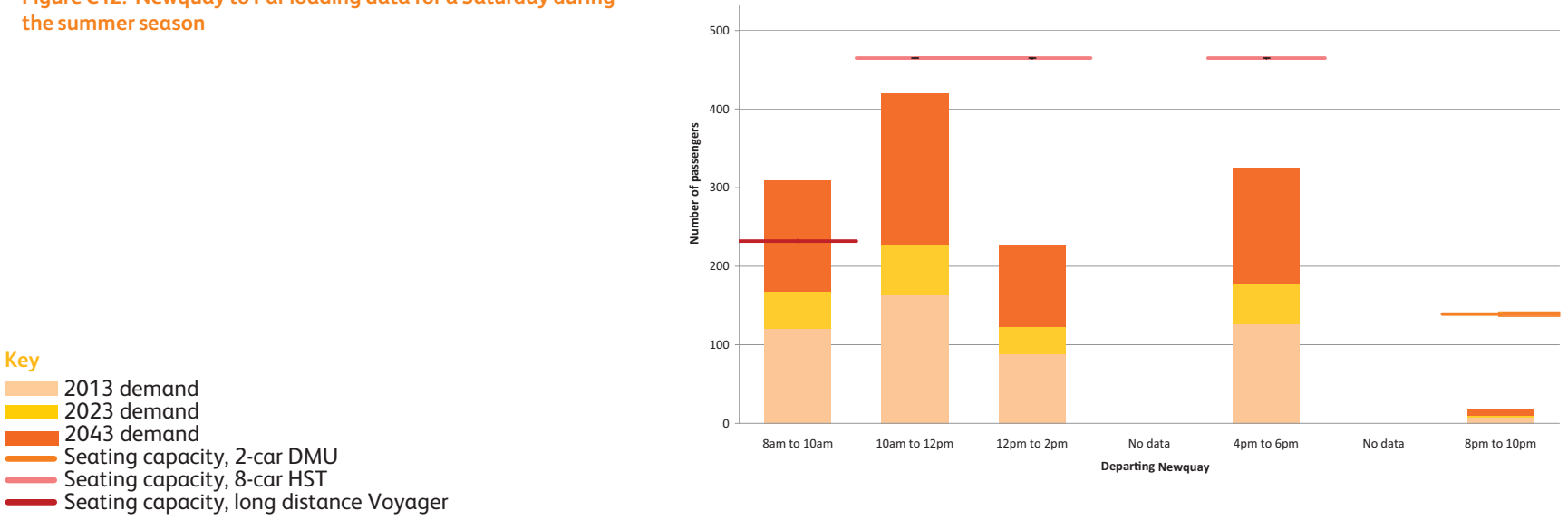


Figure C13: Par to Newquay loading data for a Sunday during the summer season

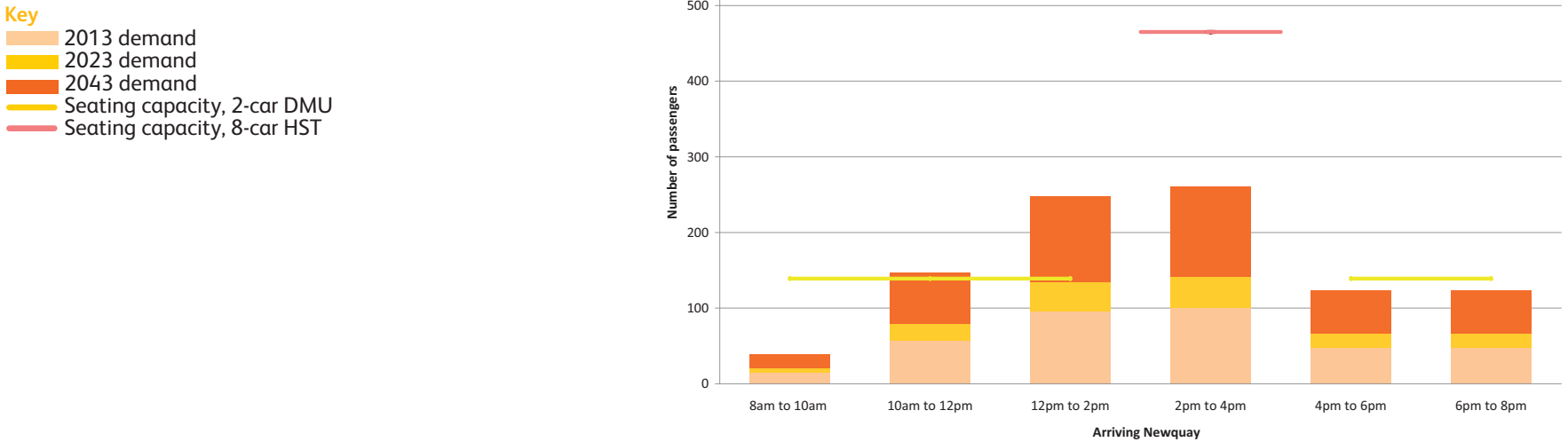
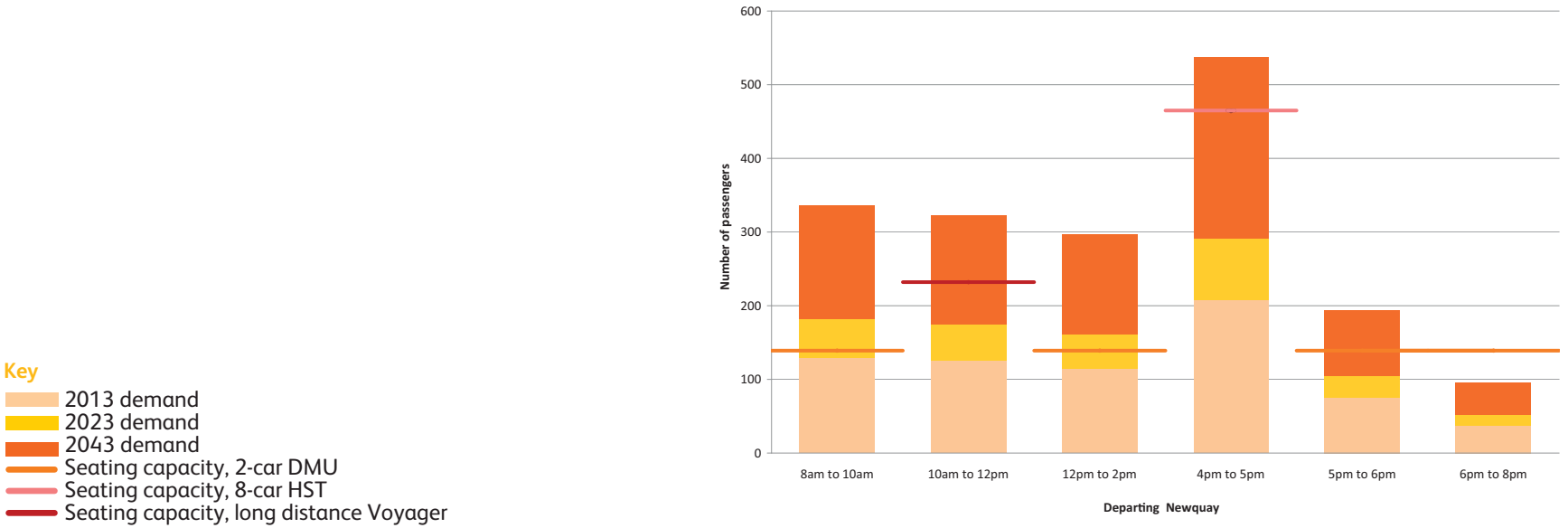


Figure C14: Newquay to Par loading data for a Sunday during the summer season



Section 5: Non-London long distance analysis

Figures C15 to C18 show forecast loads for individual trains at different locations along the route. On these graphs each horizontal line represents a service, with the colour of the line identifying an average load factor. For reasons of brevity graphs are not presented for all routes in all directions. They are only presented for a number of routes where they have been thought to be most informative, and where relevant, have only been presented in the most heavily loaded direction. Further commentary is provided in Section 3.3.7.

Plymouth to Edinburgh Waverley/Glasgow Central services via Birmingham New Street and Derby (Figures C15 and C16)

The heaviest loads are widely spread both between services and across the route. Crowding on these services is not exclusively within the peak periods, with several non-peak services at risk of crowding. The forecast growth would present significant crowding problems in 2023 with baseline capacity on both the Plymouth to Edinburgh Waverley/Glasgow Central and the Southampton Central/Reading to Newcastle services.

The forecast loads on services from Plymouth to Edinburgh Waverley and Glasgow Central northbound in 2023 are illustrated in Figure C15.

The red lines show where trains are forecast to have loads in excess of baseline seating capacity. Two services are forecast to have loads in excess of seating capacity between Derby and Chesterfield. However the heaviest crowding is shown to be between Bristol and Birmingham and in Yorkshire.

By 2043 crowding south of Birmingham would become even more acute in the absence of additional capacity as illustrated in Figure C16. However current capacity will be sufficient between Birmingham and Yorkshire, because significant demand is forecast to switch from this section of the route onto HS2 once HS2 Phase 2 is opened in the early 2030s. Changes to these services would probably be required, so that more capacity is provided south of Birmingham and north of Leeds compared with Birmingham to Leeds.

Figure C15: Plymouth to Edinburgh/Glasgow forecast load factors by train 2023

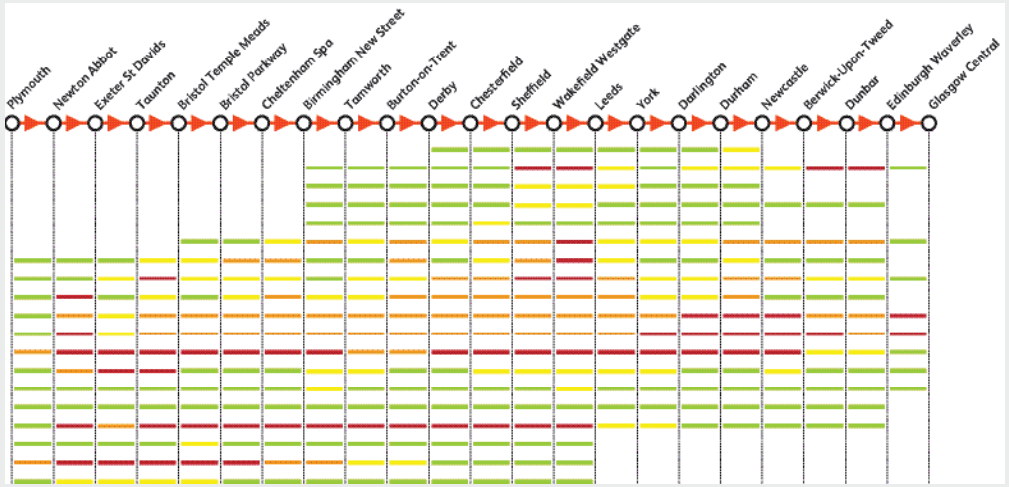
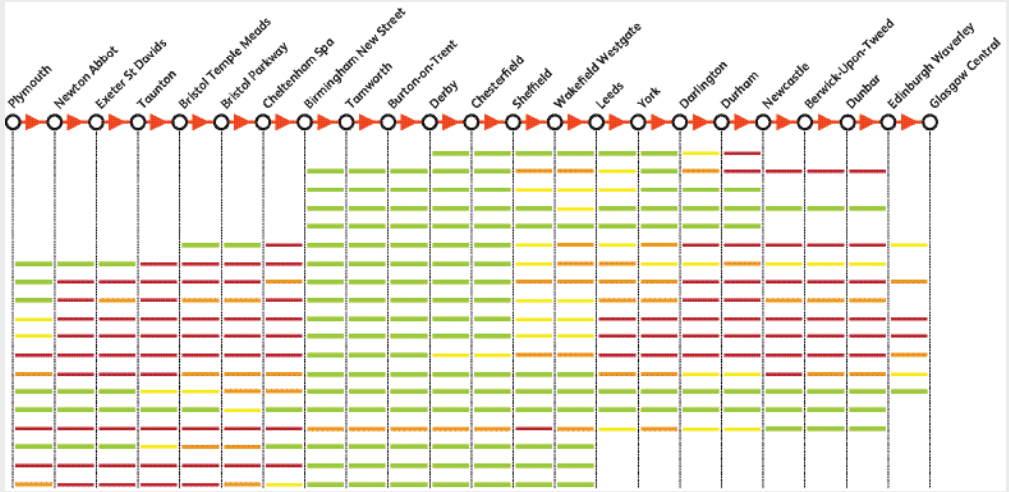


Figure C16: Plymouth to Edinburgh/Glasgow services forecast load factors by train 2043



Key

- Seats available: up to 70% seats taken on average
- Seats busy: 70% – 85% seats taken on average
- Seats full: 85% – 100% seats taken on average
- Standing i.e., load: > 100% of seats

Note: Baseline seating capacities assumed

Bournemouth to Manchester (Figure C17)

The heaviest loads are widely spread both between services and across the route. Crowding on these services is not exclusively within the peak periods, with non-peak services at risk of crowding. The forecast growth would present significant crowding problems in 2023 with baseline capacity.

The forecast loads on services from Bournemouth to Manchester Piccadilly in 2023 are illustrated in Figure C17.

The red lines show where trains are forecast to have loads in excess of baseline seating capacity. Ten services are forecast to have loads in excess of seating capacity south of Oxford. However, the heaviest crowding is shown to be between Oxford and Birmingham.

Penzance, Paignton and Bristol to Manchester Piccadilly (Figure C18)

The heaviest loads are north of Birmingham. Crowding on these services is mainly within the peak periods, with some non-peak services at risk of crowding. The forecast growth would present crowding problems in 2023 with baseline capacity.

The forecast loads on services from Penzance to Manchester Piccadilly in 2023 are illustrated in Figure C18.

The red lines show where trains are forecast to have loads in excess of baseline seating capacity. Three services are forecast to have loads in excess of seating capacity south of Birmingham. However, the heaviest crowding is shown to be north of Birmingham.

Figure C17: South Coast to North West forecast load factors by train 2023

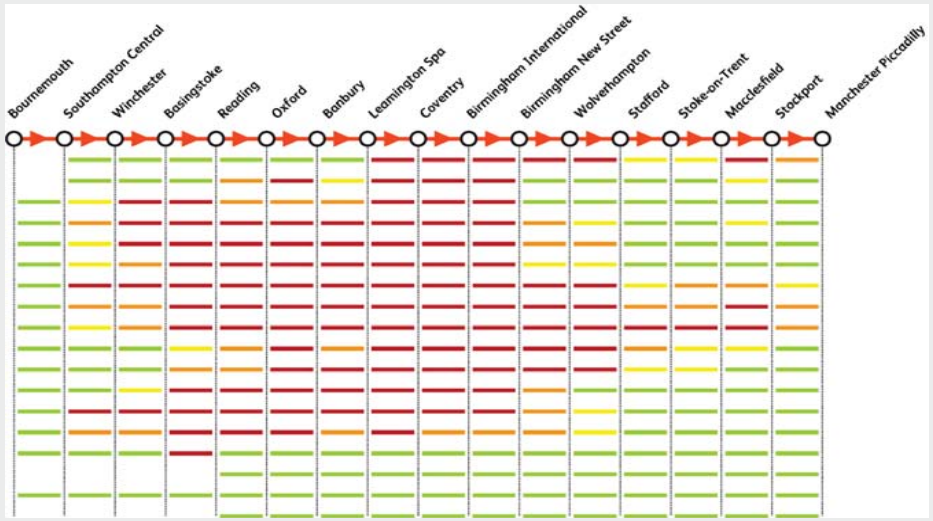
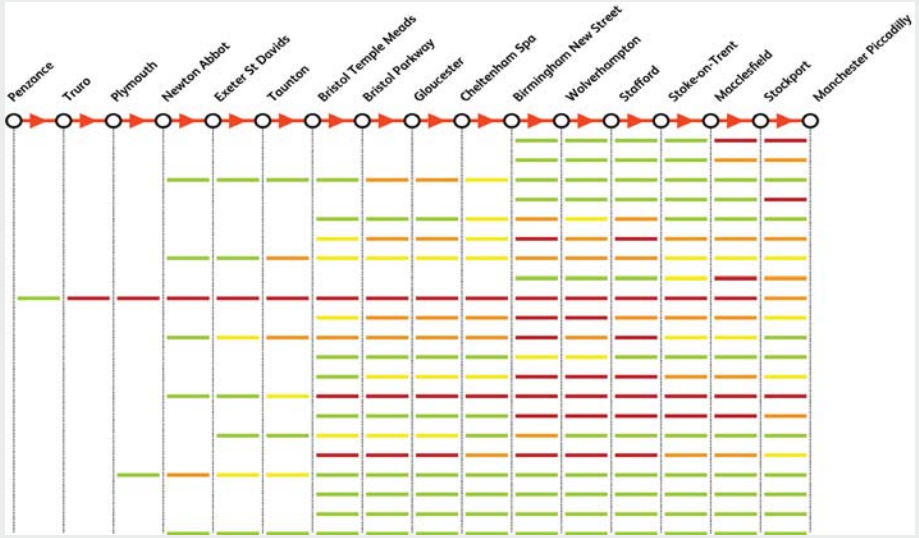


Figure C18: South West to North West forecast load factors by train 2023



Key

- Seats available: up to 70% seats taken on average
- Seats busy: 70% – 85% seats taken on average
- Seats full: 85% – 100% seats taken on average
- Standing i.e., load: > 100% of seats

Note: Baseline seating capacities assumed

Appendix D
Appraisal Results

The choices identified for the next Control Period (CP6, commencing April 2019) have been categorised from a financial and socio-economic perspective.

In the context of the financial perspective, CP6 choices have been categorised into those that:

- (a) worsen the rail industry's net operating position (in other words, the additional operating costs exceed the value of revenue generated); or
- (b) improve the industry's net operating position. For these schemes, the Route Study also indicates the extent to which this improvement is able to cover the capital cost of the initial investment.

The choices have also been appraised from a wider 'socio-economic' perspective, which compares the value of benefits to users and non-users to the net financial cost to funders. The appraisals have been conducted in line with funders' guidelines, in particular WebTAG; the Department for Transport's appraisal guidelines. Further details of appraisals including assumptions will be provided to the Office of Road and Rail.

Option A5: Lengthening peak services between London Paddington and Newbury	
Conditional Output	CO2 - To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel.
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate estimated 2023 demand and reduce on-train crowding on services into London Paddington from Newbury. High growth forecasts established in the Market Studies indicate that the high peak (08:00 – 08:59) arrivals into London Paddington that call at Newbury and stations along the Berks & Hants line will reach an average load factor of 93 per cent. This scheme provides the capacity required to meet 2023 demand and reduce on-train crowding.
Description	Lengthen the high peak (08.00-08.59) arrival and the busy evening peak departure between Newbury and London Paddington from 8-car to 12-car.
Infrastructure required	Platform extensions at Reading West
Operational requirement	Four additional EMU vehicles
Passenger impact	Additional on-train capacity between Newbury and London Paddington in the morning and evening high peak
Freight impact	None
Relates to other options	This option is an alternative to Option A6: Train lengthening for West of England long distance
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Decreases operating subsisdies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity; the scheme no longer is financially positive but is still very high value for money.
Note	The scheme assumes additional mileage as a result of the peak journeys only; 46% optimism bias applied to all operating cost assumptions, as per DfT's WebTAG guidance

Option A5: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		☐	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	✓	

Option A5: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	£m (2010 PV)
Costs to government (broad transport budget)	
Capital costs (c)	0.93
Non user benefits - road infrastructure cost changes	-0.02
Revenue transfer*	-12.72
NR operating costs and TOC operating costs transfer**	11.04
Sub-total (b)	**-0.76**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	6.93
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	7.07
Non user benefits - noise, air quality, greenhouse gases & accident benefits	0.46
Rail user and non user disruption disbenefits during possessions	-0.07
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-2.52
Sub-total (a)	**11.87**
Net Present Value (NPV) (a-b)	12.63
Benefit Cost Ratio to Government (BCR) (a/b)	financially positive
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	1.80

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option A6: Lengthening high peak West of England Long Distance Services	
Conditional Output	CO2 – To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate estimated 2023 demand and reduce on-train crowding on services into London Paddington from Newbury. High growth forecasts established in the Market Studies indicate that the high peak (08:00 – 08:59) arrivals into London Paddington that call at Newbury and stations along the Berks & Hants line will reach an average load factor of 93 per cent without provision of additional capacity
Description	Lengthen high peak arrivals into London Paddington (08.00-08.59) services from Plymouth/Penzance and Exeter St Davids from 8-car to 9-car
Infrastructure required	Platform Extensions required in both directions at Castle Cary. SDO (Selective Door Operation) required for Theale, Thatcham, Hungerford, Pewsey, Westbury, Frome
Operational requirement	Two extra vehicles required to run from Plymouth and Exeter St Davids to London Paddington
Passenger impact	Additional on-train capacity on the peak services from 2023
Freight impact	None
Relates to other options	This option is alternative to A5: Newbury to London Paddington peak services train lengthening
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Decreases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity; the scheme is no longer financially positive but is still very high value for money.
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. 46% optimism bias has been applied to the operating costs, as per DfT's WebTAG guidance. The option also assumes that both the lengthened services call at Hungerford and Newbury to spread the demand more evenly across the services. Journey time implications have not been modelled as part of this appraisal.

Option A6: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		☐	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☑	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option A6: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	1.48
Non user benefits - road infrastructure cost changes	-0.02
Revenue transfer*	-13.39
NR operating costs and TOC operating costs transfer**	12.85
Sub-total (b)	**0.92**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	5.14
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	3.78
Non user benefits - noise, air quality, greenhouse gases & accident benefits	8.17
Rail user and non user disruption disbenefits during possessions	-0.10
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-2.73
sub-total (a)	**14.26**
Net Present Value (NPV) (a-b)	13.34
Benefit Cost Ratio to Government (BCR) (a/b)	15.48
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	0.36

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option A7: Lengthening peak semi-fast services between London Paddington and Oxford	
Conditional Output	CO2 – To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate forecast demand and reduce on-train crowding on services into London Paddington from stations between Oxford and Reading. High growth forecasts established in the Market Studies indicate that in the high peak (08:00 – 08:59) arrivals into London Paddington from Oxford will reach an average load factor of 100 per cent at Tilehurst
Description	Lengthen high peak arrivals into London Paddington (08.00-09.00) and departures (17.00-18.00) from the base line assumed length of 8-car, to 12-car.
Infrastructure required	Platform Extensions: Tilehurst, Pangbourne, Goring, Cholsey, Radley. All Relief Line only, 4-car extensions.
Operational requirement	Eight additional EMU vehicles required to lengthen two trains, running between London Paddington and Oxford
Passenger impact	Additional on-train capacity on the peak services from 2023
Freight impact	None
Relates to other options	None
Socio-economic Value for money categorisation	Medium
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity. An alternative option to lengthen to 10-car (instead of 12) increases the value for money categoisation to High (making a high level assumptions on the reduced cost of platform lengthening as a result).
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. 46% optimism bias has been applied to the operating costs, as per DfT's WebTAG guidance.

Option A7: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Medium
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option A7: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	4.39
Non user benefits - road infrastructure cost changes	-0.03
Revenue transfer*	-18.80
NR operating costs and TOC operating costs transfer**	22.46
Sub-total (b)	**8.02**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	9.88
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	8.52
Non user benefits - noise, air quality, greenhouse gases & accident benefits	0.65
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-3.50
Sub-total (a)	**15.55**
Net Present Value (NPV) (a-b)	7.53
Benefit Cost Ratio to Government (BCR) (a/b)	1.94
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	-0.83

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option A9a: Additional high peak services between London Paddington and Swindon	
Conditional Output	CO2 – To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel.
Timeframe	CP6 (specifically 2023)
Purpose	To accommodate demand and reduce on-train crowding on high peak services between Swindon and London Paddington, including intermediate stations Didcot Parkway and Reading.
Description	A9a is a 'making best use' option. Provision of an additional 2tph between Swindon and London Paddington, calling at Didcot Parkway and Reading, to accommodate demand and reduce crowding. The additional services will be accomodated by removing 2tph express airport services during the high peak hour from the main lines.
Infrastructure requirement	None
Operational requirement	Twelve additonal EMU cars to run the additional Swindon-London services.
Passenger impact	Additional services and reduced on-train crowding in the peak.
Freight impact	None
Relates to other options	Option A9b and A13
Socio-economic value for money categorisation	High
Rail industry financial categorisation	Decreases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity, decreasing the BCR, but remaining within the high value for money categorisation.
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. 46% optimism bias has been applied to the operating costs, as per DfT's WebTAG guidance.

Option A9a: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		☐	High
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	✓	

Option A9a: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.29
Revenue transfer*	106.57
NR operating costs and TOC operating costs transfer**	37.95
Sub-total (b)	**144.24**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	84.20
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	122.29
Non user benefits - noise, air quality, greenhouse gases & accident benefits	7.34
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	191.82
Current TOC operating costs**	0.00
Indirect taxation impact on government	-18.29
Sub-total (a)	**387.36**
Net Present Value (NPV) (a-b)	243.13
Benefit Cost Ratio to Government (BCR) (a/b)	2.69
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option A9b: Additional high peak services between London Paddington and Swindon	
Conditional Output	CO2 – To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel.
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate demand and reduce on-train crowding on high peak services between London and Swindon.
Description	A9b is a 'making best use' option. Provision of an additional 2tph between Swindon and London Paddington, calling at Didcot Parkway and Reading, to accommodate demand and reduce crowding. The additional services will be accomodated by removing 2tph non-stopping services during the high peak hour from the main line. Connectivity to Heathrow is improved through introduction of an additional 2tph Heathrow services on the Relief Lines in the peak, increasing the proposed baseline frequency of 4tph to 6tph in the high peak only.
Infrastructure required	None
Operational requirement	Twelve additonal EMU cars to run the additional Swindon-London services and eighteen additional crossrail EMU vehicles is assumed.
Passenger impact	Additional services and reduced on-train crowding in the peak.
Freight impact	None
Relates to other options	Option A9a and A13
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Decreases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity, decreasing the BCR but the scheme remains in the very high value for money categorisation
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. 46% optimism bias has been applied to the operating costs, as per DfT's WebTAG guidance.

Option A9b: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option A9b: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.29
Revenue transfer*	-63.31
NR operating costs and TOC operating costs transfer**	108.31
Sub-total (b)	**44.72**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	110.77
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	122.47
Non user benefits - noise, air quality, greenhouse gases & accident benefits	7.35
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	191.82
Current TOC operating costs**	0.00
Indirect taxation impact on government	-47.00
Sub-total (a)	**385.40**
Net Present Value (NPV) (a-b)	340.68
Benefit Cost Ratio to Government (BCR) (a/b)	8.62
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option A13: Grade separation at Ladbroke Grove	
Conditional Output	CO2 – To provide sufficient capacity for passengers travelling into central London, taking into account anticipated growth over the period to 2043 for Main Line services from the Outer Suburban area and longer distance travel.
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate demand and reduce on-train crowding on high peak services between London Paddington and Swindon.
Description	Provision of up to an additional 4tph between Swindon and London Paddington in the peak, calling at Didcot Parkway and Reading, to accommodate demand and reduce crowding. This appraisal has quantified the benefits of an additional 2tph in the high peak hour only.
Infrastructure required	Grade separation at Ladbroke Grove
Operational requirement	Twelve additonal EMU cars to run the additional Swindon-London services
Passenger impact	Additional services and reduced on-train crowding in the peak
Freight impact	None
Relates to other options	Option A8, A9 are related 'making best use' options.
Socio-economic Value for money categorisation	High
Rail Industry financial categorisations	Decreases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity and reduces the appraisal value for money categorisation to Medium
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. 46% optimism bias has been applied to the operating costs, as per DfT's WebTAG guidance.

Option A13: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		☐	High
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☑	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option A13: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	123.92
Non user benefits - road infrastructure cost changes	-0.32
Revenue transfer*	-36.51
NR operating costs and TOC operating costs transfer**	107.91
Sub-total (b)	**195.00**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	123.49
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	145.61
Non user benefits - noise, air quality, greenhouse gases & accident benefits	8.28
Rail user and non user disruption disbenefits during possessions	-9.01
Current TOC revenue benefits*	191.82
Current TOC operating costs**	0.00
Indirect taxation impact on government	-42.74
Sub-total (a)	**417.45**
Net Present Value (NPV) (a-b)	222.44
Benefit Cost Ratio to Government (BCR) (a/b)	2.14
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	0.97
Notes *Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d **Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e	

Option A17: Relief Line enhancements	
Conditional Output	Connectivity - reduced journey times
Timeframe	Longer term or CP6 depending on funder priority - review case for passive provision in CP6
Objectives	To improve all-day connectivity and reduce journey times to London Paddington for stations east of Reading
Description	Two semi-fast trains per hour all day (currently peak only services) to call at Reading and stations east of Reading such as Twyford, Maidenhead, Slough and Hayes & Harlington.
Infrastructure required	Two additional tracks providing Up and Down dynamic loops for semi-fast services to overtake slower services calling at all stations
Operational requirement	Additional mileage all day between London Paddington and Reading
Passenger impact	An all day semi-fast service to London Paddington for passengers boarding at some stations East of Reading
Freight impact	None
Relates to other options	A18
Socio-economic Value for money categorisation	Medium
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity; the scheme's value for money categorisation reduced to Low
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment, no additional leasing costs are assumed. 46% optimism bias has been applied to the mileage and staff related operating costs, as per DfT's WebTAG guidance. Other unquantified benefits include the provision of an overtaking capability when a two-track railway is in operation. The creation of additional capacity on the Relief Lines for a suitable length of this Route Section may deliver the potential for timetable flexibility, service resilience and enhanced maintenance access to support future system requirements for both infrastructure and rolling stock, stabling and maintenance. This choice therefore merits further analysis as other work streams develop, including the maintenance and engineering access requirements and final form of the service specification.

Option A17: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Medium
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option A17: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	73.33
Non user benefits - road infrastructure cost changes	-0.13
Revenue transfer*	-60.58
NR operating costs and TOC operating costs transfer**	109.39
Sub-total (b)	**130.05**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	96.13
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	109.29
Non user benefits - noise, air quality, greenhouse gases & accident benefits	4.18
Rail user and non user disruption disbenefits during possessions	-5.52
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-11.60
Sub-total (a)	**192.48**
Net Present Value (NPV) (a-b)	70.47
Benefit Cost Ratio to Government (BCR) (a/b)	1.58
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	-0.67

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option G2: Grade Separation at Didcot East and Oxford North Junctions and associated capacity improvements at Oxford Station	
Conditional Output	Reading - Oxford (CO56) Bath - Oxford (CO51), if including infrastructure enhancement of I4 Swindon - Oxford (CO53), if including infrastructure enhancement of I4 Freight demand
Timeframe	2023 or longer term depending on funder priority
Objectives	To accommodate the 2043 ITSS, taking into consideration funder aspirations for CP6. Also allows capability for additional freight paths, helping to accommodate longer term freight growth
Description	The infrastructure would provide capacity for an additional two trains per hour, however, this appraisal assesses the connectivity benefit of an additional train path per hour between Oxford and Didcot Parkway. The service is assumed to be an extension of the current Bicester Town to Oxford service (to Reading). The second train path could accommodate the aspiration for an additional service between Oxford and Bristol; this service needs to be considered in conjunction with both G2 and I4.
Infrastructure required	Reduction of planning headways between Reading and Didcot Parkway on the Main Lines; Grade separation approaching Didcot East Junction to reduce Main Line and Relief Line conflicts; Grade separation approaching Oxford North Junction to reduce conflicts between East West Rail and North-South flows; remodelling of Oxford station to provide a 4th through platform.
Operational requirement	Additional rolling stock units required, with associated leasing and operating costs as a result of additional mileage
Passenger impact	Increased frequency of services between Oxford and Reading and better connectivity to Reading from North of Oxford. Potentially a new direct service opportunity between Oxford and Bristol Temple Meads, provided capacity is available between Swindon and Didcot Parkway.
Freight impact	Additional freight path, the benefits of which have not been assessed as part of this appraisal
Relates to other options	G3 and I4
Socio-economic Value for money categorisation	Poor
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity and the value for money remains poor.
Note	Unquantified benefits include potential performance benefits and freight benefits. The appraisal is also potentially underestimating demand on the Bicester Town - Reading connection as the impact of East-West Rail was not included in the analysis. To deliver the connectivity output between Oxford and Bristol Temple Meads, a combination option needs to be considered, as it is assumed that the infrastructure enhancement from both G2 and I4 is required to accommodate this path. A high level assessment of both the costs, and all benefits associated with the each of the schemes indicates Low value for money.

Option G2: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Poor
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option G2: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	121.22
Non user benefits - road infrastructure cost changes	-0.05
Revenue transfer*	-18.05
NR operating costs and TOC operating costs transfer**	69.38
Sub-total (b)	**402.51**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	36.49
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	3.30
Non user benefits - noise, air quality, greenhouse gases & accident benefits	0.90
Rail user and non user disruption disbenefits during possessions	-9.13
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-3.62
Sub-total (a)	**27.94**
Net Present Value (NPV) (a-b)	-144.57
Benefit Cost Ratio to Government (BCR) (a/b)	0.16
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	-0.42

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option G3: Grade Separation at Didcot East Junction, capacity improvements between Didcot and Oxford and at Oxford Station	
Conditional Output	Reading - Oxford (CO56) Bath - Oxford (CO51), if including infrastructure enhancement of I4 Swindon - Oxford (CO53), if including infrastructure enhancement of I4 Freight demand
Timeframe	2023 or longer term depending on funder priority
Objectives	To accommodate the 2043 ITSS, taking into consideration funder aspirations for CP6. Also allows capability for additional freight paths, helping to accommodate longer term freight growth
Description	As G2, but allows more regular service for passengers at Appleford, Culham and Radley.
Infrastructure required	• Reduction of planning headways between Reading and Didcot Parkway on the Main Lines • Grade separation approaching Didcot East Junction to reduce Main Line and Relief Line conflicts • Increase of the number of running lines between Didcot North Junction and Oxford station to: – Provide additional plain-line capacity between Didcot Parkway and Oxford – Improve the maintainability and resilience of the route section – Avoid the need for grade separation approaching Oxford North Junction by maintaining the traffic separation established by the grade separation at Didcot East Junction • Remodelling of Oxford station to suit the four-tracking alignment described above which includes provision of a 4th platform through platform.
Operational requirement	Additional rolling stock units required, with associated leasing and operating costs as a result of the additional mileage.
Passenger impact	As G2, with the additional benefits to passengers from Radley, Appleford, Culham through the provision of a regular half hourly service throughout the day.
Freight impact	Additional freight path, the benefits of which have not been assessed as part of this appraisal
Relates to other options	G2 and I4
Socio-economic Value for money categorisation	Poor
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity and the value for money remains poor.
Note	Unquantified benefits include potential performance benefits, freight benefits, journey time saving and Schedule 4 savings. The appraisal is also potentially underestimating demand on the Bicester Town - Reading connection as the impact of East-West Rail was not included in the analysis. To deliver the connectivity output between Oxford and Bristol Temple Meads, a combination option needs to be considered, as it is assumed that the infrastructure enhancement from both G3 and I4 is required to accommodate this path.

Option G3: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Poor
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option G3: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	245.60
Non user benefits - road infrastructure cost changes	-0.06
Revenue transfer*	-24.49
NR operating costs and TOC operating costs transfer**	69.38
Sub-total (b)	**290.43**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	52.61
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	4.05
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.10
Rail user and non user disruption disbenefits during possessions	-18.49
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-4.84
Sub-total (a)	**34.43**
Net Present Value (NPV) (a-b)	-166.75
Benefit Cost Ratio to Government (BCR) (a/b)	0.59
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	-0.13

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option N1: Enhancement of Abbotswood Junction	
Conditional Output	Option is designed to accommodate the following Conditional Outputs from the LDMS: • London – Worcester (B) • Swindon – Birmingham (C) • Swindon – Manchester (C) • Swindon – Liverpool (C)
Timeframe	2019-2024 (Control Period 6)
Objectives	To accommodate the 2043 ITSS
Description	A CP6 renewals opportunity to increase capacity at Abbotswood junction to provide an extension of the hourly service from London Paddington to Cheltenham Spa to Worcester Shrub Hill.
Infrastructure required	Provision of an enhanced junction (a double rather than a single lead junction) when renewed
Operational requirement	Additional mileage on the services to Worcester Shrub Hill.
Passenger impact	Connectivity improvement
Freight impact	None
Relates to other options	None
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Scheme increases operating subsidies
Sensitivity test	Using the low growth scenario as described by the LDMS reduces the value for money category to Medium value for money
Note	None

Option N1: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option N1: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	6.50
Non user benefits - road infrastructure cost changes	-0.05
Revenue transfer*	-20.19
NR operating costs and TOC operating costs transfer**	18.78
Sub-total (b)	**5.04**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	37.26
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	13.46
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.02
Rail user and non user disruption disbenefits during possessions	-0.49
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-3.93
Sub-total (a)	**47.32**
Net Present Value (NPV) (a-b)	42.29
Benefit Cost Ratio to Government (BCR) (a/b)	9.39
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	0.22

Notes

*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d

**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option O1: Train Lengthening on the Exmouth Line	
Conditional Output	CO5: provide sufficient capacity for passengers travelling into Exeter Area, taking into account anticipated growth over the period to 2043
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate estimated 2023 demand and reduce on-train crowding on services into Exeter from the Exmouth corridor. High growth forecasts established in the Market Studies and new passenger demand estimated from new stations along the corridor indicate that by 2023 it is expected that the peak hour passengers will be standing from Topsham.
Description	Lengthen the high peak (08.00-08.59) arrival and the busy evening peak departure between Exmouth and Exeter to 5-car. The baseline infrastructure is capable of 4-car, therefore this appraisal assess the benefits of lengthening these services from 4 to 5-car.
Infrastructure required	Infrastructure may be required but the costs have not been assessed as part of this appraisal
Operational requirement	Three additonal DMU cars to lengthen two peak services to 5-car, incremental to the assumed rolling stock formation in the peak of 3 and 4-car services.
Passenger impact	Additional on-train capacity in the peak
Freight impact	None
Relates to other options	None
Socio-economic Value for money categorisation	Poor
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	The scheme assumes additional mileage as a result of the peak journeys only; 46% optimism bias applied to all operating cost assumptions, as per DfT's WebTAG guidance. The infrastructure is capable of 4-car services, the appraisal therefore only assesses the crowding relief benefits incremental to the assumed base infrastructure. Lengthening one peak service from 3 to 4 car indicates low value for money, if assuming no additional leasing costs the case is significantly improved to financially positive.

Option O1: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Poor
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option O1: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	0.00
Revenue transfer*	-0.48
NR operating costs and TOC operating costs transfer**	5.44
Sub-total (b)	**4.97**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	2.17
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	0.06
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-0.02
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-0.09
Sub-total (a)	**2.12**
Net Present Value (NPV) (a-b)	-2.85
Benefit Cost Ratio to Government (BCR) (a/b)	0.43
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	NA

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option O3a: An additional service between Exeter St Davids and Axminster	
Conditional Output	CO5: provide sufficient capacity for passengers travelling into Exeter Area, taking into account anticipated growth over the period to 2043.
Timeframe	CP6 (specifically 2023)
Objectives	To accommodate forecast peak rail passenger demand, relieve peak crowding and improve connectivity between Exeter and Yeovil
Description	Provision of an additional one train per hour between Exeter St David's and Axminster to create a two train per hour service, accommodating 2023 peak passenger demand into Exeter St David's and improving connectivity along the corridor.
Infrastructure required	Loop at Whimple
Operational requirement	Two additional 2-car DMUs required to run additional 1tph between Axminster and Exeter St David's.
Passenger impact	Additional on-train capacity on the peak services from 2023, improved connectivity.
Freight impact	None
Relates to other options	Wessex diversionary - Option O3b
Socio-economic Value for money categorisation	Low
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment. Multiple sensitivities have been assessed for different CAPEX, formation of new services and running hours of new services. Highest BCR given (representing low value for money) by running 1tph as 2-car DMUs throughout whole day.

Option O3a: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Low
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option O3a: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	7.81
Non user benefits - road infrastructure cost changes	-0.05
Revenue transfer*	-21.83
NR operating costs and TOC operating costs transfer**	61.87
Sub-total (b)	**47.81**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	59.20
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	6.02
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-2.00
Rail user and non user disruption disbenefits during possessions	-0.59
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-3.09
Sub-total (a)	**59.54**
Net Present Value (NPV) (a-b)	11.73
Benefit Cost Ratio to Government (BCR) (a/b)	1.25
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	-5.13

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option O3b: An additional service between Exeter St Davids and Axminster and diversionary capabilities	
Contitional Output	O3 (b) - Capacity Improvements between Exeter St Davids and Axminster and diversionary capabilities for London to West of England services
Timeframe	Resilience and 2023 capacity and connectivity
Objectives	The scheme enables diversionary capabilities for London to West of England services when GWML is unable to operate or has a reduced service. The scheme also accommodates forecast peak rail passenger demand, relieve peak crowding and improve connectivity between Exeter and Yeovil when the diversionary route is not in use
Description	Provision of an additional 1tph between Exeter St Davids and Axminster to create a two train per hour service to accommodate 2023 peak passenger demand into Exeter St Davids and improve connectivity along the corridor and also diversionary capabilities for services between London Paddington and the South West
Infrastructure required	Loops, additional signal sections and additional platforms
Operational requirement	Two additional 2-car DMUs required to run additional 1tph between Axminster and Exeter St Davids
Passenger impact	Maintaining connectivity between the West Country, the Thames Valley and London Paddington and the rest of the network during flooding incidents and planned engineering work. Additional on-train capacity on the peak services from 2023 and improved connectivity to Exeter St Davids throughout the rest of the year
Freight impact	None
Relates to other options	O3 - Capacity Improvements between Exeter St Davids and Axminster without the diversionary capabilities
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Medium capital cost coverage, decreases operating subsidies
Sensitivity test	Sensitivity 1: without Schedule 8 savings this scheme's value for money category is reduced to Low Sensitivity 2: the low growth scenario reduces the scheme's value for money category to Low
Note	None

Option O3b: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		☐	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☑	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option O3b: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	82.83
Non user benefits - road infrastructure cost changes	-0.28
Revenue transfer*	-112.60
NR operating costs and TOC operating costs transfer**	61.87
Sub-total (b)	**31.82**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	209.16
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	34.32
Non user benefits - noise, air quality, greenhouse gases & accident benefits	2.93
Rail user and non user disruption disbenefits during possessions	-6.24
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-21.14
Sub-total (a)	**219.03**
Net Present Value (NPV) (a-b)	187.21
Benefit Cost Ratio to Government (BCR) (a/b)	6.88
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	0.61
Notes *Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d **Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e	

Option P1: Train Lengthening on the Falmouth Line	
Conditional Output	CO6: Provide sufficient capacity for passengers within Devon and Cornwall, taking into account anticipated growth over the period to 2043
Timeframe	CP6 (specifically 2023)
Objectives	To reduce on-train crowding on services into Truro from Falmouth Docks, and stations in between. High growth forecasts indicates that by 2023, the high peak hour arrivals into Truro (08.00-08.59) will be at 89% average load factor; indicating that there is likely to be crowding on arrival to Truro.
Description	Lengthen two high peak arrivals into Truro from 2-car to 3-car
Infrastructure required	None assumed
Operational requirement	Two additional vehicles, running in the am peak and pm peak
Passenger impact	Additional on-train capacity on the peak services from 2023
Freight impact	None
Relates to other options	None
Socio-economic Value for money categorisation	Low
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	The low growth scenario for rail passenger demand (struggling in isolation) was applied as a sensitivity and impacts the value for money categorisation to poor value for money. If assume no additional leasing costs are required above the baseline to strengthen the peak services then the scheme value for money is improved to very high value for money.
Note	The operating costs are estimated on a high level diagramming assumption and subject to further assessment.

Option P1: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Low
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option P1: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	0.00
Revenue transfer*	-0.15
NR operating costs and TOC operating costs transfer**	5.44
Sub-total (b)	**5.29**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	1.68
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	0.02
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-0.03
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-0.02
Sub-total (a)	**1.65**
Net Present Value (NPV) (a-b)	-3.64
Benefit Cost Ratio to Government (BCR) (a/b)	0.31
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	NA

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD1: Cross-country train lengthening on the South West to West Midlands axis (18 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate 2023 estimated demand and reduce on-train crowding on long distance services across Bristol Temple Meads, and other locations outside the Western Route Study area. Estimated 2023 demand indicates overcrowding on many services running from Plymouth to Edinburgh and Glasgow.
Description	Capacity analysis reveals 18 additional vehicles are required by 2023 to provide sufficient total capacity for passengers on many services running from Plymouth to Edinburgh and Glasgow Central. The crowding is not focussed on any single area, but occurs at a variety of locations along the route.
Infrastructure required	No infrastructure required.
Operational requirement	18 additional vehicles to lengthen the majority of services; including most four and five car sets to be lengthened by one or two vehicles with one service requiring three additional vehicles. This includes all long distance services across Bristol in the three hour peak (07.00 - 09.59) and the majority of services throughout the rest of the day.
Passenger impact	Provides sufficient seated capacity to meet the anticipated demand growth to 2023.
Freight impact	None
Relates to other options	Option LD2; only includes train lengthening on services that have a medium, high or very high value for money business.
Socio-economic Value for money categorisation	Low/Medium
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD1: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Low / Medium
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option LD1: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.0
Non user benefits - road infrastructure cost changes	-0.1
Revenue transfer*	-55.5
NR operating costs and TOC operating costs transfer**	90.9
Sub-total (b)	**35.3**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.0
Rail user journey time benefits	49.1
Journey ambiance inc. station amenity	0.0
Non user benefits - road decongestion	14.4
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-1.3
Rail user and non user disruption disbenefits during possessions	0.0
Current TOC revenue benefits*	0.0
Current TOC operating costs**	0.0
Indirect taxation impact on government	-10.8
Sub-total (a)	**35.3**
Net Present Value (NPV) (a-b)	16.2
Benefit Cost Ratio to Government (BCR) (a/b)	1.5
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD2: Cross-country train lengthening on the South West to West Midlands axis (8 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Plymouth to Edinburgh and Glasgow Central long distance services
Description	Only those additional vehicles with a medium, high or very high value for money business case are included. This option will not fully meet the crowding standards
Infrastructure required	No infrastructure required
Operational requirement	Eight additional vehicles to lengthen some services from four and five-cars to five or six-cars
Passenger impact	Provides sufficient seated capacity to partially meet the anticipated demand growth to 2023
Freight impact	None
Relates to other options	Option LD1; lengthens the majority of trains across the service group to accommodate estimated 2023 demand, including services that individually have a poor or low value for money categorisation
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD2: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option LD2: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.06
Revenue transfer*	-36.04
NR operating costs and TOC operating costs transfer**	39.22
Sub-total (b)	**3.12**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	31.69
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	9.36
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-0.06
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-7.65
Sub-total (a)	**33.33**
Net Present Value (NPV) (a-b)	30.21
Benefit Cost Ratio to Government (BCR) (a/b)	10.68
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD3: Cross-country train lengthening between Bournemouth/Southampton/Reading and the North East/North West (15 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecast demand and reduce on-train crowding on long distance services across Reading, and other locations outside the Western Route Study area. Estimated 2023 demand indicates overcrowding on many services running from Southampton/Reading and Newcastle. This includes long distance services that arrive at Reading across the three hour peak (07.00 - 09.59).
Description	Train lengthening of the majority of long distance services between Southampton/Reading and Newcastle
Infrastructure required	No infrastructure required
Operational requirement	15 additional vehicles to lengthen services. Most four-car sets to be lengthened to five-cars with a few being lengthened to six-cars
Passenger impact	Provides sufficient seated capacity to meet the anticipated demand growth to 2023
Freight impact	None
Relates to other options	Option LD4; only includes train lengthening on services that have a medium, high or very high value for money categorisation
Socio-economic Value for money categorisation	Poor
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. T he business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD3: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Poor
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option LD3: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.04
Revenue transfer*	-26.28
NR operating costs and TOC operating costs transfer**	66.62
Sub-total (b)	**40.30**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	22.66
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	7.45
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-1.22
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-4.60
Sub-total (a)	**24.29**
Net Present Value (NPV) (a-b)	-16.01
Benefit Cost Ratio to Government (BCR) (a/b)	0.60
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD4: Train lengthening for Southampton/Reading to Newcastle services (4 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Southampton/Reading to Newcastle long distance services
Description	Only those additional vehicles with a medium, high or very high value for money business case are included. This option will not fully meet the crowding standards
Infrastructure required	No infrastructure required
Operational requirement	Four additional vehicles to lengthen a small selection of services. Four car sets to be lengthened to five cars in each case
Passenger impact	On-train crowding is reduced on one service arriving at Reading across the three hour peak (07.00-09.59) from the North and one service departing from Reading to the North. Other selected services throughout the day are also lengthened. Additional capacity met through lengthening of services from Southampton/Bournemouth to Manchester and Sheffield; see option LD5-LD6
Freight impact	None
Relates to other options	Option LD3; lengthens the majority of trains across the service group to accommodate estimated 2023 demand, including services that individually have a poor or low value for money categorisation
Socio-economic Value for money categorisation	Medium
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD4: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Medium
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option LD4: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.02
Revenue transfer*	-10.58
NR operating costs and TOC operating costs transfer**	16.31
Sub-total (b)	**5.71**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	9.03
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	2.99
Non user benefits - noise, air quality, greenhouse gases & accident benefits	-0.09
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-2.17
Sub-total (a)	**9.76**
Net Present Value (NPV) (a-b)	4.05
Benefit Cost Ratio to Government (BCR) (a/b)	1.71
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD5a: Cross-country train lengthening on the South West to West Midlands axis (18 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Penzance/Newton Abbot to Manchester Piccadilly long distance services
Description	Capacity analysis reveals 18 additional vehicles are required by 2023 to provide sufficient total capacity for passengers on many services running from Penzance/Newton Abbot to Manchester Piccadilly. The crowding is not focussed on any single area, but occurs at a variety of locations along the route.
Infrastructure required	No infrastructure required
Operational requirement	18 additional vehicles to lengthen services. All four and five-car sets lengthened to six-car, with a few being lengthened to eight-car
Passenger impact	Provides sufficient capacity to meet the anticipated demand growth to 2023
Freight impact	None
Relates to other options	Option LD5b; only includes train lengthening on services that have a medium, high or very high value for money business
Socio-economic Value for money categorisation	Low
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. he business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD5a: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Low
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option LD5a: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.06
Revenue transfer*	-48.18
NR operating costs and TOC operating costs transfer**	79.53
Sub-total (b)	**31.29**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	31.08
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	11.50
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.66
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-11.38
Sub-total (a)	**32.86**
Net Present Value (NPV) (a-b)	1.57
Benefit Cost Ratio to Government (BCR) (a/b)	1.05
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD5b: Cross-country train lengthening on the South West to West Midlands axis (11 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Penzance/Newton Abbot to Manchester Piccadilly long distance services
Description	Only those additional vehicles with a medium, high or very high value for money business case are included. This option will not fully meet the crowding standards
Infrastructure required	No infrastructure required
Operational requirement	11 additional vehicles to lengthen services. All four and five-car sets lengthened to five and six-car
Passenger impact	Provides additional capacity to partially meet the anticipated demand growth to 2023
Freight impact	None
Relates to other options	LD5; lengthens the majority of trains across the service group to accommodate estimated 2023 demand, including services that individually have a poor or low value for money categorisation
Socio-economic Value for money categorisation	High
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD5b: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	High
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option LD5b: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.04
Revenue transfer*	-39.09
NR operating costs and TOC operating costs transfer**	46.89
Sub-total (b)	**7.75**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	25.01
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	9.33
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.34
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-9.23
Sub-total (a)	**26.46**
Net Present Value (NPV) (a-b)	18.71
Benefit Cost Ratio to Government (BCR) (a/b)	3.41
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD6: Cross-country train lengthening between Bournemouth/Southampton/Reading and the North East/North West (17 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Bournemouth to Manchester Piccadilly long distance services
Description	Capacity analysis reveals 17 additional vehicles are required by 2023 to provide sufficient total capacity for passengers on many services running from Bournemouth to Manchester Piccadilly. The crowding is not focussed on any single area, but occurs at a variety of locations along the route
Infrastructure required	No infrastructure required
Operational requirement	17 additional vehicles to lengthen services. All four and five-car sets lengthened to six-car, with a few being lengthened to eight-car
Passenger impact	Provides sufficient capacity to meet the anticipated demand growth to 2023
Freight impact	None
Relates to other options	Option LD7; only includes train lengthening on services that have a medium, high or very high value for money business
Socio-economic Value for money categorisation	Low
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD6: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			Socio-economic impact (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Low
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%	☐	
	Medium capital cost coverage (33 – 66%)	☐	
	High capital cost coverage (66 – 100%)	☐	
	Positive financial case (> 100%)	☐	

Option LD6: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	£m (2010 PV)
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.06
Revenue transfer*	-53.11
NR operating costs and TOC operating costs transfer**	74.32
Sub-total (b)	**21.15**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	34.47
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	11.87
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.71
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	0.00
Sub-total (a)	**48.04**
Net Present Value (NPV) (a-b)	26.89
Benefit Cost Ratio to Government (BCR) (a/b)	2.27
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Option LD7: Cross-country train lengthening between Bournemouth/Southampton/Reading and the North East/North West (12 vehicle option)	
Conditional Output	Capacity
Timeframe	CP6, 2023
Objectives	To accommodate forecasted demand and reduce on-train crowding on the Bournemouth to Manchester Piccadilly long distance services
Description	Only those additional vehicles with a medium, high or very high value for money business case are included. This option will not fully meet the crowding standards
Infrastructure required	No infrastructure required.
Operational requirement	12 additional vehicles to lengthen services. Some four and five-car sets lengthened to six-car
Passenger impact	Provides sufficient capacity to meet the anticipated demand growth to 2023
Freight impact	None anticipated.
Relates to other options	Option LD6; lengthens the majority of trains across the service group to accommodate estimated 2023 demand, including services that individually have a poor or low value for money categorisation
Socio-economic Value for money categorisation	Very high
Rail Industry financial categorisations	Increases operating subsidies
Sensitivity test	None
Note	These services will be significantly affected by HS2 phase 2 causing a reduction in demand on the classic route north of Birmingham New Street in 2033. For this reason the appraisal has been conducted over a 10 year appraisal period only. The business case is only valid if funders consider an appropriate re-deployment of the additional vehicles can be found from 2033. The 2012 Department for Transport High Level Output Specification mentions the electrification of sections of this route. If this was delivered, this would present an opportunity for running electric services over part of this route. The issues outlined above, relating to rolling stock deployment, would then need to be considered for high-speed electric multiple units rather than diesel units.

Option LD7: Financial and socio-economic categorisation			
Rail industry financial impact (Categorisation of Revenue, Operating costs, and Capital costs over appraisal period)			**Socio-economic impact** (WebTAG VfM category, see summary TEE table for further details)
Scheme increases operating subsidies (i.e. R - O < 0)		✓	Very high
Scheme decreases operating subsidies (i.e. R - O > 0)	Low capital cost coverage (i.e. (R - O) / C < 33%		
	Medium capital cost coverage (33 – 66%)		
	High capital cost coverage (66 – 100%)		
	Positive financial case (> 100%)		

Option LD7: Summary TEE (Transport Economic Efficiency) table	
30 year appraisal	**£m (2010 PV)**
Costs to government (broad transport budget)	
Capital costs (c)	0.00
Non user benefits - road infrastructure cost changes	-0.05
Revenue transfer*	-45.39
NR operating costs and TOC operating costs transfer**	51.23
Sub-total (b)	**5.79**
Net benefits to consumers and private sector (plus tax impacts)	
Rail user reliability benefits	0.00
Rail user journey time benefits	29.36
Journey ambiance inc. station amenity	0.00
Non user benefits - road decongestion	10.84
Non user benefits - noise, air quality, greenhouse gases & accident benefits	1.56
Rail user and non user disruption disbenefits during possessions	0.00
Current TOC revenue benefits*	0.00
Current TOC operating costs**	0.00
Indirect taxation impact on government	-10.72
Sub-total (a)	**31.04**
Net Present Value (NPV) (a-b)	25.26
Benefit Cost Ratio to Government (BCR) (a/b)	5.37
Commercial Benefit Cost Ratio to Government (CBCR) ((d-e)/c)	N/A

Notes
*Total revenue benefits = revenue benefits to private sector + revenue transfer to government , d
**Total change in operating costs = change in operating costs to private sector + change in operating cost transfer to government, e

Glossary

Term	Meaning
Access for All	A programme which is part of Department for Transport's (DfT) Railways for All Strategy and is designed to address the issues faced by disabled passengers using railway stations in Great Britain. As a part of this programme new footbridges have been installed at some stations with new stairs and lift access between station entrance and platforms.
AFC	Anticipated Final Cost, a cost presented in the Route Study to allow options to be compared, composed of the Point Estimate plus Risk (also known as a Proposal Estimate).
Baseline	Infrastructure, timetable or rolling stock which is assumed to be in place as a starting point for the route study. This is detailed in Chapter 2 of this document.
BCR	Benefit to Cost Ratio, a measure of the value for money presented by an option.
Berks & Hants	A commonly used term to describe the railway line between Reading and Taunton, named after the original railway company which built parts of the route.
Bi-directional	A line which is signalled to be used in either direction.
Bi-directional signalling	Additional infrastructure above that normally provided, to allow a line to be used in either direction.
Bi-mode	A type of train which can use two different sources of power, either being electrically powered where suitable infrastructure is available, and self-powered elsewhere.
Classic network	A term which describes the UK rail network not including HS1 or HS2. Can also be referred to as a 'conventional network.
Class 4	A classification of freight train timetabled to operate at up to 75mph, typically carrying intermodal containers or automotive traffic.
Class 6	A classification of freight train timetabled to operate at up to 60mph, typically heavier than a Class 4 train due to the goods carried.
Class 7	A classification of freight train timetabled to operate at up to 45mph, typically on Western Route, carrying aggregate traffic and whose speed is limited by the design of wagons used.
Churn	The sum of boarding and alighting passengers for a train service that stops at a given station.
Committed Enhancement	Infrastructure investment schemes which have been identified for funding in the Government's High Level Output Specification (HLOS) or are funded by third parties.
Conditional Outputs	Aspirations for the industry to provide, subject to feasibility, value for money and affordability etc.
Control Period 4 (CP4)	Network Rail is funded in five yearly periods. Control Period 4 is the funding period between 2009 – 2014.
Control Period 5 (CP5)	Network Rail is funded in five yearly periods. Control Period 5 is the funding period between 2014 – 2019.
Control Period 6 (CP6)	Network Rail is funded in five yearly periods. Control Period 6 is the funding period between 2019 – 2024.
Control Period 7 (CP7)	Network Rail is funded in five yearly periods. Control Period 7 is the funding period between 2024 – 2029.
Cornwall Rail Improvement package	In July 2014 the Government announced funding for several related rail improvement projects for Cornwall including an upgrade to the Sleeper service, bringing forward the signalling renewal on the Main Line and enhancements to the train maintenance depot in Penzance to maintain the Sleeper stock.

Term	Meaning
Crowding standards	Threshold levels above which crowding is not acceptable, and which would trigger the need for measures to mitigate the crowding. The standards used in the Route Study are that passengers should have a seat available within 20minutes of boarding a train, and that the standard class load should not be greater than the specified total standard class capacity of the train (including standing where appropriate). The standards are based on relevant DfT and franchising guidance and documentation.
Crossrail	A project to provide new railway infrastructure to allow trains from London Paddington (and west thereof) to continue across London and through to the Anglia and South Eastern routes, and trains to make use of this infrastructure.
Crossrail Core	The tunnel constructed as part of the Crossrail project which starts at Royal Oak near London Paddington station.
Devolved Route	One of the ten organisations to which Network Rail has devolved the day-to-day running of Britain's railway infrastructure, to work more effectively with passenger and freight operators. Each route operates as a separate business unit with its own accounts allowing greater benchmarking of financial performance and efficiency between the routes and sharing of best practice. Each devolved route also has its own management team to operate, maintain and renew the infrastructure.
DfT	Department for Transport, a Government department.
Digital Railway	Digital Railway is a rail industry-wide programme designed to benefit Great Britain's economy by accelerating the digital-enablement of the railway.
DMU	Diesel Multiple Unit. A type pf train using internal diesel power source only.
Down line	Usually the line(s) carrying trains away from London.
East West Rail	A project to provide new and upgraded infrastructure between Oxford and Aylesbury in the west, and Milton Keynes and Bedford in the east, also to allow trains to run between Oxford and London Marylebone via the Chilterns.
EMU	Electric Multiple Unit. A type of train using an external electric power source which can be joined together to make longer trains.
ETCS	European Train Control System. A new signalling control and train protection system being installed widely across the Western Route.
ERTMS	European Rail Traffic Management System. A system for managing train movements using ETCS to signal trains and GSMR to communicate with trains.
ESG	Event Steering Group, a cross-industry working group to ensure the smooth transition to a new timetable for a defined event.
Freight delay measure	A metric for lateness of a freight train.
FOC	Freight Operating Company.
Gauge	Key dimensions of the railway which define the size of trains which can be accommodated. Track gauge is the distance between rails. Loading gauge is the width, height and shape of the trains which can be accommodated.

Term	Meaning
GDP	Gross Domestic Product. The monetary value of finished goods and services produced within a country or area in specific time period, usually a year. GDP is commonly used as an indicator of the economic health of an area.
Generalised Journey Time	A measure of the passenger rail service offer that takes account of in-vehicle time, service frequency and interchange penalty.
Grade Separation	Infrastructure which allows trains to pass over or under another route to avoid the timetable conflicts which would otherwise occur.
GRIP	"Governance for Railway Investment Projects", a Network Rail standard for project managing changes to the infrastructure.
GSM-R	Global System for Mobile communications – Railway. A particular standard for a radio system designed for communication between trains and control centres. See also ERTMS and ETCS.
GWML	Great Western Main Line.
High-peak hour	The busiest hour of the day for passenger arrivals or departures, taken as 8am-9am or 5pm-6pm at a destination station such as London Paddington.
HLOS	High Level Output Specification, the Government's statement of what it wishes to buy from the industry over a Control Period.
HST	High Speed Train. A train typically of 8-car length with two power cars, used on long distance passenger services, see also Rolling Stock Appendix B.
HS1	The High Speed link between St Pancras International and the Channel Tunnel.
HS2	The planned High Speed link between London, Birmingham, and beyond to Manchester and Leeds.
HS2 Phase 1	First phase of High Speed Two to provide a high speed line from London to Birmingham and the West Coast Main Line.
HS2 Phase 2	Second phase of HS2 to extend the High Speed Two Phase 1 network, which is proposed for the early 2030s. It includes a high speed line from Birmingham to Manchester and from Birmingham to the East Midlands, Sheffield and Leeds.
IEP	Intercity Express Programme. A series of linked projects to introduce new Super Express Trains (SETs), associated with depots infrastructure on the Western Route and elsewhere.
Indicative Cost	See AFC.
Inner suburban	Relating to trains or demand in the area near London served by trains which call at all or most stations.
Inter-regional	Relating to trains or demand which passes between regions.
Inter-urban	Relating to trains or demand which passes between built-up areas (but within regions).

Term	Meaning
IPG	Industry Planning Group, a cross-industry working group to: • iterate infrastructure design with train service outputs to optimise the investment • identify delivery phasing • finalise infrastructure capability to allow a project to move into delivery.
ITSS	Indicative Train Service Specification. A list of possible or proposed train services including key characteristics such as: • origin • destination • routeing • stopping pattern (full passenger trains).
ITSS 2019	Indicative Train Service Specification for 2019. This specification was used to form the baseline for the analysis carried out for the Western Route Study.
ITSS 2043	Indicative Train Service Specification for 2043. This specification was developed within the Western Route Study to meet all of the passenger connectivity and freight Conditional Outputs within and across the Western Route Study area. The specification is subject to feasibility, affordability and value for money.
ITSS Cross-Boundary	Indicative Train Service Specification, also for 2043, was developed for the whole country as part of the cross-boundary workstream to meet all of the passenger and freight Conditional Outputs which cross Route Study boundaries. The specification is subject to feasibility, affordability and value for money.
Jn (or Jcn)	Abbreviation for Junction.
LEP	Local Enterprise Partnership.
Load factor	The ratio of standard class passengers to standard class seats, on a train or averaged over a defined time period, at a given location.
LTPP	Long Term Planning Process, the programme of Market and Route Studies which together define the capacity and capability required of the Great Britain railway network over a 30-year time horizon.
LUL	London Underground Limited, the company which operates the 'tube' network, interfacing on the Western Route at Ealing Broadway and between Westbourne Park and London Paddington Stations.
Main Lines	Refers to the southern pair of tracks between London Paddington and Didcot generally used by trains which do not call at intermediate stations on this section and operate at higher average speeds than on the Relief Lines.
Market Study	One of four studies undertaken at the beginning of the Long Term Planning Process, to forecast demand and to articulate Conditional Outputs for the markets, namely London & South East, Long Distance, Regional Urban and Freight.
MML	Midland Main Line.

Term	Meaning
MOIRA	A piece of software used by train operating companies and others to forecast how demand and therefore revenue will be distributed between trains in a given timetable. For the purposes of the Route Study it has been used to estimate the number of passengers boarding or alighting at a station where data is unavailable.
mph	miles per hour.
National Operating Strategy	A Network Rail programme to centralise the control of signalling at a limited number of Route Operating Centres (ROCs) to reduce costs and to improve performance. The ROC for the Western route will be located at Didcot. See also Traffic Management.
NOS	See National Operating Strategy
NRDF	Network Rail Discretionary Fund, a mechanism for funding minor schemes that can either be linked to renewals or stand-alone schemes and have a positive whole-industry business case. It is primarily aimed at schemes that will result in an increase in the capacity or capability of the network.
NSIP	National Stations Improvement Programme, a series of projects to improve railway stations.
OLE	Overhead Line Electrification. A system to transfer power to trains using electric cables mounted above and along the tracks (also see Third Rail).
ORR	Office of Rail and Road, the safety and economic regulator for the rail industry in Great Britain.
Outer suburban	Relating to trains or demand beyond the inner suburban area but not long distance. For the Western Route this means the area between Reading, Oxford, Swindon and Newbury.
Peak period	The busiest hours of the day for passenger train loading, often defined as 7am to 10am,and 4pm to 7pm, at a particular location, for example London Paddington station.
Peninsula Regional Working Group	One of three Regional Working Groups for the Route Study covering Devon and Cornwall and extending as far east as Taunton.
Periodic Review	The process which establishes Network Rail's outputs and funding for the next Control Period.
Planning headways	The minimum time which can be used with in a timetable for one train to follow another. This is determined by the signalling system, signal spacing, linespeed and train braking characteristics.
Point Estimate	An estimate of the most likely cost of the project, package or element. It includes the 'Base Construction Works' (Direct Construction and Indirect Construction Costs), together with all Management (typically Network Rail), Design, Surveys and any Other Services and Works, and if applicable, any escalation and cost of work expended to date on the project. When the Risk component of an estimate is added, it then becomes a 'Proposal Estimate', (also known as the 'Anticipated Final Cost or AFC').
PPM	Punctuality Performance Measure, a metric of the proportion of trains which arrive within a defined time window starting at the scheduled arrival time.
RA	Route Availability, a measure of the ability of part of the railway to carry heavier trains.

Term	Meaning
RDG	Rail Delivery Group, a cross-industry body which exists to promote greater co-operation between train operators and Network Rail through leadership in the industry and by working together with Government, the supply chain and stakeholders.
Regional Working Group	A stakeholder group formed of representatives of local authorities with transport responsibities plus ports, airports and freight end-users.
Relief Lines	The northern pair of tracks between London Paddington and Didcot generally used by trains which call at intermediate stations on this section and operate at lower average speeds than on the Main Lines.
Resilience	The ability of the railway to continue to operate despite the impact of events such as severe weather.
RIPG	Rail Industry Planning Group, a cross-industry body which exists has as its purpose railway industry input into the structure and development of the national railway strategic planning processes. Its members are drawn from railway funders, operators and users.
Route Study	A piece of work to define the future required long-term capacity and capability of part of the network, taking into account the demand forecasts and relevant Conditional Outputs from the Market Studies.
Route Study Board	A body formed to steer development and approve publication of the Route Study composed of senior representatives from Network Rail, passenger and freight train operating companies, Department for Transport and Transport for London.
RUS	Route Utilisation Strategy, a report which considers the future development of the railway in a particular area (geographic RUS), or one aspect of its development in depth (Network RUS). Geographic RUSs are being superseded by Market Studies and Route Studies in the Long Term Planning Process.
Scope (of the Route Study)	As per the Western Route but with the exclusion of Oxford-Banbury, Oxford-Bicester, Worcester-Hereford/ Hartlebury/Bromsgrove, and the incorporation of Reading-Basingstoke and Exeter-Axminster.
SDO	Selective Door Operation, used where the whole of a passenger train does not fit into a station platform to allow passengers to board and alight safely.
SET	Super Express Train (see IEP).
SFN	Strategic Freight Network.
SFO	Station Facility Operator. The train operating company responsible for the operation and day-to-day maintenance of a particular railway station. For major stations including London Paddington, Reading and Bristol Temple Meads, this function is undertaken by Network Rail directly.
TEN-T	Trans-European Network – Transport, a strategy to develop a trans-European network in the transport sector, adopted by the European Parliament and the Council in 1996, to establish a 'master plan' connecting national networks of all transport modes.
TfL	Transport for London.

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