
# South West Main Line Strategic Study

# Phase 1

**2021**

# Network Rail

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# 1.0 Executive Summary

## Context

This SWML Strategic Study – Phase One has been undertaken between April 2020 and March 2021 to refresh the Main Line strategy between Woking and Waterloo, which originally formed part of the Wessex Route Study (2015). The study considers:

- The current capability of the network;
- Future passenger demand scenarios;
- A road map of interventions to increase capacity on the SWML to respond to future demand.

The train paths available on the Woking to Waterloo section of the SWML are full in the high-peak period when passenger crowding is most acute. This was reflected in the performance challenges of the 2019 peak timetable and levels of overcrowding. The current network capacity is predominantly driven by the current headways (c.2min), the flat junction at Woking and the need for trains making ECS moves out of Waterloo to share lines with Main Line trains going into Waterloo.

Relieving these capacity constraints is the key to releasing additional capacity in a resilient manner on the SWML. It will be vital to make sure additional services are introduced in a robust and resilient way to protect train performance. Strategic power supply enhancements will also need to be progressed in parallel to rectify current lack of resilience and support future train service uplifts.

## Key Findings

The Study used demand forecasting to assess the potential future morning high-peak train service requirement using a range of scenarios ranging from a pre-COVID forecast to a post-COVID low forecast. This is shown in the image below. This is set against the context of the global COVID-19 pandemic that has seen changes that encompass the way people work and travel. It is not possible to know when and to what extent passengers will return to the rail network which is why the Strategic Study outlines a range of future demand scenarios and goes on to set out a strategy or roadmap that can be adopted as required in future years.

Although the pandemic has unquestionably had a significant impact on rail demand, it should be remembered that the SWML was already considerably over capacity, with the resultant impact on performance, and even a long-term reduction in demand is very unlikely to negate the need for any future investment.

The Government has advised they are planning to deliver a once in a generation investment programme in infrastructure to support economic recovery. This supports the Prime Ministers' stated desire to make sure that the industry does not wait until pressure on current infrastructure becomes intolerable and supply once again is outstripped by demand for investment decisions to be made.

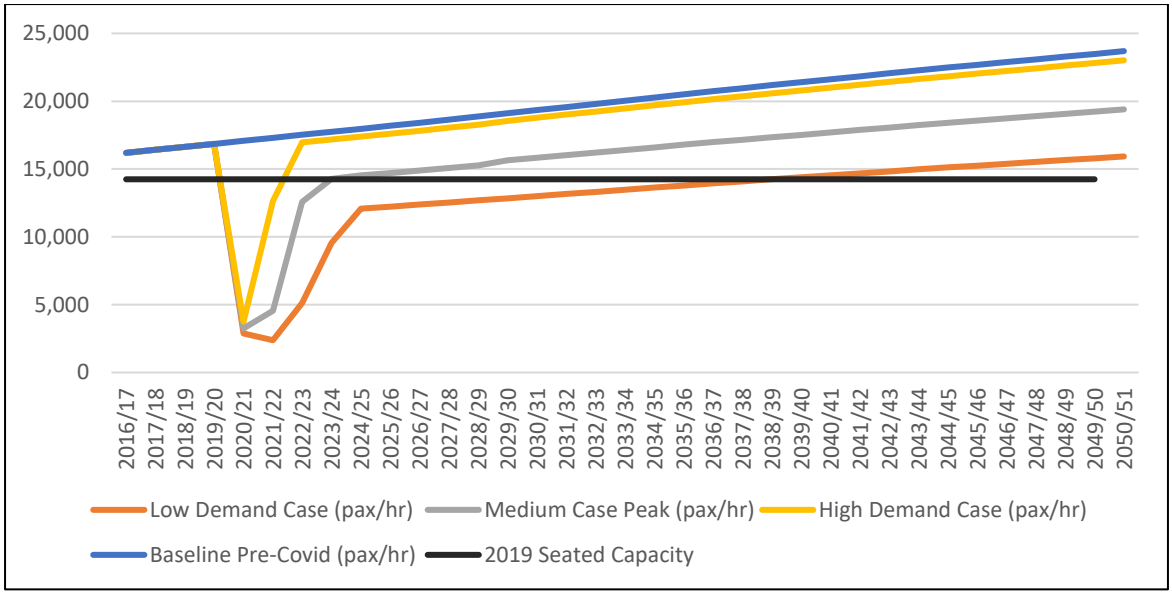


*Figure 1 - Passenger Demand Forecasts on the South West Main Line under different future scenarios*

The baseline, high and medium scenarios all forecast demand to be exceeding seated capacity by the mid-2020s. The Study has not identified any solutions that could be implemented in such a timescale to mitigate this. In the medium to long-term, several potential interventions to release additional capacity on the SWML in the high-peak hour have been identified, these are primarily as follows:

- Headway reduction to c.90s between Woking and Waterloo (potentially aligned with Wimbledon Re-signalling);
- Intervention at Queenstown Road (service change/additional platform/additional track) to separate out ECS moves;
- Woking Area Capacity Enhancement.

Modelling indicates that this set of interventions would release up to eight train paths on the SWML between Woking and Waterloo, allowing the additional services to be introduced over time as required. The Queenstown Road intervention could also be considered for delivery before the other two interventions to release performance/resilience benefits on the route.

To provide any additional train paths beyond the eight outlined above would require the delivery of further enhancements, such as Crossrail 2, together with re-modelling of Waterloo throat to provide additional performance and operational robustness by reducing conflicting moves.

The Study also developed a set of interventions to call peak Main Line services more flexibly at Clapham Junction. These could not be delivered in isolation and so will be further considered by the wider Clapham Junction Station Enhancement Portfolio as part of the Comprehensive Redevelopment concept.

1. Recommendations and Next Steps

The Strategic Study proposes the following recommendations and immediate next steps:

2. Quarterly reviews of SWML demand levels and how the return of passengers post-Covid is proceeding against the forecast range of scenarios – this is a key action for understanding when additional train services would be required to accommodate passenger demand and therefore when to look to implement the interventions described in the Study. It should be noted that enhancements of this type take several years to develop, design and deliver;

3. Progress a study on the feasibility, cost and timescales associated with achieving a c.90 second headway between Woking and London Waterloo and the potential interface with Wimbledon Re-signalling;
4. Progress a workstream looking at the Queenstown Road interventions and whether operational and performance benefits would warrant delivering the new platform as a first phase of work in advance of train paths being released by completion of the headway reduction and Woking Area Capacity Enhancement;
5. Progress strategic power supply interventions to support the future uplifts in train service outlined in the Study together with resilience for existing services
6. Pass the Clapham Junction interventions over to the Clapham Junction Programme for consideration as part of the wider workstream;
7. Undertake a second phase of this SWML Strategic Study looking at the outer area to identify where the additional future train services described in this first phase should operate beyond Woking and whether the network could accommodate them. This second phase will commence in April 2021.

# 2.0 Long-Term Planning Process

Network Rail's Long-Term Planning Process involves the development of Strategic Studies, previously known as Continuous Modular Strategic Plans (CMSPs) and encompasses the economic planning, transport planning and decision-making involved in the strategic development of the railway. The Strategic Study process aims to fulfil the following outcomes:

- Clear focus on customer needs, including those of both passengers and freight end-users;
- Improved engagement with train and freight operators as the representatives of these customers;
- Increased support for the needs of the devolved Regional businesses with Region- and Route-based plans;
- Shift from Control Period funding to a continuous enhancements pipeline.

The Strategic Study process sets out a method for narrowing the focus on particular areas with a set of clearly defined strategic questions, which is in contrast to the previous approach of large Route studies each aligned to Control Periods. This new continuous approach to planning allows these studies to be explored in more depth with a greater focus on working with stakeholders including Local Authorities, Local Enterprise Partnerships as well as Passenger and User Groups, to enhance local engagement and adopt a fully collaborative approach.

The Strategic Study process begins with identifying a specific strategic issue which requires further exploration, and, with the help of funders and stakeholders, this issue is defined and then developed through the formation of a Working Group. This group is consulted throughout the process and helps to formulate recommendations for solutions through a feedback loop of development, consultation and refinement.

When the topic has been looked at in depth and a strategy developed, details are published in a report or study document. This report provides the basis for Network Rail's strategy in the area covered by the Strategic Study and ensures informed conversations can be had with our funders in order to proceed with the most suitable course of action.

The work and outputs of one study may highlight additional strategic needs or issues which may need to be explored further, thus illustrating the continuous nature of the Strategic Study process.

## 2.1 Strategic Study Governance and Consultation

The South West Main Line Strategic Study required a two-tier working group structure to inform and facilitate the programme. The SWML Strategic Study Working Group was developed to oversee activities and provide feedback and guidance with input from consulted stakeholders. This Working Group included representation from Network Rail, South Western Railway and the Department for Transport.

Supporting and informing the main Working Group were three Sub-Groups, each tasked with specific areas of analysis

**Demand Sub-Group** focusing on current and future demand on the SWML to refresh baselines and understand how various growth forecasts could translate into additional service requirements.

**Timetabling and Capacity Sub-Group** modelling timetables and infrastructure interventions to test the capacity potential of the SWML and understand how future demand could be met.

**Headway Sub-Group** looking at what signalling solutions could benefit capacity and performance across the route.

Throughout the study, progress, findings and outputs were reported upwards to several groups with varying degrees of consultation required

**Route Strategy Planning Group (RSPG)** Strategic forum for Wessex Strategic Planning to engage with Wessex Route, wider Southern Region and other required departments within Network Rail for consultation, as well as for general progress reporting.

**Route Investment Review Group (RIRG)** Forum for Wessex Strategic Planning to engage and consult with rail industry partners including TOCs, FOCs and the Rail Delivery Group (RDG).

**Wessex Programme Board** As the final tier in the governance structure, the Programme Board receives progress reports throughout the Strategic Study process and is consulted where required. The Programme Board is chaired by the DfT and is the channel through which Network Rail brings schemes forward into the Railway Network Enhancement Pipeline (RNEP), such as those recommended by a Strategic Study. The publication of the final study report is also approved by the Programme Board.

**Wider Stakeholder Newsletters** Updates and emerging findings were communicated to rail industry and wider stakeholders such as Local Authorities, Local Enterprise Partnerships (LEPs) and Sub-National Transport Bodies via regular newsletters. This provided the opportunity for these wider stakeholders to input and feedback.

# 3.0 The South West Main Line Today

## 3.1 Introduction and Baseline

### 3.1.1 Geographic Scope

The South West Main Line (SWML) is the key rail artery within the Wessex Route which connects London with the south coast of England. Running from London Waterloo, the Main Line passes through the major commuting belt in South West London via Clapham Junction and Wimbledon towards Surbiton and Woking, at which point it splits into separate lines to Portsmouth Harbour and Weymouth.

On its route to the South coast, the Main Line serves several central hubs including Guildford, Basingstoke and Southampton and attracts flows from the counties of Surrey, Berkshire, Hampshire, Dorset, Somerset and Wiltshire, thus making it one of the busiest lines on the network.

Given the scale and complexity of the SWML, this Strategic Study will look to deliver outputs in stages to allow the strategic questions to be answered in an appropriate level of detail. At this stage, the SWML has been categorised into two distinct geographical areas which are defined by their relation to Woking.

This first phase of the SWML Strategic Study is predominantly focused on the line running between London Waterloo and Woking; the lines beyond Woking will only be considered in this phase for current capacity and demand requirements on the SWML as a whole.

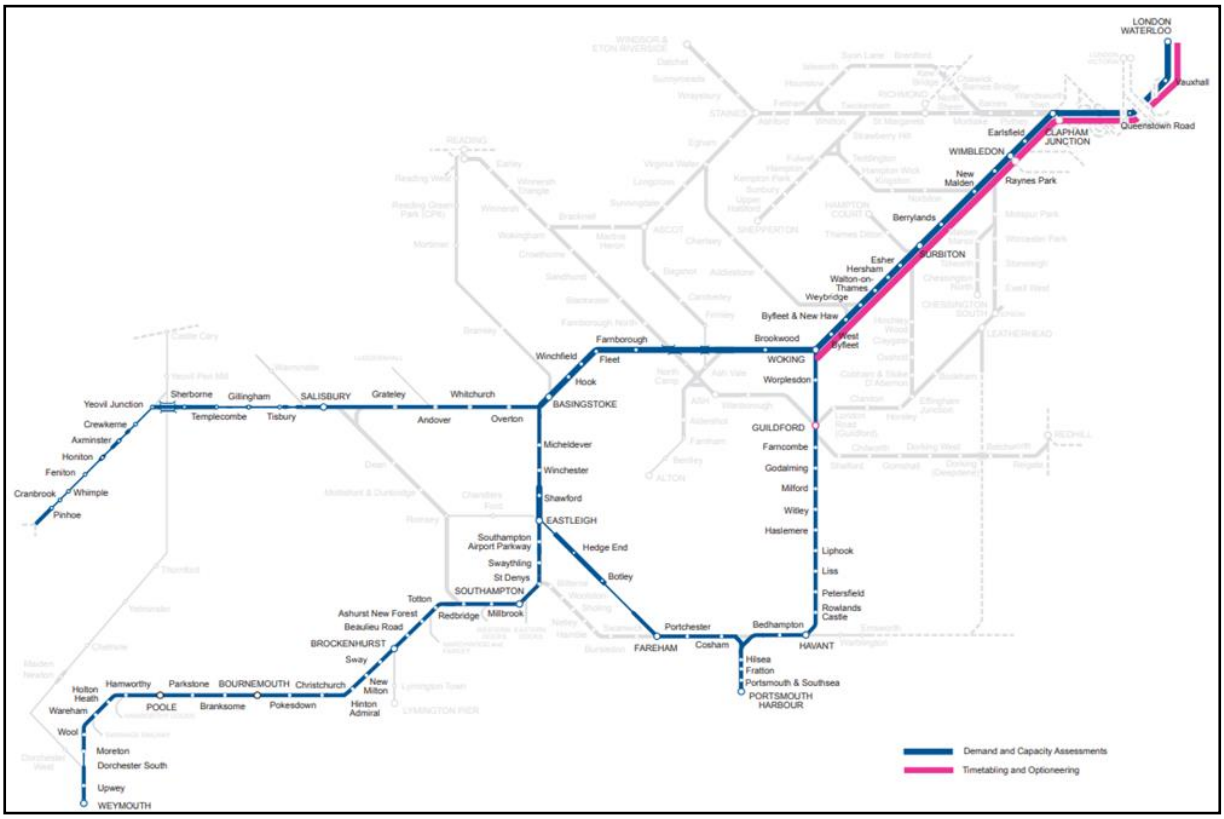


*Figure 2 - Map of the South West Main Line*

The line between London Waterloo and Woking covers an approximate distance of 24.5 miles with 15 stations in between. Between London Waterloo and Clapham Junction there are eight tracks which includes four Windsor lines, two Main Fast lines and two Main Slow lines, although this reduces to seven tracks between Nine Elms and Queenstown Road. From Clapham Junction to Woking, the main line consists of four tracks. r
This Strategic Study will primarily focus on the capacity of the Main Fast line as it accommodates Main Line services into and out of London Waterloo. However, where necessary, reference will be made to both the Main Slow lines and Windsor lines when considering opportunities for maximising the capacity and enhancing resilience across this inner section of the SWML.

### 3.1.2 Rolling Stock and Passenger Services

Services on the SWML are operated by South Western Railway (SWR) and the rolling stock used varies in class and formation, with notable differences in seat numbers and overall capacity as can be seen in Figure 1. The fleet is a combination of Diesel Multiple Units (DMUs) and Electric Multiple Units (EMUs). The majority of Main Line services are formed of Class 450 rolling stock which is reflected in the capacity analysis work, although the capacity differences between the various classes should be noted.

| Class | Unit Formation | No. First Class Seats | No. of Standard Seats | Total Seats | Overall Capacity |
|---|---|---|---|---|---|
| 159 | 9-car | 69 | 522 | 591 | 774 |
| 158/159 | 10-car | 72 | 572 | 644 | 850 |
| 442 | 10-car | 64 | 672 | 736 | 1022 |
| 444 | 10-car | 64 | 666 | 730 | 974 |
| 450 | 12-car | 48 | 792 | 840 | 1188 |

*Figure 3 - SWML rolling stock specifications*

At the time of this study, there are 25 Main Line services timetabled to arrive at London Waterloo between 0800 and 0859 Monday-Friday (the high-peak hour) which operate on the Main Fast line between Woking and London Waterloo. The timetable included 24tph up until May 2019, at which point an additional Havant service was added to bring the total up to 25tph. Alongside other issues, this extra service contributed to a decline in performance and so, although these are timetabled, poor operational performance may lead to service changes and cancellations. As a result of this, 24tph is used as the baseline for this analysis; though it should be noted that performance and reliability remain issues.

Although the Main Fast line predominantly sees the Main Line services run into London Waterloo, there are seven Main Suburban services which utilise the Main Fast line and run fast from Surbiton to London Waterloo. Therefore, the services operating on the SWML within the high peak include up to 18 Main Line and 7 Main Suburban. A breakdown of the services arriving into London Waterloo on the Main Fast Line within the AM high-peak and their service group can be found in Figure 4.

| Start Time | Origin | London Waterloo Arrival Time | Service Group |
|---|---|---|---|
| 0651 | Southampton Airport Parkway | 0802 | Main Line |
| 0706 | Basingstoke | 0804 | Main Line |
| 0640 | Havant | 0806 | Main Line |
| 0712 | Haslemere | 0808 | Main Line |
| 0716 | Guildford | 0810 | Main Suburban |
| 0541 | Yeovil Pen Mill | 0812 | Main Line |
| 0604 | Bournemouth | 0814 | Main Line |
| 0732 | Woking | 0818 | Main Suburban |
| 0714 | Alton | 0820 | Main Line |
| 0640 | Hilsea | 0822 | Main Line |
| 0746 | West Byfleet | 0824 | Main Suburban |
| 0724 | Basingstoke | 0827 | Main Line |
| 0640 | Portsmouth Harbour (via Cobham) | 0829 | Main Line |
| 0624 | Portsmouth Harbour (via Eastleigh) | 0832 | Main Line |
| 0747 | Woking | 0834 | Main Suburban |
| 0643 | Southampton Central | 0836 | Main Line |
| 0710 | Havant | 0839 | Main Line |
| 0802 | Woking | 0842 | Main Suburban |
| 0510 | Exeter St David's | 0844 | Main Line |
| 0634 | Bournemouth | 0848 | Main Line |
| 0744 | Alton | 0850 | Main Line |
| 0714 | Portsmouth Harbour | 0852 | Main Line |
| 0739 | Farnham | 0856 | Main Suburban |
| 0751 | Basingstoke | 0857 | Main Line |
| 0807 | Guildford | 0859 | Main Suburban |

*Figure 4 - Morning high-peak hour service specification in the Up Direction on the SWML*

It should be noted that fast services in the morning high-peak will usually have their last stop at, or before, Woking before terminating at London Waterloo, which carries a journey time of approximately 30 minutes. This is important when considering levels of standing across services as it is considered unacceptable to have passengers standing for any journeys that are longer than 20 minutes, according to guidance set out by the Department for Transport[1].

## Performance

Figure 5 shows a steady decline in performance for Main Line services operated by South Western Railway using the industry standard of Public Performance Measure (PPM) over the last several years. PPM is defined as the percentage of trains which arrive at their terminating station within five minutes of the scheduled arrival time, while also calling at all scheduled stops along its journey. The PPM Moving Annual Average (MAA) shows a continuous decline from the end of 2016/2017 to Period 9 of 2018/2019, at which point it begins to level off and even increases slightly but begins to show another dip towards the end of 2019/2020.

[1] Rail passenger numbers and crowding statistics: notes and definitions (publishing.service.gov.uk)

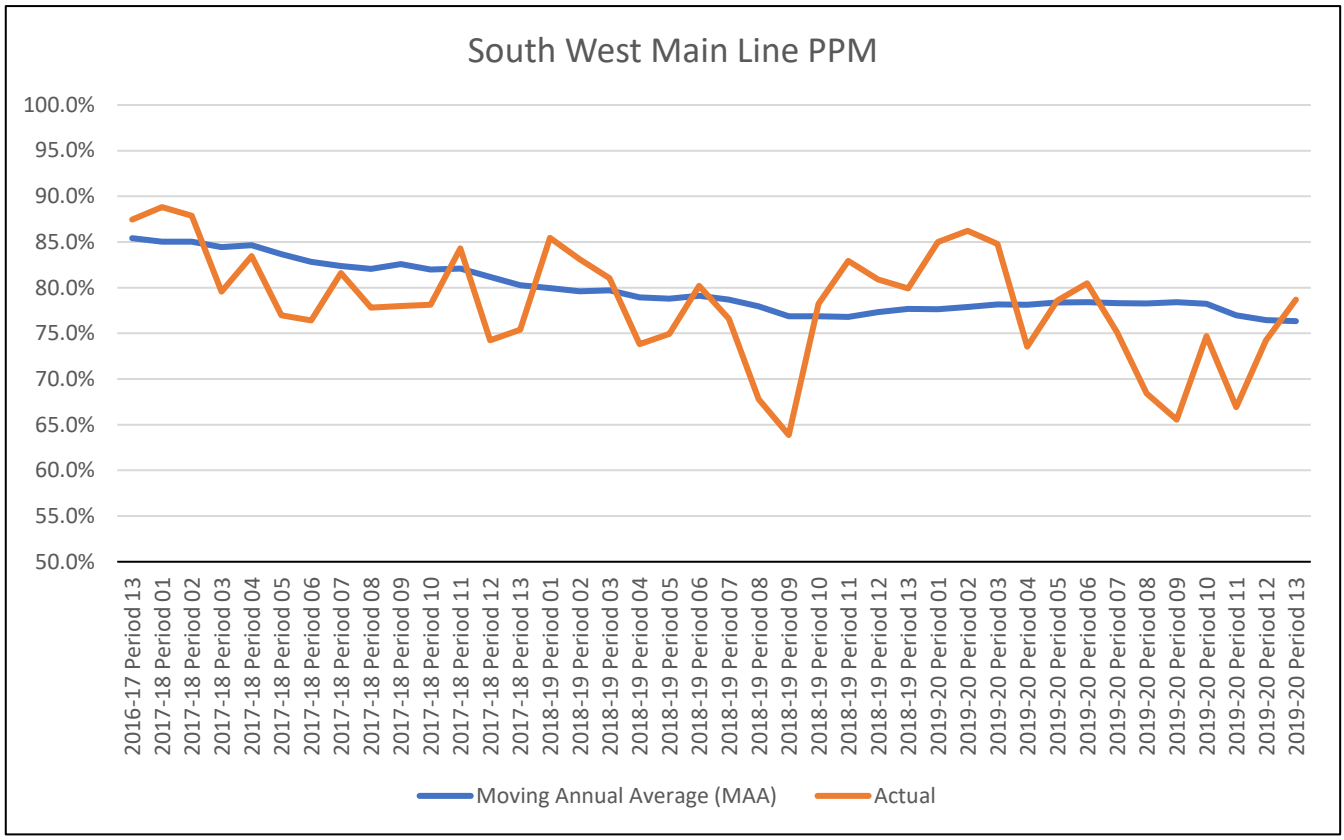


*Figure 5 - SWML PPM by Period*

In 2019 Network Rail undertook a study into resilience on the Wessex network which provided the basis for understanding the challenges of operating such a high capacity railway.. Alongside the constraints at Clapham Junction station, detailed in section 4.1.2, a number of challenges were also identified on the approach into London Waterloo. These included:

- The capacity for movement of Empty Coaching Stock (ECS) to Clapham Yard during the peak which can conflict with passenger services operating into and out of London Waterloo;
- The complications and inefficiencies of operations at the section of track crossings known as West Crossings which requires additional attention from inspections;
- The speed reduction at Carlisle Lane Junction necessary for services to utilise the Up Main Relief to access some of the platforms at London Waterloo;
- The signalling on the approach into London Waterloo can impact speeds reached by the arriving trains, meaning the linespeed benefit is not realised and results in negative operational impact within a very dense section of the SWML.

The operational challenges between Clapham Junction and London Waterloo, particularly in the London Waterloo throat, and the high numbers of services running in the high-peak mean there are currently few opportunities for embedding additional resilience into the network which could have performance and passenger benefits. Any intention to increase services into London Waterloo would require the layout and operation of this section of the SWML to be reviewed and changes made to offer the resilience that is needed. Even without additional services, the declining performance of the current timetable suggests that amendments already need to be made.

### 3.1.3 Freight Services

Figure 6 represents a typical day of services operating via Basingstoke, Woking and Clapham Junction and includes passenger services alongside freight and maintenance. It is worth noting that freight services using the SWML to access routes via Clapham Junction do so via Chertsey and the Windsor Lines and not via Weybridge and Surbiton.

This table demonstrates the significant differences between the types of services at these locations and highlights the limited freight operation along the SWML between Woking and London Waterloo in comparison to locations beyond Woking, such as Basingstoke.

No freight services operate during peak hours on the SWML. For this reason, freight consideration in the first phase of this Strategic Study is limited but will be factored into the analysis where appropriate. Figures have been taken from Wednesday 4th September 2019.

| | **Count by unique train ID** | | |
|---|---|---|---|
| **Location** / **Service Type** | Basingstoke | Woking | Clapham Junction (P1-11) |
| Ballast | 7 | 7 | 6 |
| FOC | 43 | 4 | 7 |
| TOC | 482 | 610 | 1651 |
| Yellow Plant | 1 | 4 | 0 |

*Figure 6 - Typical daily freight movements on the SWML (data taken from Wednesday 4th September 2019)*

In addition to the freight flows listed above the SWML also accommodates flows to the aggregates terminal at Tolworth which operate via Wimbledon and Raynes Park. There are also plans for a freight terminal at Chessington South.

### 3.1.4 Safety Baseline

A safety baseline assessment has been undertaken for the study area to identify any particular causes for concern which may need to be incorporated into recommended strategic plans. The process of safety baselining sourced 2019-2020 safety incident report data from the Train Running System (TRUST) and the Safety Management Intelligence System (SMIS), which was then analysed against a set of categories and compared with incident numbers across the entire Wessex Route, highlighting hotspots or where improvements could be made. The full detail of the safety baseline can be found in Appendix A which outlines each category of safety incidents that were analysed with a breakdown of locations where relevant.

Of note:

- London Waterloo and Clapham Junction were found to share 86 % of the slips, trips and falls reported on the SWML which would most likely be, at least in part, due to the large numbers of passengers moving through these stations;
- New Malden and Weybridge share 39 % of the total number of suicide incidents reported.

# 4.0 Strategic Context

## 4.1 Known Constraints and Issues

The SWML between Woking and London Waterloo is an extremely busy part of the network which is heavily constrained in some areas. The constraints set out below had already been identified prior to this study, however the capacity analysis undertaken further highlights and explores them as capacity blockers, with further detail found in the capacity analysis section.

### 4.1.1 Woking

Woking Junction is recognised as a significant constraint across the whole of the SWML and has previously been highlighted as an inhibitor to increasing capacity across the route. Services from Guildford and beyond join the SWML at Woking Junction which, owing to the flat nature of the junction, requires services towards London to cross both the SWML Down Fast and Slow Lines. Prior to this Strategic Study, the Woking Area Capacity Enhancement (WACE) scheme had identified the need to address this capacity constraint by grade separating Woking Junction to allow services from Guildford to join the SWML on their approach into Woking without the need to cross the Down Lines.

### 4.1.2 Clapham Junction

Clapham Junction is also a constraint on the Line. All services operating on the Up Main Fast Lines in the morning high peak towards London Waterloo pass through Clapham Junction without stopping, this maximises network capacity in the area. In addition to this, even if the operator should wish to accept a reduced throughput and call services at Clapham Junction in the high-peak hour - platform capacity, curvature and stepping distances mean this isn't possible in a safe and reliable manner.

### 4.1.3 Infrastructure

The number of services that currently operate on the SWML during the high peak push the infrastructure to be used near to its maximum recommended capacity for flows into London Waterloo. The combination of track availability, track layout and signalling capability of the SWML means the option to introduce additional services using the infrastructure currently in place is not feasible.

The operational impact of introducing additional services during the high peak is demonstrated when considering the 25th train that has been timetabled since May 2019 but not successfully operated due to the performance impact . The ability to operate additional services into London Waterloo with the necessary operational resilience integrated into the timetable is heavily constrained by the current infrastructure and this study has sought to identify what interventions are required to allow for an increase in capacity, as well as improvements to performance.

## 4.2 Current Main Line Strategy

The 2015 Wessex Route Study formulated strategic recommendations for enhancing both capacity and connectivity across the Wessex Route and used the Control Period 5 (CP5) baseline schemes already being undertaken to propose potential schemes for Control Period 6 (CP6) and beyond. The demand and capacity analysis sections of this work will re-baseline our forecasted

passenger growth and the required interventions to meet the future demand on the network. This will then allow our future strategy to be revisited and amended as appropriate.

The impact of the COVID-19 pandemic on passenger numbers and the economy is beginning to translate into variations in the current strategy, however it is important to recognise that growth on the railway is expected to begin again and our current and future strategy will need to prepare scenarios where passengers return to the railway in significant numbers once again.

### 4.2.1 Woking Area Capacity Enhancements

The Woking Area Capacity Enhancement (WACE) scheme seeks to resolve the network capacity issues at Woking which are known to prevent any future unlocking of capacity on the SWML, as well as improving the reliability of services operating through this area. The WACE scheme aims to deliver grade separation of Woking Junction to remove the need for Up services from Guildford to cross the Down Lines on their approach to Woking to join the SWML. This would reduce conflicting train movements at this junction, therefore benefitting operational performance and reliability as well as facilitating future uplifts in services on the inner section of the SWML.

The scope of WACE also includes the extension of Platform 6 at Woking station converting it from a largely unused bay platform to a through platform for down slow services. This provision of additional platform capacity at Woking station would provide opportunities to operate additional services and improve passenger connectivity, with the potential to reduce passenger congestion as a result.

Without the WACE scheme, other interventions to increase capacity both into London and out beyond Woking will struggle to realise any benefits and the scheme should be a key first step towards delivering capacity enhancements across the SWML.

WACE would also open up capacity for other potential future flows such as services from Surrey/Hampshire to Heathrow Airport should they be specified as part of the Southern Access to Heathrow scheme[2].

### 4.2.2 Digital Signalling

The 2015 Route Study outlined the opportunities for a digital signalling system such as European Train Control System (ETCS) to support additional Main Line services into London Waterloo. Implementing ETCS across the Wessex network, but particularly on the inner section of the SWML, could enable headways between consecutive trains to be reduced, allowing trains to run closer together and therefore increasing the number of services running on the network at any one time.

This approach would also provide opportunities to enhance the operational resilience of the existing timetable, providing the potential benefit of improved performance and ability to be more agile during times of perturbation. The switch from conventional signalling to digital signalling could unlock some Fast Line capacity into London, however this would need to be in conjunction with infrastructure interventions that would unlock flat junctions and support additional services from an operational perspective. Moving over to digital signalling also has significant implications on rolling stock as the whole fleet that operates over the line would need to be fitted with in-cab signalling equipment.

[2] Southern Access to Heathrow: strategic objectives - GOV.UK (www.gov.uk)

Reducing headways through means of digital signalling is explored in further detail as part of the capacity analysis workstream within this study.

### 4.2.3 Crossrail 2

Crossrail 2 is the proposed rail solution which would provide a cross-London link, from Hertfordshire to Surrey, offering improved connectivity, increased travel capacity and reduced journey times.

The importance of delivering Crossrail 2 cannot be overlooked when considering the current and future strategy of the SWML. As outlined in the Wessex Route Study, Crossrail 2 is a key facilitator to unlocking capacity into London by re-routing a portion of the Main Suburban services using the Main Slow lines into the Crossrail 2 tunnel planned at Wimbledon. By removing these services, the seven trains that currently cross from the Main Slow Line over to the Main Fast Line into London Waterloo can then operate on the Slow Line for the duration of their journey, therefore freeing up a significant number of paths for additional Main Fast Line services.

The Crossrail 2 project is currently paused and is prioritising safeguarding activity because of the funding agreement between Transport for London and the Government, set out towards the end of 2020. The uncertain financial climate and reduced rail passenger numbers mean there is currently no confirmed date for the project to restart, however it is still acknowledged that the scheme provides a significant range of benefits, including those for the SWML.

## 4.3 Government Policy and Initiatives

The way in which the rail industry changes and develops is largely directed through central Government policy. This policy guides and influences the strategic planning decisions that are made and is instrumental in taking forward recommendations such as those in this SWML Strategic Study.

There have been some central Government publications, released by Department for Transport (DfT), that have influenced this Strategic Study and are summarised below.

### 4.3.1 Connecting people a strategic vision for rail (2017)

This publication[3] sets out five objectives that form the Government's strategic vision for growing and improving the rail network and industry; these are:

- A more reliable railway;
- An expanded network;
- A better deal for passengers;
- A modern workforce;
- A productive and innovative sector.

**A more reliable railway** - The document recognises that many lines are intensively used, and that rail assets are ageing which in turn is putting service reliability at risk. As will be described later in this Strategic Study, the intense usage of the SWML to meet demand, particularly for travel into and out of London, and the resultant impact this has had on resilience and reliability of service is a key reason why this Strategic Study has been undertaken.

[3] A strategic vision for rail - GOV.UK (www.gov.uk)

**An expanded network** - It is noted in the document that there has been a surge in rail demand over the past 20 years that rail investment has not kept up with. To rebalance the economy and create more homes we also need to forge new links between places, spurring development and economic growth.

**A better deal for passengers** Putting the right controls and incentives on each part of the network to improve the customer experience on an increasingly busy railway is seen as key in providing a better railway for passengers and freight customers. This includes such initiatives as smart ticketing, increased Wi-Fi connectivity, community rail and implementing the Rail Freight Strategy[4].

**A modern workforce** Improving skills, diversity, training and development in the rail workforce, and enabling staff to share in the success of the railway.

**A productive and innovative sector** The acknowledgement that a productive, innovative rail industry is essential to deliver changes to the railway and for benefitting the UK economy overall.

The first two objectives that are described, above, were key drivers for the need to look at the Main Line service provided into London Waterloo as part of this Strategic Study. Addressing the implications of a surge in rail demand and the subsequent impact this has had on reliability are acknowledged by Network Rail as forming a key part of the vision for the railway in the Wessex Route and Southern Region.

The fifth objective around innovation is key in addressing the issues and constraints that are identified in this Strategic Study.

### 4.3.2 Decarbonising transport: setting the challenge (2020)

This document[5] sets out the how the Government will develop a plan to accelerate the decarbonisation of transport. The Transport Decarbonisation Plan (TDP) is due to be published in Spring 2021 and will outline what Government, business and society need to do to deliver the significant emissions reduction needed across all modes of transport, putting us on a pathway to achieving carbon budgets and net zero emissions across every single mode of transport by 2050.

[4] Rail Freight Strategy (publishing.service.gov.uk)
[5] Creating the transport decarbonisation plan - GOV.UK (www.gov.uk)


*Figure 7 - Six strategic priorities for the Transport Decarbonisation Plan*

Specifically, for public transport, the document states that accelerating modal shift to public and active transport is essential in meeting the decarbonisation challenge; the importance of making public transport and active travel the natural first choice for daily activities; supporting the move towards fewer car trips through a coherent, convenient and cost-effective public network; encourage cycling and walking for short journeys; and exploring how best to support the behaviour change required.

It also referenced that Network Rail was preparing a cross-industry Traction Decarbonisation Network Strategy (TDNS). The interim programme business case of the TDNS has now been published on the Network Rail website and is detailed in section 4.4.2.

This Governmental document reiterates the need for a reliable and efficient railway if the decarbonisation of transport is to be achieved. Addressing how best to encourage rail travel into

London Waterloo through the provision of a reliable service, that meets demand, provides an excellent customer experience and is operated with sustainability at its core is a key part of the vision for the Wessex Route and Southern Region network. This Strategic Study seeks to build upon these objectives.

### 4.3.3 National Infrastructure Strategy

The ongoing Covid-19 pandemic has brought major disruption to the UK economy during 2020 and 2021. In response to this and to coincide with the November 2020 Comprehensive Spending Review, the Government has published the National Infrastructure Strategy (NIS)[6].

Building on the work that was undertaken as part of the Industrial Strategy (2017), the NIS outlines the importance of infrastructure in underpinning economic growth and helping the UK to recover from the impact of Covid-19. The strategy describes how, through investment in infrastructure, the Government will:

- Boost growth and productivity across the whole of the UK
- Put the UK on the path to meeting its net-zero emissions target by 2050
- Support private investment
- Accelerate and improve delivery

## 4.4 Rail Industry Policy and Initiatives

### 4.4.1 Putting Passengers First (Network Rail)

In 2012 Network Rail instigated a transformation programme to move from a centralised organisation to one with devolved businesses operating within a national framework. Andrew Haines, chief executive, joined Network Rail in Summer 2018 and implemented a 100-day review of the organisation. The review looked at three main things:

- how to provide the best possible service for passengers and freight users;
- how to ensure we deliver the promises we've made for CP6;
- how to improve the way we work together and with the industry.

From this review the Putting Passengers First (PPF) programme[7] was initiated in February 2019 to change the way Network Rail works, including its culture and capabilities, and deliver structural changes.

Key to this transformation has been the devolution of Network Rail's Routes and Regions to align with political and economic geographies, ensuring that investment in UK railways meets the needs of local stakeholders and customers. This is shown in Figure 8 below.

[6] National Infrastructure Strategy - GOV.UK (www.gov.uk)
[7] Putting passengers first - Network Rail

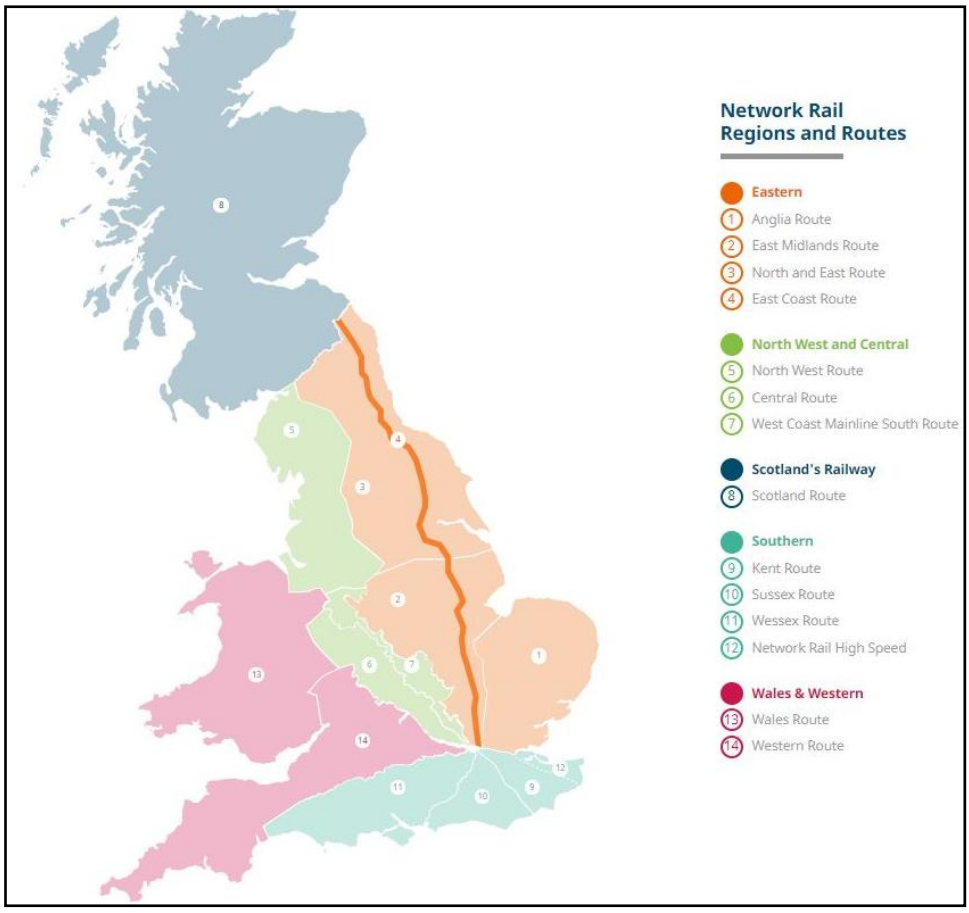


*Figure 8 -Network Rail Regions and Routes*

The Wessex Strategic Planning team has therefore been transferred from the central System Operator function into the Southern Region. This allows strategic planners to work more closely with Route/ Region based colleagues to understand the whole railway system and make the right decisions about the future of the Wessex network; whilst utilising our close working relationships with wider stakeholder, passenger and customer groups.

### 4.4.2 Traction Decarbonisation Network Strategy (Network Rail)

In response to the international Paris Climate Agreement in 2015, which saw global commitment to limit average temperature rise to well below 2˚C with aspirations to limit the rise to below 1.5˚C, the UK Government has legislated for the UK economy to achieve net-zero greenhouse gas emissions by 2050. This requires all sectors of the economy to act immediately along the 'road to zero'. Supplementary to this, then Rail Minister, Jo Johnson in 2018, identified an aspiration to remove all diesel only trains from the network by 2040. In response to this the rail industry convened the Decarbonisation Taskforce which concluded that this aspiration was possible for passenger services through deployment of trains powered by battery, electric or hydrogen but for freight, removal of diesel only trains required significant deployment of additional overhead line electrification. A brief timeline of these events is summarised below.

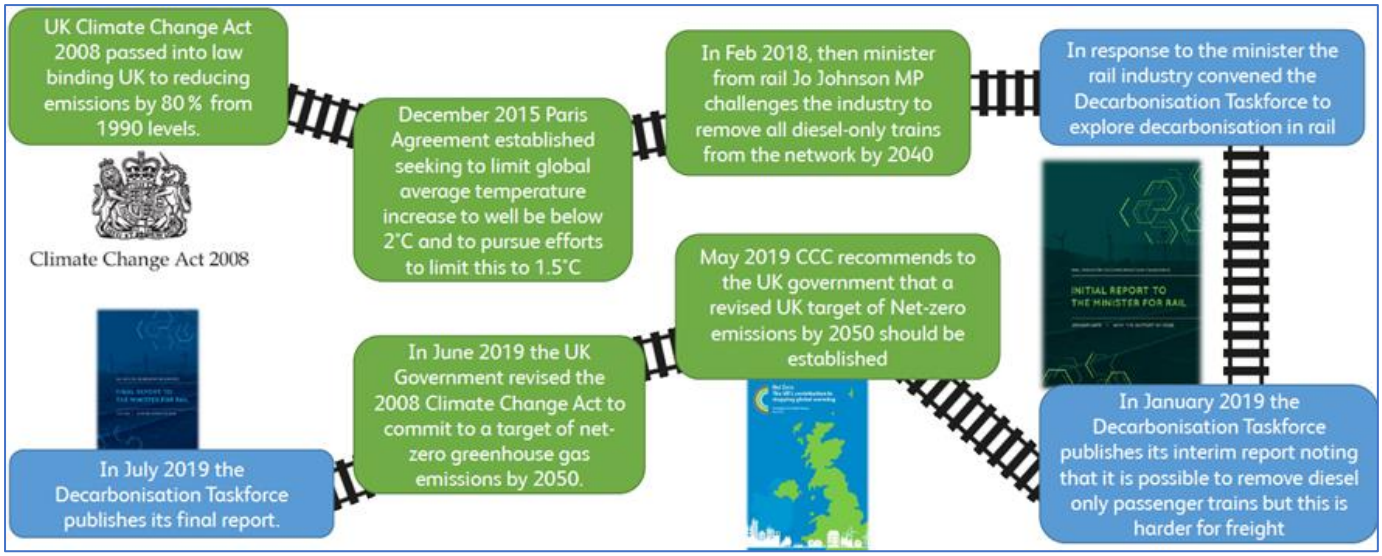


*Figure 9 - Summary of rail industry's response to decarbonisation agenda*

Network Rail, building on the work of the Decarbonisation Taskforce[8], has published the Traction Decarbonisation Network Strategy[9]. This work has determined the extent to which further electrification, battery technology and hydrogen technology could be deployed across the GB rail network to achieve zero emissions from rail traction. Overall, rail contributes around 3 $MtCO_2e$ per year (Mega tonnes of Carbon Dioxide equivalents per year). This represents a very small amount of the total UK emissions (less than 1 %) with rail being one of the lowest emitting transport modes in the UK (from a total transport emissions perspective).

Overall, due to the substantial third rail electrification found in the wider Southern region, the contribution to rail emissions from this region is relatively small. Nonetheless this remains an issue for this Strategic Study as the West of England line, from which services operate into London Waterloo, is one of the few Main Line railway routes into a London Terminal over which diesel rolling stock operates; this also leads to air quality issues within the station environment. Removal of diesel traction would assist in the Southern rail network in reducing its contribution to overall national emissions as well as providing a long-term solution to air quality improvements at London Waterloo as well as other stations along the route.

The rail industry's impact on air quality is examined in more detail in the RSSB's Air Quality Strategic Framework[10], published in 2020. It is based on a robust, risk-based approach to reducing air quality impacts. The framework details a series of recommendations based around three key themes:

- modelling: improving our ability to understand risks at a local level
- mitigating: ensuring appropriate and effective measures are taken to reduce emissions
- monitoring: establishing a programme to measure emissions and ensure improvements.

The industry has committed to reporting on progress on annual basis.

### 4.4.3 Environmental Sustainability Strategy 2020 – 2050 (Network Rail)

8 Decarbonisation (rssb.co.uk)
9 Traction Decarbonisation Network Strategy - Interim Programme Business Case (networkrail.co.uk)
10 Air Quality (rssb.co.uk)

This sustainability strategy[11] sets out Network Rail's vision to serve the UK with the cleanest, greenest mass transport. It seeks to put passengers first, help passengers and freight users to make green choices, support local communities and be a good neighbour. To deliver this vision the document identifies four core priorities:

1. A low-emission railway
2. A reliable railway service that is resilient to climate change
3. Improved biodiversity of plants and wildlife
4. Minimal waste and sustainable use of materials

Improvements to the rail service into London Waterloo, through the recommendations of this Strategic Study, will encourage the use of rail as a means of mass transport. Any future development of schemes associated with this Strategic Study will adhere to and promote these four core priorities.

### 4.4.4 The Williams Rail Review and Whole Industry Strategic Plan

The Williams Rail Review was established in September 2018 to look at the structure of the whole rail industry and the way passenger rail services are delivered. The review will make recommendations for reform that prioritise passengers' and taxpayers' interests.

The review was in its final stages at the outbreak of COVID-19 which has led to its publication being delayed. However, Government has expressed its' view that industry reforms are as important as ever. Following publication of the Williams Review, a White Paper with details on plans for rail reform will be published.

Subsequent to the commencement of the Williams Review, the DfT asked Network Rail to work with stakeholders to develop a 30-year rail strategy. The strategy, known as the Whole Industry Strategic Plan, will be a key mechanism that DfT / Ministers can use to ensure that the railways respond to public priorities such as levelling up, the environment, housing and regeneration.

The strategy will provide options and choices to the DfT / Ministers to make informed decisions about the balance of local and national objectives, shorter-term and longer-term goals, key investment decisions and strategic priorities.

The 30-year strategy will drive better value by informing the supply chain and partners in other planning and transport bodies about long-term priorities. The ambition is to implement a continuous process of long-term planning to respond to changes in government priorities, policy or other circumstances (e.g. demand for rail).

The strategy will respond explicitly to the priorities specified by the Secretary of State in the White Paper when published, but its overarching aims themes are:

- Aim to be in the context of **wider economic, social and environmental aims;**
- Provide a planning framework and **support delivery** of government objectives;
- Give short term decisions the **longer-term context** and confidence;
- Provide a framework for decision-making that takes account of **future uncertainties** (including longer-term trends as well as the shorter-term impacts of COVID-19);
- Enable decisions to be taken on a **whole industry view** of profit and loss so that changes for the overall good are not held up because of the effect on one organisation;
- Improve coordination with other modes, through **local integration**;
- **Encourage innovation** and private investment, including new technology to give better services to passengers and freight users and to improve efficiency.

11 Environmental sustainability strategy 2020-2050 (networkrail.co.uk)

Each Network Rail region is also developing their own Regional Strategy which will feed into the overarching network-wide WISP. Engagement with stakeholders is taking place on the emerging strategy throughout 2021 with an aim of having a complete draft document by the end of the year.

## 4.5 Other Relevant Policy

### 4.5.1 Transport Focus

To understand passengers' experience of making their journeys on the SWML, data has been presented from the National Rail Passenger Survey (NRPS)[12] which is carried out by Transport Focus and offers insight into drivers for change and levels of satisfaction across the network. South Western Railway's operations on the SWML fall into the category of long-distance services within London and the South East and the data from journeys made on these services are highlighted in the figures below.

Looking at the NRPS data is a way to view trends over time and understand where journey experience can be improved in the future. With the survey carried out in 'waves' which cover Spring or Autumn, it would be reasonable to expect differences between waves where external factors may play a part in passengers' perceptions of their journey, or there may be notable changes to the way the TOC operate which would have a direct impact on the NRPS scores.

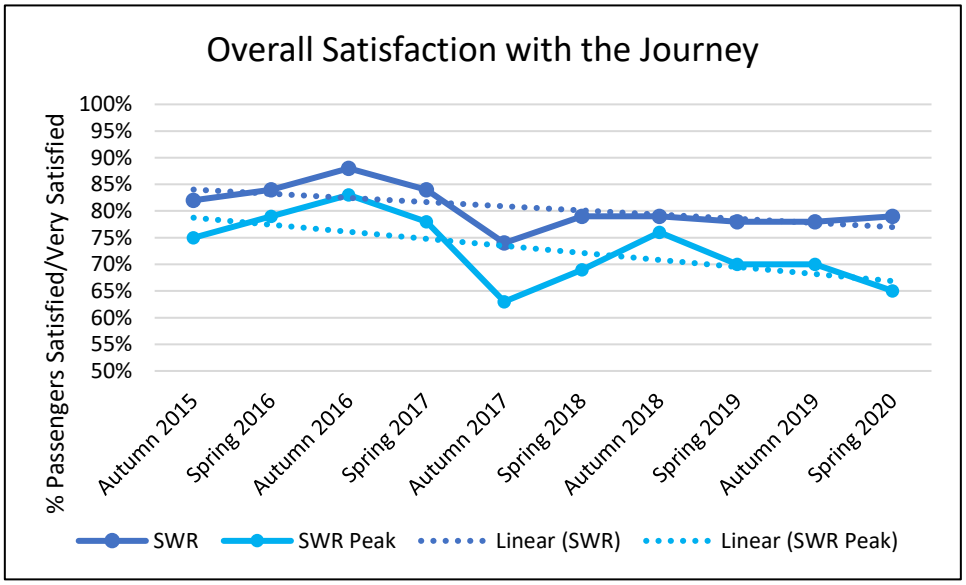


*Figure 10 - NRPS scores for passenger satisfaction on the SWML*

Figure 10 shows the NRPS scores for passengers' 'overall satisfaction with the journey' and includes the results for all journeys, as well as those taken in just the peak. The significant drop in satisfaction in the Autumn 2017 results can be attributed to generally poor operational performance, recognised by both SWR and Network Rail, with significant works at London Waterloo in August 2017 adding to the negative experience that passengers were facing on their journeys on the SWML. Figure 10 also shows a downward trend of satisfaction, with those passengers travelling during the peak hours consistently less satisfied with their journeys than those travelling outside of these times.

[12] National Rail Passenger Survey – NRPS – spring 2020 – main report and other documents - Transport Focus

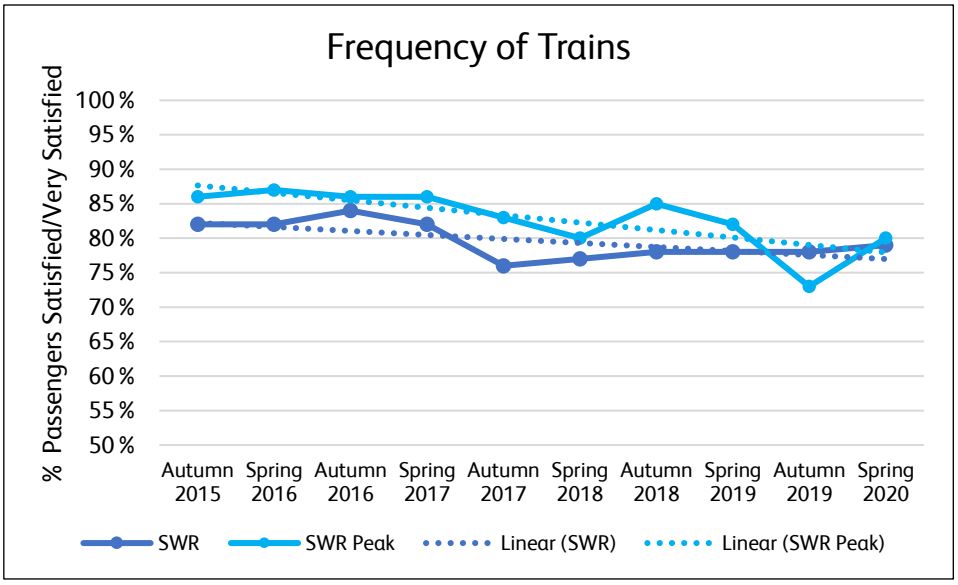


*Figure 11 - NRPS scores for train frequency on the SWML*

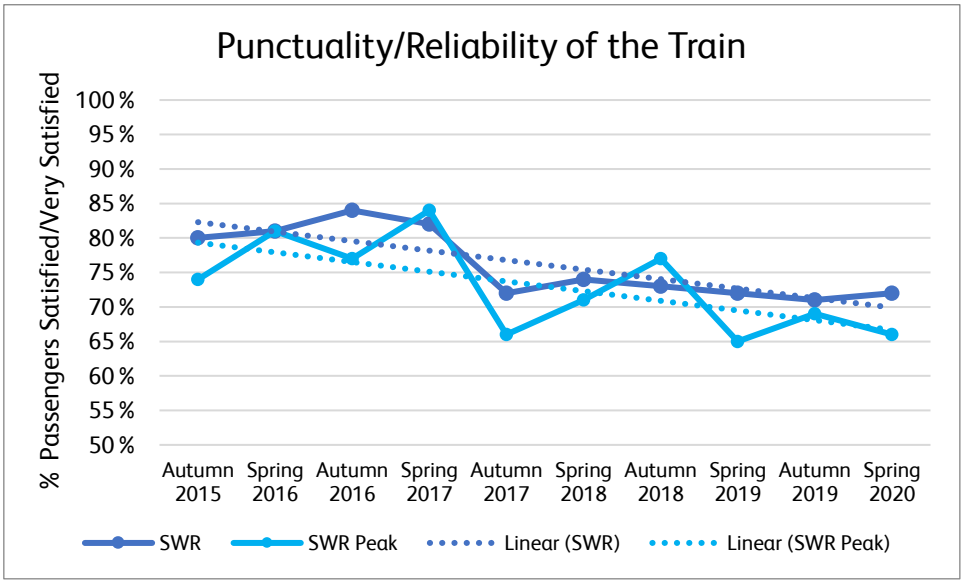


*Figure 12 - NRPS scores for punctuality/reliability of trains on the SWML*

Figures 11 and 12 show a downward trend for the frequency of trains and their punctuality, respectively, and can be considered a cause for concern moving forward. Passengers are reasonably satisfied with the frequency of their trains with peak-time passengers showing a higher satisfaction, which can be assumed to be due to the uplift in services during their time of travel. Although these figures are quite high in comparison to others in the London and South East area, the slow decrease in satisfaction could become quite noticeable over time and should not be ignored.

The levels of satisfaction with the punctuality of trains in figure 12can be seen to be much more erratic, particularly amongst peak-time passengers. The emphasis on punctuality and reliability would be expected to be greater for those passengers commuting, however with more services running during the peak and the higher risk of a greater operational impact should something not

go to plan, it is not surprising to see that this group of passengers are more sensitive to changes in performance and this is reflected in the NRPS results.

## 4.6 Strategic Questions

Based on the constraints identified so far in this document, the following strategic questions were agreed with the SWML Strategic Study Working Group

1. What is the capacity baseline for journeys to London Waterloo from the SWML , Portsmouth Direct, Alton Line and West of England Line – concentrating on the section inwards of Woking?
2. What is the current level of patronage and where is demand in excess of capacity?
3. What passenger growth is forecast for the travel flows into London Waterloo on the SWML, Portsmouth Direct, Alton Line and West of England Line to 2050?
4. What operational, timetable or rolling stock interventions could be implemented to help meet any shortfall in on-train capacity, if any?
5. Where are the service change constraints and what possible infrastructure interventions could be implemented between Woking and London Waterloo to help meet the capacity challenge?
6. Based on the workstreams undertaken on resilience by the Wessex Strategic Planning team and the Joint Performance Improvement Centre (JPIC), what are the opportunities to improve current performance resilience on the route whilst addressing the capacity challenge?

These strategic questions were agreed prior to the full emergence of the Covid-19 pandemic and therefore, subsequent to these six questions, an additional one has been included

7. What are the post-Covid passenger growth scenarios and what impact may they have on how passengers return to the railway following the pandemic?

This study has sought to answer these questions and therefore identify a strategy or road map to meeting the challenges identified.

# 5.0 South West Main Line - Demand

## 5.1 Introduction to section

This section focuses on the pre-COVID level of passenger demand on the SWML between Woking and London Waterloo and a range of scenarios for how this could change in the future.

The global COVID-19 pandemic is an unprecedented event in modern society that has seen changes that encompass the way people work and travel. It is not possible to know when and to what extent passengers will return to the rail network which is why this Strategic Study outlines a range of future demand scenarios and will go on to set out a strategy or roadmap that can be adopted as required in future years.

Although the pandemic has unquestionably had a significant impact on rail demand, it should be remembered that the SWML was already considerably over capacity, with the resultant impact on performance, and even a long-term reduction in demand is very unlikely to negate the need for any future investment.

Further to this, the Prime Minister has clearly stated that he expects passenger demand for transport to return as people return to offices, socialising and leisure activities and that rail has a key role in the Government's plan to Build Back Better following the COVID-19 pandemic.

The Government has advised they are planning to deliver a once in a generation investment programme in infrastructure to support economic recovery. This supports the Prime Ministers' stated desire to make sure that the industry does not wait until pressure on current infrastructure becomes intolerable and supply once again is outstripped by demand for investment decisions to be made.

## 5.2 Pre-COVID Baseline Demand

The SWML has long been one of the busiest routes on the GB rail network. Like most rail arteries into London, its busiest period is the morning high-peak hour (0800 – 0859) with commuters from Dorset, Hampshire, Somerset, Surrey and Wiltshire travelling to work. However, it also sees a significant amount of passenger traffic at weekends for leisure travel, throughout the day for business travel and supports a significant number of events such as those at Twickenham, Wimbledon and Ascot.

Department for Transport guidance states that nobody should have to stand for more than 20 minutes when travelling by train. However, SWML services already far exceed this as, on average, high-peak passengers stand from Woking, which is 30 minutes from London Waterloo, and Guildford which is around 40 minutes away. Furthermore, these average figures hide the fact that there are some services that see passengers standing from as far as Winchester and Haslemere, which are around an hour from London Waterloo, and even Andover which is 1hr15mins away.

Inwards of Woking, passengers experience crowding that sees them having to stand, with up to two passengers per square metre. This results in a very poor travel experience for passengers.

The following heat map shows how average on-train crowding builds up across the route on services arriving in London Waterloo in the baseline year over the high-peak hour.

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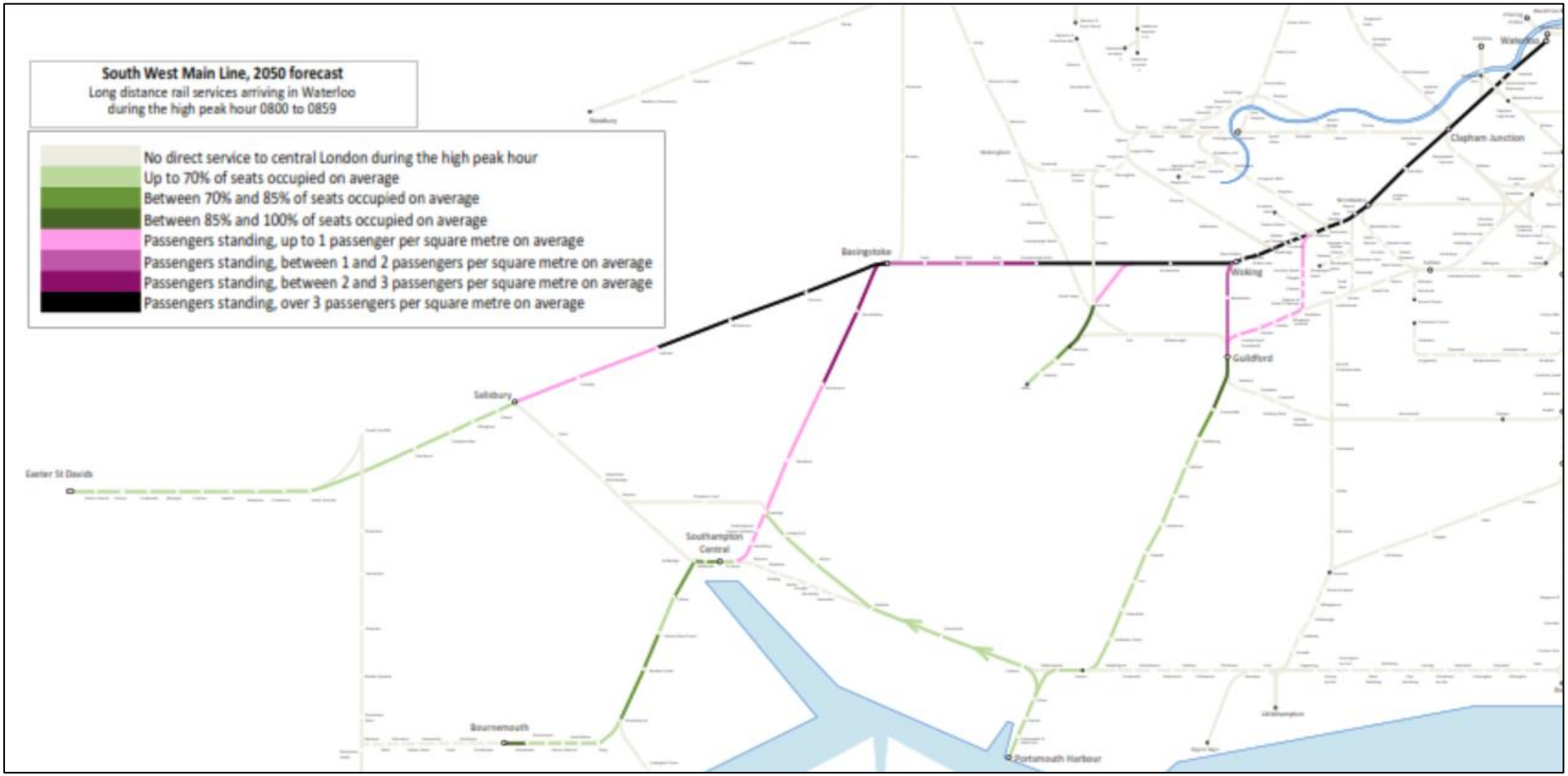


*Figure 13 - Average crowding build up on services arriving into London Waterloo in the high-peak hour*

## 5.3 Future Passenger Demand

As outlined above, we do not yet know when and in what form rail demand will return. Several factors will have an influence on this including:

- When social distancing and lockdown measures can be relaxed;
- The not yet fully understood long-term changes in working from home patterns;
- Potentially more flexible ticketing policies;
- People potentially relocating away from having to be within commuting distance of major cities;
- The impact of any economic recession and recovery.

This section will therefore outline a range of potential demand scenarios from a pre-COVID forecast to a post-COVID low forecast.

### 5.3.1 Pre-COVID forecast

Network Rail's pre-COVID forecast was developed as part of the London Rail Strategy, a piece of work presenting a unified forecast for capacity requirements into London in the morning high-peak hour, Appendix B provides a technical methodology as to how the forecasts were developed.

Growth in passenger demand on SWML services has been forecast to rise by 1.7 % per annum in the short term to 2026, falling to 0.9 % per annum in the long term to 2050. This is equivalent to an average of 1.2 % growth per annum between 2016 and 2050 and the following table shows the compound annual growth rate broken down by section.

| **Section** | **2016-2026** | **2026-2036** | **2036-2043** | **2043-2050** |
|---|---|---|---|---|
| Arrivals at London Waterloo | 1.7 % | 1.1 % | 1.0 % | 0.9 % |
| Arrivals at Woking from Basingstoke | 2.0 % | 1.5 % | 1.3 % | 1.2 % |
| Arrivals at Woking from Guildford | 2.2 % | 1.2 % | 0.9 % | 0.6 % |

*Figure 14 - Compound Annual Growth Rate by SWML section*

These growth rates result in the following increases in demand relative to the 2016 base data

| **Year** | **2026** | **2036** | **2043** | **2050** |
|---|---|---|---|---|
| % growth to 2016 | 13.6 % | 28.1 % | 37.5 % | 46.3 % |

*Figure 15 - Demand increases on the SWML based on 2016 base data*

This level of demand growth means that, for example, by 2036 average standing to London in the high-peak hour is forecast to be from as far as Winchester and Andover with some services experiencing standing from further afield. An additional 100 vehicles would be needed for there to be no standing under average conditions into Woking.

The following tables show the additional number of vehicles required to meet various crowding outcomes for passengers on the SWML route sections in the range of future years. As the last stop on the SWML in the morning peak is Woking (which is more than 20 minutes from London Waterloo) there should be no standing on services from this point and all passengers should have a seat.

| | 2026 Vehicle Requirements | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Expected outcome for passengers | < 85 per cent of seats occupied | 116 | 20 | 83 | 2 | 13 | 1 |
| | < 100 per cent of seats occupied | 68 | 8 | 54 | | 3 | |
| | < 1 standing passenger per square metre | 23 | | 28 | | | |
| | < 2 standing passenger per square metre | | | 10 | | | |

Figure 16 - 2026 Vehicle Requirements on the SWML

| | 2036 Vehicle Requirements | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Expected outcome for passengers | < 85 per cent of seats occupied | 160 | 30 | 112 | 9 | 27 | 5 |
| | < 100 per cent of seats occupied | 105 | 17 | 79 | 5 | 15 | |
| | < 1 standing passenger per square metre | 54 | 4 | 49 | 2 | 4 | |
| | < 2 standing passenger per square metre | 17 | | 27 | | | |

Figure 17 - 2036 Vehicle Requirements on the SWML

| | 2043 Vehicle Requirements | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Expected outcome for passengers | < 85 per cent of seats occupied | 189 | 36 | 133 | 15 | 36 | 7 |
| | < 100 per cent of seats occupied | 130 | 22 | 97 | 11 | 22 | 2 |
| | < 1 standing passenger per square metre | 74 | 8 | 63 | 7 | 10 | |
| | < 2 standing passenger per square metre | 34 | | 40 | 4 | 2 | |

Figure 18 - 2043 Vehicle Requirements on the SWML

| | 2050 Vehicle Requirements | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Expected outcome for passengers | < 85 per cent of seats occupied | 214 | 41 | 153 | 23 | 45 | 9 |
| | < 100 per cent of seats occupied | 152 | 26 | 114 | 17 | 30 | 4 |
| | < 1 standing passenger per square metre | 92 | 11 | 77 | 12 | 17 | |
| | < 2 standing passenger per square metre | 49 | | 52 | 9 | 7 | |

Figure 19 - 2050 Vehicle Requirements on the SWML

Without further intervention, by 2050, standing is forecast from Salisbury and Southampton (both c.90mins from London Waterloo). Passengers will be standing in conditions of up to two passengers per square metre from beyond Basingstoke and at more than three passengers per square metre under average conditions from Woking.

An additional 152 vehicles would be required for there to be no standing in average conditions from Woking, meaning a doubling of today's long distance train service in required in the long-term under the pre-COVID scenario.

### 5.3.2 Post COVID - High

The post COVID demand forecasts used in this Study were produced by Network Rail for the purpose of strategic planning.

The most optimistic post-COVID passenger demand forecast assumes vaccine rollout is largely complete by Spring 2021 allowing measures to be relaxed/removed and a rapid resolution to the COVID threat. It also assumes most people return to the office with only a small proportion choosing to remain working from home. This scenario would see less than a five percent negative impact on passenger demand from the pre-COVID forecast and patronage would return to pre-COVID levels in circa three years.

This therefore has minimal impact on the SWML capacity requirements, with additional vehicle requirements as follows to allow all forecast passengers to have a seat

| | Year | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Additional vehicles required (< 100 per cent of seats occupied) | 2026 | 60 | 6 | 50 | 0 | 2 | 0 |
| | 2036 | 97 | 15 | 74 | 4 | 13 | 0 |
| | 2043 | 120 | 20 | 91 | 10 | 20 | 2 |
| | 2050 | 141 | 23 | 108 | 16 | 28 | 3 |

*Figure 20 – Post-Covid high scenario vehicles required (less than 100% of seats occupied)*

### 5.3.3 Post-COVID – Medium

This scenario assumes the vaccine rollout is largely complete by Autumn 2021 and around a 25 per cent reduction in commuting and business travel due to an increase in working from home. It also assumes a similar reduction in leisure trips due to a long-term impact on the leisure, entertainment and hospitality industry. This scenario results in a circa 20% negative impact on pre-COVID demand and patronage would return to current levels in 15 – 20 years.

However, as the SWML is currently subject to such significant overcrowding, even a c.20% reduction in demand would still see the need for additional on-train capacity by the mid-2020s. This is demonstrated in the table below which outlines vehicle requirements for all passengers to have a seat in the Post-COVID medium scenario.

| | Year | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Additional vehicles required (< 100 per cent of seats occupied) | 2026 | 20 | 0 | 26 | 0 | 0 | 0 |
| | 2036 | 51 | 3 | 46 | 1 | 3 | 0 |
| | 2043 | 71 | 8 | 61 | 6 | 9 | 0 |
| | 2050 | 89 | 11 | 75 | 11 | 16 | 0 |

*Figure 21 - Post-Covid medium scenario vehicles required (less than 100% of seats occupied)*

### 5.3.4 Post-COVID - Low

The low scenario assumes the vaccine rollout is largely complete by Spring 2022 and 45 – 50% per cent reduction in commuting and business travel due to an increase in working from home. It also assumes a similar reduction in leisure trips due to a long-term impact on the leisure,

entertainment and hospitality industry. This scenario results in a circa 40 % negative impact on pre-COVID demand and patronage would return to pre-COVID levels in 35 – 40 years.

On the SWML this would mean additional capacity would be required by the mid-2030s, as demonstrated in the table below.

| | Year | Clapham Jn from Woking | Woking from Guildford | Woking from Basingstoke | Basingstoke from Salisbury | Basingstoke from Winchester | Alton Branch |
|---|---|---|---|---|---|---|---|
| Additional vehicles required (< 100 per cent of seats occupied) | 2026 | 0 | 0 | 2 | 0 | 0 | 0 |
| | 2036 | 6 | 0 | 19 | 0 | 0 | 0 |
| | 2043 | 22 | 0 | 31 | 2 | 0 | 0 |
| | 2050 | 37 | 0 | 43 | 6 | 3 | 0 |

*Figure 22 - Post-Covid low scenario vehicles required (less than 100% of seats occupied)*

Figure 23 shows the relationship between the pre-COVID forecast and the alternative scenarios as described above.

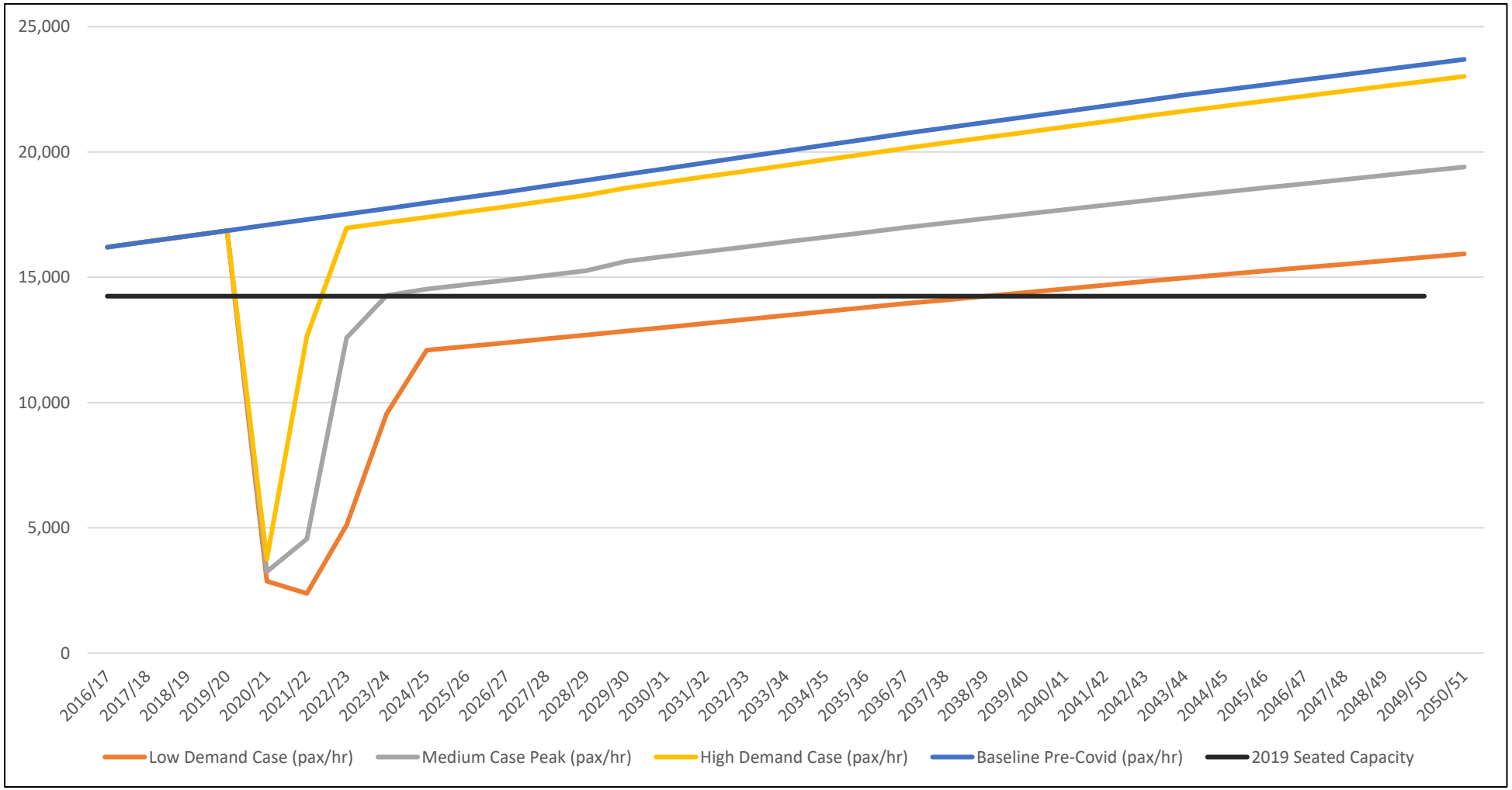


*Figure 23 - Forecast morning high-peak hour demand into London Waterloo under the four modelled scenarios*

The following section describes what level of train service would be required in future to meet the crowding guidance in each of these four scenarios.

## 5.4 Train service requirement

The following tables for the four demand scenarios assume the vehicle requirements as detailed in the demand analysis, above, for the purposes of informing the timetable analysis conducted for this Study.

These vehicles numbers have been converted into additional trains rather than there being any consideration of extending services beyond the current maximum length of 12-car 20m stock or 10-car 23m stock. This is because the Main Line network has been configured for this maximum length and extensive enhancement would be required at every station on the route as well as impacts on level crossings, linespeeds and power supply.

A 'train' is assumed to be a Class 450 Desiro service as operated by South Western Railway (SWR). These trains are made up of 4-car units and run at a maximum of 12-car length (3 x 4-car units). It should be noted that although the majority of the trains would be required to operate at full 12-car length some could be operated at a shorter length dependent on the number of vehicles required to meet demand.

As the geographic scope of this phase of the study extends only as far as Woking, the origin of the additional trains is not included in the specification of the quantum of trains. Further analysis of where these trains should originate beyond Woking (based on the demand analysis, above) will be addressed through phase two of the study as part of the 2021/22 programme of Wessex strategic studies.

### 5.4.1 Pre-COVID scenario

Figure 24 shows the number of additional trains required by timeframe for each of the expected passenger outcomes.

| Expected Outcome for Passengers | Across all Main Line Routes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | By 2026 | | By 2036 | | By 2043 | | By 2050 | |
| | Vehicles | Trains | Vehicles | Trains | Vehicles | Trains | Vehicles | Trains |
| <85 % of seats occupied | 116 | 10 | 160 | 15 | 189 | 16 | 214 | 20 |
| <100 % of seats occupied | 68 | 6 | 105 | 10 | 130 | 11 | 152 | 14 |
| <1 standing passenger per square metre | 28 | 3 | 54 | 6 | 74 | 7 | 92 | 9 |
| <2 standing passengers per square metre | 10 | 1 | 27 | 2 | 40 | 4 | 49 | 5 |

*Figure 24 - Required vehicles and trains by timeframe across all Main Line routes - pre-Covid scenario*

This means that by 2050 it is expected that to meet demand the following will be required:

- To enable up to 85 % of seats occupied there will need to be up to 20tph additional trains;
- To enable between 86 % and 100 % of seats occupied there will need to be up to 14tph additional trains;
- To enable up to one standing passenger per square metre there will need to be up to 9tph additional trains;
- To enable between one and two standing passengers per square metre there will need to be up to 4tph additional trains.

Worthy of note is the potentially high number of trains required to meet current overcrowding and growth to 2026:

- To enable up to 85 % of seats occupied there will need to be up to 10tph additional trains;
- To enable between 86 % and 100 % of seats occupied there will need to be up to 6tph additional trains;
- To enable up to one standing passenger per square metre there will need to be up to 3tph additional trains;
- To enable between one and two standing passengers per square metre there will need to be up to 1tph additional trains.

### 5.4.2 Post-COVID scenarios

Figure 25 shows the number of additional trains required by timeframe for each of the post-Covid scenarios, based on <100 % of seats occupied.

| Post-Covid Scenario | Across all Main Line Routes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | By 2026 | | By 2036 | | By 2043 | | By 2050 | |
| | Vehicles | Trains | Vehicles | Trains | Vehicles | Trains | Vehicles | Trains |
| High | 60 | 5 | 97 | 8 | 120 | 10 | 141 | 12 |
| Medium | 20 | 2 | 51 | 5 | 71 | 6 | 89 | 8 |
| Low | 2 | 1 | 6 | 1 | 22 | 2 | 37 | 3 |

*Figure 25 - Required vehicles and trains by timeframe across all Main Line routes – pre-Covid scenario*

This means that by 2050 it is expected that to meet post-Covid demand:

- For the 'High' post-Covid scenario there will need to be up to 12tph additional trains;
- For the 'Medium' post-Covid scenario there will need to be up to 8tph additional trains;
- For the 'Low' post-Covid scenario there will need to be up to 3tph additional trains.

The 'High' post-Covid scenario is reasonably comparable to the pre-COVID forecast, with a significant uplift in capacity required in the long-term and even by 2026.

The 'Medium' and 'Low' post-Covid scenarios show that additional trains are still required by 2026 and in the longer term, but the numbers are considerably lower than the pre-Covid scenario.

It is impossible to know which of these scenarios will prove most accurate and passenger demand levels will emerge in the coming years as life in the UK returns to one that is more familiar. For this reason, this strategy is a roadmap of operational and physical intervention options that would increase the capacity, performance and resilience of the SWML as desired by funders and industry colleagues in the coming years.

# 6.0 Capacity Analysis

## 6.1 Introduction

The Main Line demand analysis and subsequent train service specification, as detailed in Chapter 5, were used to inform a piece of capacity/ timetable analysis. This work was undertaken by WSP on behalf of Network Rail and was reviewed and assured by the Network Rail Capacity Analysis team.

For this analysis, the pre-Covid train service specification for 85 % of passengers having seats and no standing for more than 20 minutes has been chosen as the 'worst-case' scenario. This represents the most significant growth forecast, in terms of the number of additional trains, for the period to 2050. The up to 100 % of passengers having a seat scenario has also been assessed to show a comparison to what is achievable if a higher percentage of seats occupied is preferred.

Initial analysis was focussed on the Up direction (towards London Waterloo) in the morning high peak hour (arrivals between 0800 and 0859). This hour was chosen as pre-Covid it was the time of the day when there was the greatest demand concentrated into a relatively short time period. Subsequent to this, a further piece of analysis was undertaken to investigate the Down direction in the morning peak (the 'contra-peak') and the evening peak (departures from London Waterloo between 1700 and 1759).

The analysis has examined several current and potential future issues and opportunities, including:

- The theoretical maximum number of trains that could operate, robustly and resiliently, utilising existing signalling, track layout and rolling stock in both the morning high peak hour, contra-peak and evening high peak hour;
- The interaction between passenger services arriving at and departing from London Waterloo and Empty Coaching Stock (ECS) movements into and out of Clapham Yard. This is relevant for the morning high peak hour when a large number of trains are arriving at London Waterloo, not all of which need to form a subsequent passenger journey;
- Whether any form of digital signalling solution, such as ETCS (European Train Control System), would provide benefits in terms of allowing additional services to operate;
- What alterations to the track layout or infrastructure would allow an increase in capacity and/ or improvements in resilience and robustness of service in conjunction with a digital signalling capability intervention;
- The opportunity to understand what is required to enable Main Line services to call at Clapham Junction in the morning high peak hour and evening peak to inform the wider Clapham Junction enhancement programme;
- How the throat at London Waterloo could be modified to improve the operation of services in and out of platforms with the objective of any increase in service provision at London Waterloo being flexible and operationally robust.

The outcomes of the analysis are described in the following sections of this document. The analysis findings are focussed on the morning high peak hour (arrivals at London Waterloo between 0800 and 0859) and then as appropriate comment is made regarding any evening peak or contra-peak considerations that should be considered. Freight traffic has not been included in this analysis owing to the peak focus. Future development of any suggested infrastructure should consider the impact, if any, on freight flows.

Under each section, the current capability of the infrastructure is described, then the key findings are provided to show the full picture of what is required to enable the operation of the pre-Covid train service specification; this is then followed by a more in-depth description of each of the key findings as appropriate.

## 6.2 The Analysis

### 6.2.1 Analysis of current network capability

Analysis was undertaken to understand how the current (pre-Covid) level of service is operated with a view to understanding the full potential capability of the infrastructure and to consolidate our understanding of the constraints to growth. Figure 26 shows how the level of service included in the baseline timetable actually operates in the high peak hour and where the trains join the Up Fast (UF) into London Waterloo.

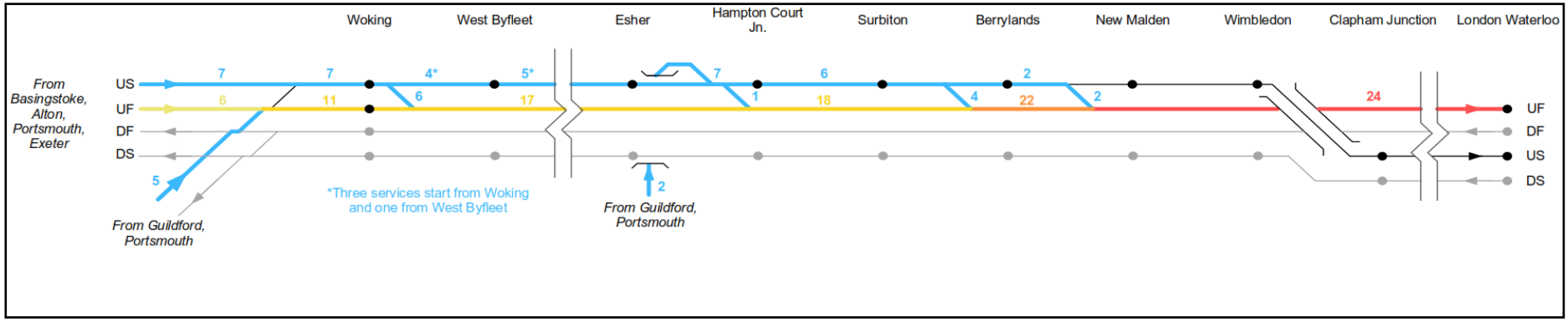


*Figure 26 - current operation of Main Line services in the morning high peak hour*

Points to note, include

- The 24tph is made up of the following, based on the Working Timetable (WTT):
  - 17tph long distance 'Main Line' services that run over the UF from Woking;
  - 7tph Main Suburban services that are made up of 1tph starting at Farnham; 3tph starting at Woking; 1tph starting at West Byfleet; and 2tph starting at Guildford. All these trains join the UF between Hampton Court Junction and New Malden, running 'fast' from Surbiton.
- When planning the timetable for these 24 trains, a two-minute (120s) headway between consecutive trains on the route is used. This means that there must be a minimum of two minutes between consecutive trains to permit a second train to proceed at line speed, unimpeded by the first when running on time. This equates to a capacity utilisation of 80 % (based on a two-minute planning headway giving a theoretical maximum capability of 30tph assuming that the current signalling can support trains running at this headway);
- When modelling network capacity, the maximum utilisation for peak time Main Line services is advised to be 85 %[13] to allow some buffer to deliver a resilient timetable. So theoretically, an additional one to two trains could be pathed on this route (therefore 25-26tph). However, this

[13] UIC 406.pdf

does not take account of how robustly the technical capability of the infrastructure, including the signalling, can support the current two-minute planning headway;

- The operation of 24tph on the UF from New Malden already faces consistent performance issues owing, in part, to the ability of the services to adhere to the 120s headways that they are planned against (this is explored below), this is also the case at times of minor perturbation when a small incident or loss of time is multiplied owing, in part, to these constraints

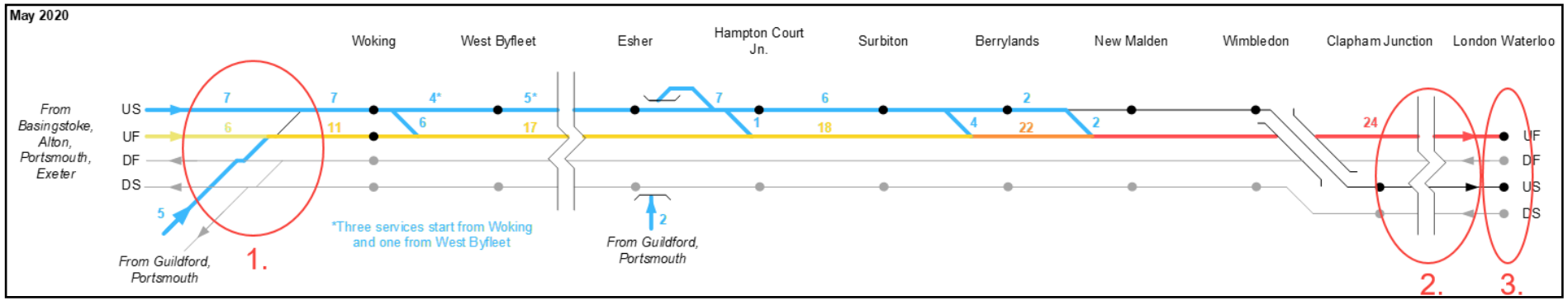


*Figure 27 - Areas that constrain Main Line capacity*

In addition to the plain line headway, there are a number of issues that prevent the existing Main Line capacity being fully utilised and operated robustly and resiliently:

- Woking Junction limits the operation of Main Line services from Guildford and Basingstoke and the ability to optimise use of plain line capability between Woking and Waterloo;
- Extended technical headways that import greater risk to achieving the required 2-minute planning headway between Clapham Junction and London Waterloo;
- A lack of track capacity through Queenstown Road for Empty Coaching Stock (ECS) to Clapham Yard;
- A highly constrained throat layout at London Waterloo which impacts service reliability and

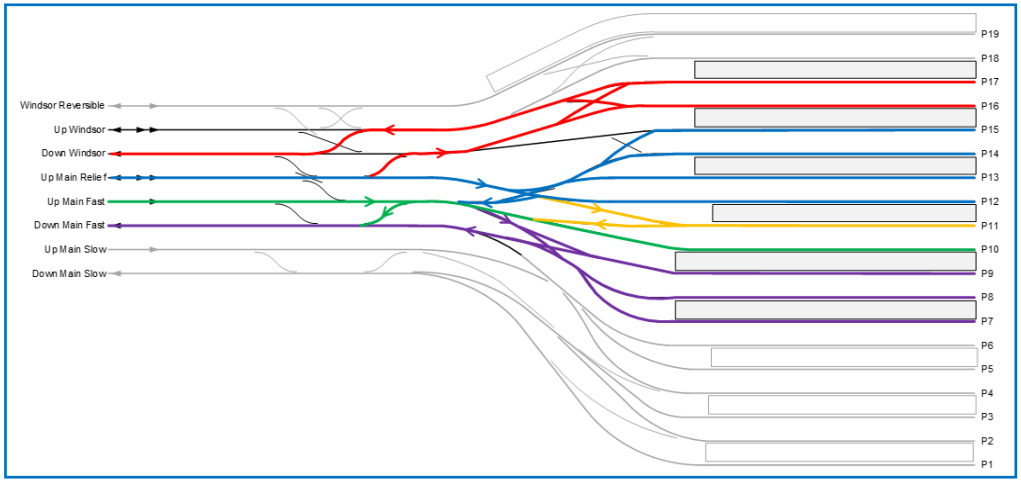


*Figure 28 - Diagram of the London Waterloo throat layout*

resilience because of low speeds with limitations on available parallel moves.

The above diagram of the London Waterloo throat layout shows how the operation of trains into and out of adjacent platforms (parallel moves) is not possible in some cases; this is shown clearly when looking at platforms 7, 8 and 9 (the lines in purple) where there is a single track that is used to access all platforms. Some parallel moves are only possible when the arriving train arrives on the Up Main Relief and the departing train departs via the Up Main fast and on to the Down Main Fast (e.g. Platform 11/12).

Figure 29 shows the conflict between Main Line services leaving London Waterloo from high numbered platforms and Main Line services arriving via the Up Fast line. It is worth noting that even if the number of parallel moves provided were improved, the inherently flat layout means that some conflicts are still inevitable.

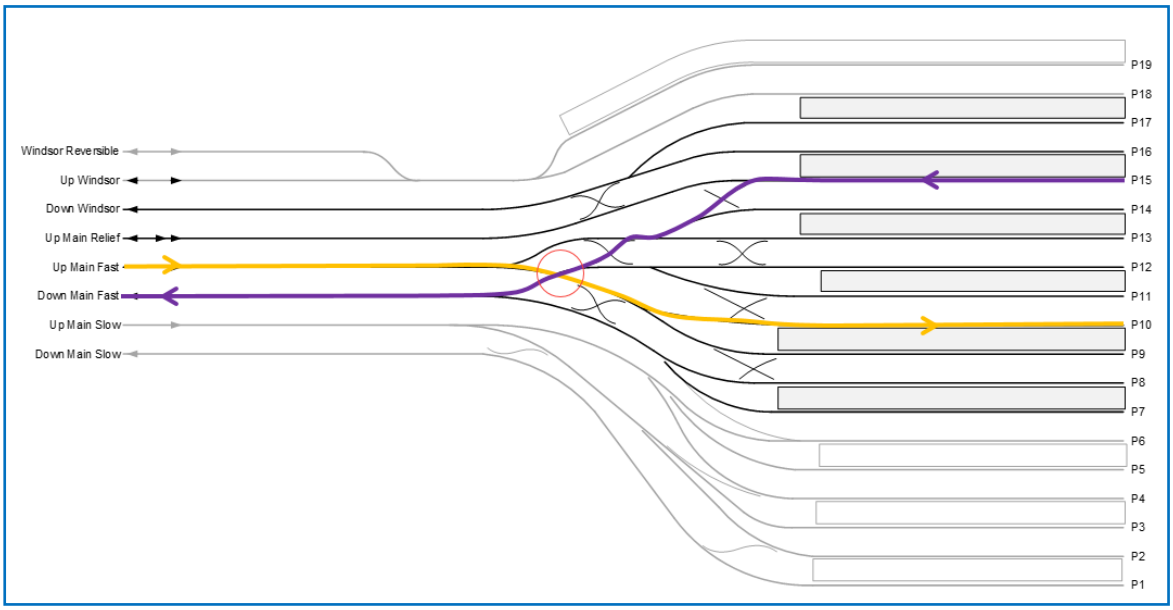


*Figure 29 – Principle of conflicting moves between Main Line services in the London Waterloo throat based on an idealised layout*

It is the need for trains departing the high numbered platforms to cross the Up Fast line at grade (on the flat) that eventually caps the total capacity of arrivals in the high peak at London Waterloo to 32tph, regardless of what headway capability is provided. Therefore, this would require the headway constraints, previously mentioned, to have been resolved as well.

### 6.2.2 Previous Analysis – Woking Area Capacity Enhancement (WACE)

Analysis has been carried out previously through the Wessex Route Study and the subsequent development of the Woking Area Capacity Enhancement (WACE) scheme to understand the impact that grade separation would have on Main Line services into London Waterloo.

From this previous analysis it is clear that Woking Junction cannot accommodate any future growth in service in a robust and resilient way. It is worth noting that a current high-peak Portsmouth Harbour to London Waterloo service is already routed via Cobham rather than Woking owing to this constraint.

The WACE scheme would grade separate Woking Junction through the installation of a flyover to 'lift' trains from the direction of Guildford over the SWML, thereby allowing trains to continue to run beneath. The scheme would also deliver an additional platform at Woking to enable future additional services to call there.

These interventions would provide both additional capacity through the junction during the peak to meet demand into London Waterloo but would also improve capacity and performance through the junction for services towards locations such as Southampton and Portsmouth. The need for capacity and flexibility through Woking Junction is important for resilience and performance as well as for both the services levels that operated pre-Covid and for emerging post-Covid travel patterns and demand.

This study assumes that WACE is an essential part of the emerging strategic advice for the Main Line and therefore all additional services identified through this study are assumed to be able to operate through Woking Junction to locations beyond Woking. It also removes a significant timetabling constraint from the Wessex network, benefiting future timetabling flexibility.

### 6.2.3 Previous Analysis – Crossrail 2

Analysis has been carried out previously through the Wessex Route Study and the subsequent development of Crossrail 2 to understand the impact the scheme would have on Main Line services into London Waterloo.

The benefits and impacts of Crossrail 2 include:

- Increased capacity from suburban locations on Wessex network into central London;
- Direct connectivity into central London via the tunnel portal at Wimbledon;
- Additional capacity released on the Fast lines for Main Line demand;
- A residual service would still be maintained from some Crossrail 2 destinations into London Waterloo;
- Changes to passenger movements and station congestion at specific locations such as Clapham Junction and London Waterloo.

The key impact/ benefit of Crossrail 2 for this study is the release of additional capacity on the Fast lines. Crossrail 2 services will make use of a new, outer, pair of tracks between New Malden and the tunnel portal at Wimbledon, thus freeing up existing Slow Line capacity for use by some services that currently run on the Fast Lines throughout.

This enables the seven main suburban services that use the Up Fast line in the morning high peak and run fast from Surbiton to be transferred on to the Up Slow line thereby freeing up seven train paths on the Up Fast line that could be used for Main Line services from Woking or beyond.

Similarly to WACE, described above, Crossrail 2 is considered to be an essential part of future strategy for the Main Line; this is reflected in the train service scenarios tested through the analysis and described below.

### 6.2.4 Train Service Scenarios

Based on the pre-Covid train service specification, described in section 5.4 of this document, the following scenarios have been tested through the analysis. An up to 85 % seat occupation scenario has been tested as the worst-case scenario; this means that each vehicle has up to 85 % of its seats occupied and there is therefore room for additional passengers to be accommodated if required. It also means that as each train is not full, more trains are required to spread the passenger demand. This may be an important scenario in a post-Covid environment where passengers may want more room within each vehicle.

As Crossrail 2 would fundamentally change the number of Main Line trains that could operate (the +7tph mentioned above), both a 'with' and a 'without' Crossrail 2 scenario have been considered. This allows us to understand what the impact would be if Crossrail 2 were not implemented.

A scenario has been examined looking at what effect increasing the seat occupation requirement to up to 100 %, and therefore having no spare seating capacity in each vehicle, would have on the ability to path the resultant train service. Looking at a 100 % of seats occupied scenario means that the trains are fuller and therefore less additional services are required to meet demand. From a planning perspective the 100 % seats occupied scenario is the level of service that would usually be planned for.

1. **2050 train service specification with <85% seats occupied**
   This scenario equates to the base service level of 24tph plus an additional 20tph. This scenario therefore seeks to operate 44tph into London Waterloo in the high peak hour on the Up Fast line. As Crossrail 2 is not assumed to be part of this scenario, the +7tph Main Suburban services remain on the Fast line

2. **2050 train service specification with <85% seats occupied assuming Crossrail 2 implementation**
   This scenario equates to the base service level of 24tph plus an additional 20tph, but minus the 7tph Main Suburban that can be transferred off the Up Fast line if Crossrail 2 is implemented. This scenario therefore seeks to operate 37tph into London Waterloo in the high peak hour on the Up Fast line.

3. **2050 train service specification with <100% seats occupied assuming Crossrail 2 implementation**
   This scenario equates to the base service level of 24tph plus an additional 14tph, but minus the 7tph main suburban that can be transferred off the Up Fast line if Crossrail 2 is implemented. This scenario therefore seeks to operate 31tph into London Waterloo in the high peak hour on the Up Fast line.

The following diagrams show how these scenarios might operate and where the constraints already highlighted through the current capability analysis will impact that operation.

### *2050 train service specification with <85% seats occupied*

This scenario does not assume the implementation of Crossrail 2 and therefore all 24 of the services included in the baseline timetable operate into London Waterloo on the Up Fast (UF) line as today. Therefore, 17tph Main Line services, 7tph main suburban services and the required 20tph additional Main Line services must all be accommodated on the UF line into London Waterloo (equating to a total of 44tph). Owing to the ultimate capacity at London Waterloo being 32tph the diagram shows that 12tph cannot be accommodated at the station. Even if London Waterloo could accommodate more than 32 fast lines trains per hour (through grade separation, as described later in this document), the number of trains required on the corridor between Woking and London Waterloo is not achievable using current signalling and headway capability.

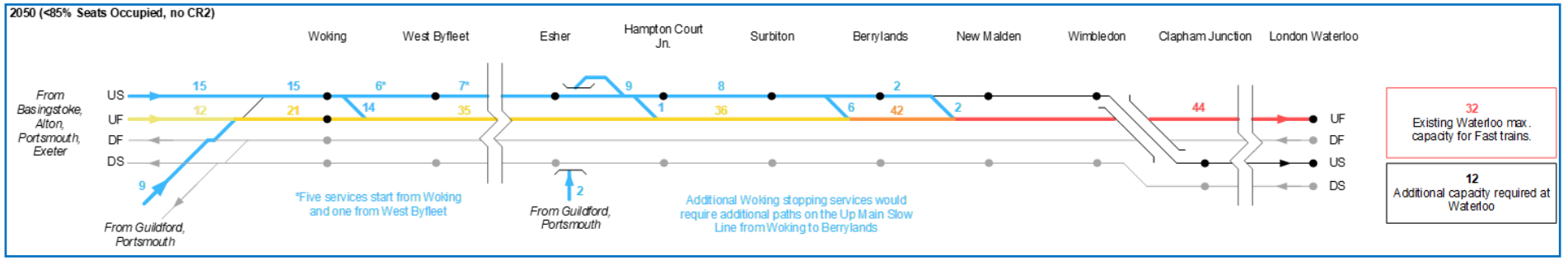


*Figure 30 - Operation of a 2050 44tph service train service specification*

### *2050 train service specification with <85% seats occupied assuming Crossrail 2 implementation*

This scenario assumes the implementation of Crossrail 2 and therefore it is assumed that the 17tph Main Line services included in the baseline timetable operate into London Waterloo on the Up Fast (UF) line and the 7tph main suburban services are displaced on to the Up Slow (US) line. Therefore, 17tph Main Line services and 20tph additional Main Line services must all be accommodated on the UF line into London Waterloo (equating to 37tph). Owing to the ultimate capacity at London Waterloo being 32tph the diagram shows that 5tph cannot be accommodated at the station without grade separation, as described later in this document. The number of trains required on the corridor between Woking and London Waterloo is not achievable using current signalling and headway capability.

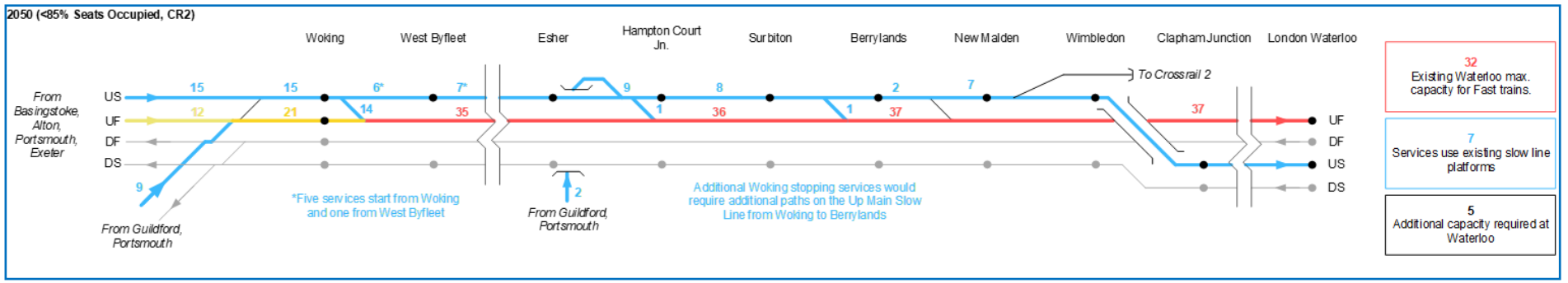


*Figure 31 - Operation of a 2050 37tph service train service specification assuming Crossrail 2 has been implemented*

### *2050 train service specification with <100% seats occupied + Crossrail 2*

This scenario assumes the implementation of Crossrail 2 and therefore the 17tph Main Line services included in the baseline timetable operate into London Waterloo on the Up Fast (UF) line and the 7tph main suburban services are displaced on to the Up Slow (US) line. Therefore, 17tph Main Line services and 14tph additional Main Line services (reduced from the additional 20tph in the <85% scenarios above) must all be accommodated on the UF line into London Waterloo (equating to 31tph). Owing to the ultimate capacity at London Waterloo being 32tph the diagram shows all 31tph can theoretically be accommodated at the station. However, the number of trains required on the corridor between Woking and London Waterloo is still not achievable using current signalling and headway capability.

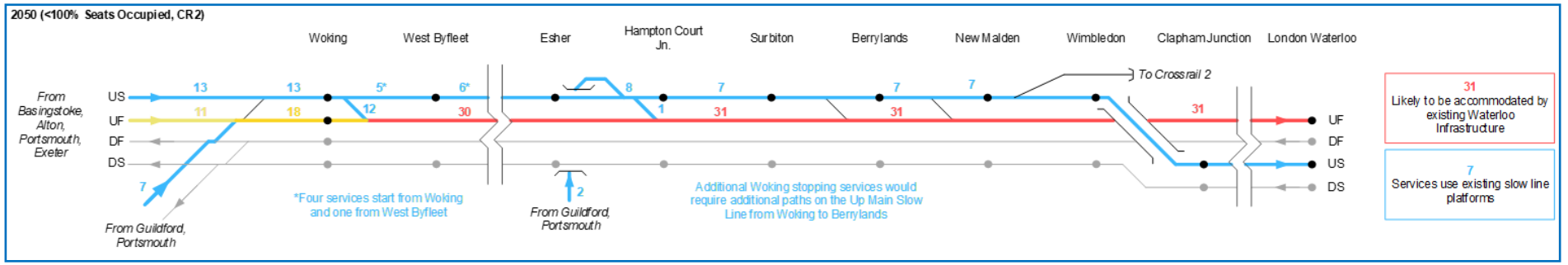


*Figure 32 - Operation of a 2050 31tph service train service specification assuming Crossrail 2 has been implemented*

### 6.2.5 Findings – Signalling headways between Woking and London Waterloo

As has already been stated, the headways between consecutive trains do not allow the robust operation of the current 24tph Main Line service operated on the Up Fast (UF) line. This also means that the addition of more trains, to meet demand, is not achievable and therefore, to allow trains to run closer together, a reduced headway is required.

The analysis has identified that the optimal planning headway for the approaches to London Waterloo is 1½ minutes (90s) between consecutive trains. This applies throughout the scope area from Woking to London Waterloo on the Up Main Fast line between consecutive non-stopping trains at line speed. In theory this would provide the capability and capacity to operate up to 40tph between Woking and London Waterloo but operating this level of service would come with resilience and reliability issues and capacity would be pushed to the limit.

In conjunction with some other infrastructure interventions (detailed below), the 90s headway would permit the planning of a standard pattern of three trains every five minutes (1½ / 1½ / 2 minutes apart), achieving up to 32tph in the morning peak, on a flat London Waterloo layout, or 36tph, should the London Waterloo throat constraints be resolved (see section 6.2.7). There is no capacity benefit to a planning headway lower than 1½ minutes as this could not be matched by capacity that could practically be provided at London Waterloo (platforms or station throat). Not attempting to operate the full 40tph means there is a level of in-built resilience to the proposed service provision.

Consideration has been given to how the 1½ minutes (90s) headways could be achieved on the network. The potential capability of the European Train Control System (ETCS) was assessed focussing on ETCS Level 2 and ETCS Level 3.

ETCS Level 2 is a radio-based train control system which displays signalling and movement information in the train cab. It removes the need for physical signals on the trackside but does require the use of balises[14] as a passive positioning beacon to report its position back to a signalling computer which then manages the relative position of trains.

ETCS Level 3 is a fully radio-based system without any trackside equipment, not even balises as in Level 2. This means the track is no longer separated in fixed blocks but split into 'moving blocks'. The analysis suggests that ETCS Level 2 or Level 3 could provide the theoretical technical headway capability to support operation of up to 36tph via the Up Main Fast line during the morning peak. This means that only scenario 3 which requires 31tph by 2050 is fully achievable, scenario 2 which requires 37tph is partially achievable, but could be achieved by relaxing the 85 % seating occupancy to a higher level but remaining less than the 100 % occupancy, and the 44tph required for scenario 1 is not achievable.

### 6.2.6 Findings – Track capacity between Clapham Junction and London Waterloo

A key finding of the capability analysis that there is a lack of track capacity through Queenstown Road to manage the throughput of trains that arrive at London Waterloo in the high-peak hour but then depart as Empty Coaching Stock (ECS) into Clapham Yard i.e. the limitation once the plain line headway is addressed is not getting trains in, but it is getting trains out. Figure 33 shows how these movements are currently made.

[14] An electronic beacon or transponder

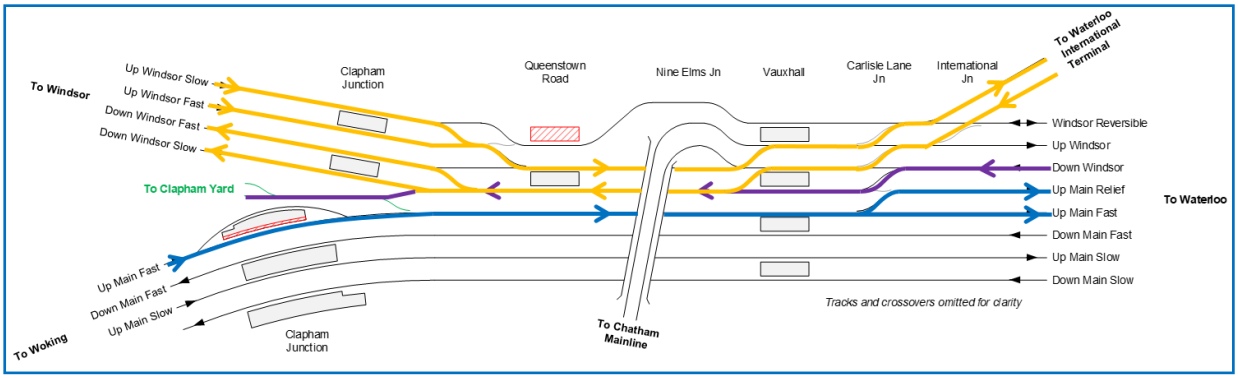


*Figure 33 - Operation of Up Main Fast services and ECS moves to Clapham Junction Yard*

The purple line relates to the ECS movements and it can be seen that owing to a reduction in tracks from eight to seven through Queenstown Road, the Down Windsor Line services and the ECS movements to Clapham Yard must share the same line. This limits the number of ECS that can be routed this way and means that as more trains are required to meet demand the ability for some of them to depart as ECS is not possible. This section of track is one of the busiest in the country, with 23tph passing Platform 3 in the busiest morning contra-peak hour. Two options to solve this problem have been proposed through the analysis.

### *Queenstown Road Option 1*

This option maintains the seven tracks without needing an additional line and requires the reinstatement of Platform 1 at Queenstown Road which means the Windsor Reversible could be used to operate the entire Up Windsor service, including those trains that stop at Queenstown Road.

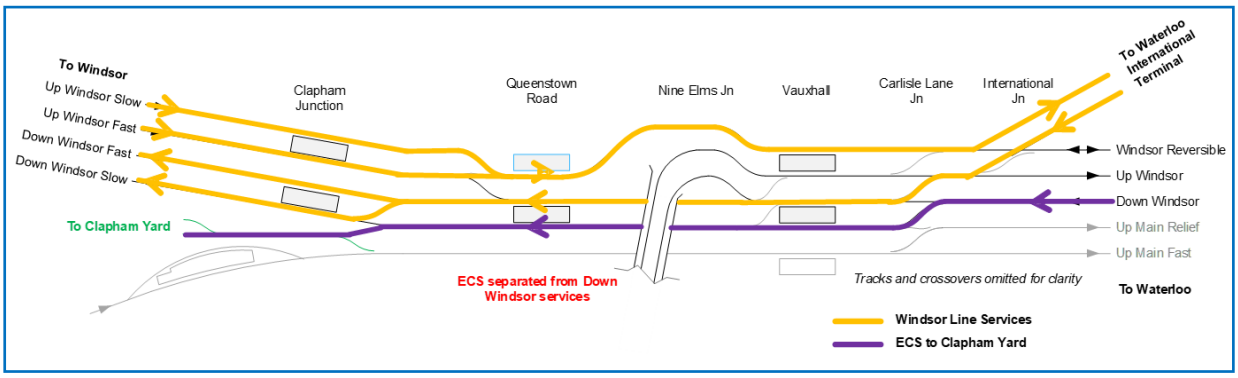


*Figure 34 - Queenstown Road Option 1 concept*

Figure 34 demonstrates that this concept now means the Windsor Line and ECS train movements can be segregated. This has the benefit of being a relatively minor intervention (no track alteration is required) that allows the maximum utilisation of London Waterloo for Main Line services. However, this reduces the Windsor Line capability from three tracks to two as the Down Windsor line is used for ECS through the area. Reducing the number of available lines for use by Windsor Line services in conjunction with other known constraints to Windsor Line growth, identified in the Wessex Route Study, could potentially impact resilience as well as the operation of additional services at some time in the future if required.

To achieve this option the tracks through Queenstown Road are re-allocated as follows.

| Current Track Allocation | New Track Allocation | Notes |
|---|---|---|
| **Windsor Reversible** | Up Windsor | Reinstate Platform 1 |
| **Up Windsor** | Down Windsor | Down trains |
| **Down Windsor** | Windsor Reversible | For ECS movements into and out of Clapham Yard |
| **Up Main Fast** | Up Main Fast | No change |
| **Down Main Fast** | Down Main Fast | No change |
| **Up Main Slow** | Up Main Slow | No change |
| **Down Main Slow** | Down Main Slow | No change |

### *Queenstown Road Option 2*

This option requires there to be an additional line through Queenstown Road to make a consistent eight lines between London Waterloo and Clapham Junction.

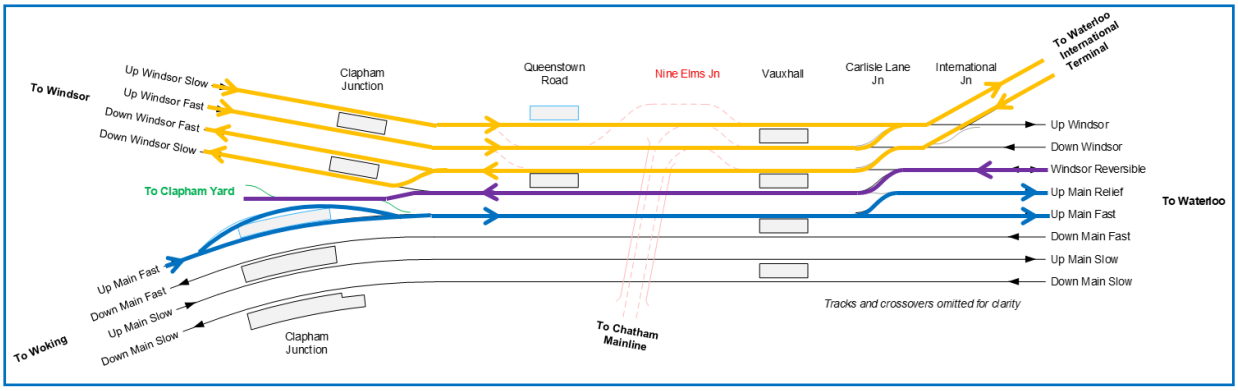


*Figure 35 - Queenstown Road Option 2 concept*

It also requires the reinstatement of Platform 1 at Queenstown Road. As can be seen in Figure 35, the Windsor Line and ECS train movements are segregated (yellow line are Windsor Line services and purple are ECS). This has the benefit of maintaining the number of tracks available for Windsor Line services (three tracks) and therefore not impacting the resilience of the Windsor Line service or impacting the operation of additional services when considered in conjunction with the unlocking of the wider Windsor Line constraints identified in the Wessex Route Study. However, the drawback is that it is a major, potentially costly intervention and could require the removal of Nine Elms Flyover and the reinstatement of the 8$^{th}$ track.

To achieve this option the tracks through Queenstown Road are re-allocated and an additional track is reinstated as follows.

| Current Track Allocation | New Track Allocation | Notes |
|---|---|---|
| **Windsor Reversible** | Up Windsor | Reinstate Platform 1 |
| | Up Windsor Fast | Reinstatement of 8-tracks |
| **Up Windsor** | Down Windsor | |
| **Down Windsor** | Windsor Reversible | For ECS movements into and out of Clapham Yard |
| **Up Main Fast** | Up Main Fast | No change |
| **Down Main Fast** | Down Main Fast | No change |
| **Up Main Slow** | Up Main Slow | No change |
| **Down Main Slow** | Down Main Slow | No change |

### 6.2.7 Findings – London Waterloo

*Improvements to London Waterloo throat*

Through the analysis on current capability at London Waterloo it was identified that the approaches and throat of the station do not allow for flexibility in the operation of services, particularly at times of perturbation.

The first issue is that the current throat layout is flat, namely that certain movements in one direction inherently involve conflicting with all movements in the opposite direction, as shown previously in section 6.2.1. Therefore, any departure from Platform 14/15 directly to the Down Main Fast line prevents any arrival being scheduled simultaneously into any of Platforms 7-15. This is detailed in the next section, 'Capacity at London Waterloo'.

The second issue regarding the station throat is the provision of 'parallel moves' within the throat. This is the ability to depart one platform and (in London Waterloo's case) simultaneously arrive into a higher numbered platform, as shown in Figure 23 below.

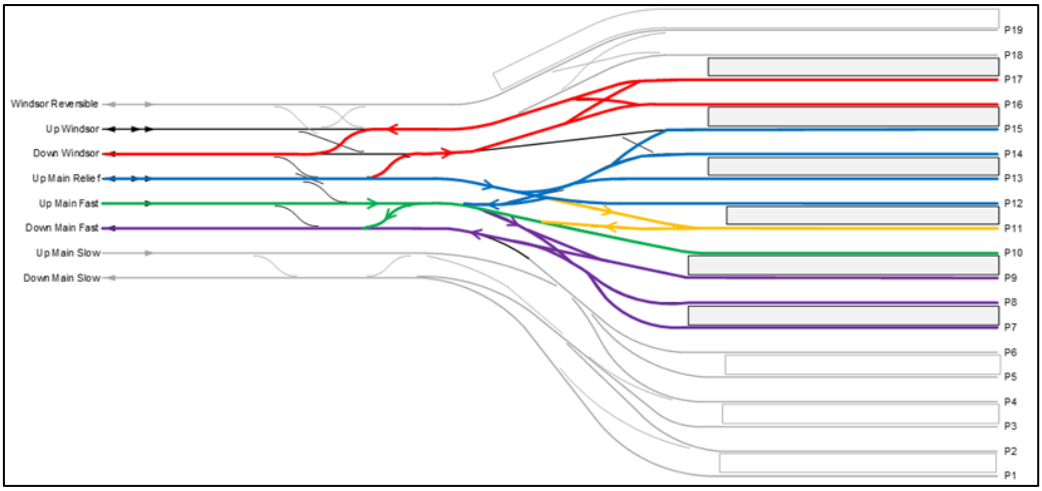


*Figure 36 - Potential train moves through the London Waterloo throat*

Provision of parallel moves across the Fast Line throat is not consistent across the station:

- Platforms 7-9 share a single lead (meaning only one arrival or departure from these platforms at a time);
- Platform 10 is fully parallel with all other platforms;
- Platform 11 is also fully parallel (albeit requiring arrival via the Up Main Relief to be parallel with Platform 10);
- Platform 12 & 13 share a single lead;
- Platform 14 and 15 are fully parallel, provided arrivals are via the Up Main Relief.

The consequence of these restrictions on parallel moves and their distribution is not capacity (i.e. more parallel moves would not provide any ability to accommodate more trains per hour) but will provide more choices in terms of how available platform capacity is used, particularly in relation to turnaround times (when trains come in and how soon they can depart again). This provides improved operational resilience and performance; particularly as additional services are introduced.

Through the analysis a set of aspired layout changes were developed for an improved throat at London Waterloo:

- Maximise the number of parallel moves possible between departing and arriving Main Line services so that, in general for any departure, a parallel arrival is possible into any higher numbered platform;
- Retain Platforms 7-15 as the 'key' Fast Line platforms with Platforms 16/17 for trains that terminate and do not go back out as passenger services i.e. they go back out as Empty Coaching Stock (ECS) to Clapham Yard/Wimbledon Park;
- Provide some alternative routes where reasonably practicable in the track layout. For example, Platforms 14/15 (more if practical) accessible via both the Main Fast lines and also the Main Relief/Down Windsor Lines;
- General increase of the throat speed above 15mph to assist platform re-occupation and platform end conflict margins, with a secondary benefit of a small journey time improvement;
- Additional access to Platform 18 from the Up Main Fast without needing to use West Crossings (an inefficient 'ladder' of switches and crossings between London Waterloo and Vauxhall), which is important to improve the approach speed.

Provision of more parallel moves in the station throat, more consistently distributed across the layout is essential in providing more choices and flexibility for operating a robust timetable,

particularly if the demand scenarios, tested through this analysis, were to come to fruition. There is also the potential that meeting these operational requirements could have a positive impact on maintenance activity in the area by simplifying the layout of the throat.

Additional parallel moves also provide more capability within the throat to absorb minor perturbation, through reducing the likelihood of a late inward train causing a late start to a departing train owing to conflict in the station throat. Also, it would reduce the consequences should a planned platform alteration be necessary, i.e. a conflict would not necessarily be introduced by using the next platform over if necessary.

### *Capacity at London Waterloo*

As described in section 6.2.4, London Waterloo's current layout could in theory accommodate up to 32tph in the high-peak hour without the need for additional platforms or major engineering works to the throat.

To achieve the theoretical 32tph capacity of London Waterloo for Main Line services will require the headway reduction through to Woking and an option at Queenstown Road. If these are implemented then the 32tph capacity of London Waterloo could mean:

- 20tph that arrive in Platforms 7-15 could depart back via the Down Main Fast (most or all in passenger service);
- 12tph that arrive in Platforms 16-17 could depart back as Empty Coaching Stock (ECS) via the Down Windsor line, nominally to Clapham Yard (or to Wimbledon Park depot via East Putney);

Of the train service scenarios described in section 6.2.4, scenario 3 (related to up to 100 % seating occupied and therefore a lower train service requirement) and the post-COVID scenarios would not require further intervention above the headway reduction and one of the Queenstown Road options to enable more trains to terminate at London Waterloo. Whereas scenarios 1 and 2 would require an intervention to enable the forecast 2050 train service level.

Increased platform capacity through the implementation of additional platforms would not enable more services to be operated as there would still be the issue of crossing the throat of the station to access the Down Main Line to depart and thus the "loss" of some potential arrival paths to permit a conflicting departure in each case. Therefore, this analysis suggests that a grade separation solution between London Waterloo and Clapham Junction would be required should demand return and increase to the point that more than 32tph were required on the Main Line. The purpose of a grade separation would be to allow Main Line services departing from higher-numbered platforms to use the Down Windsor line as in the diagram below.

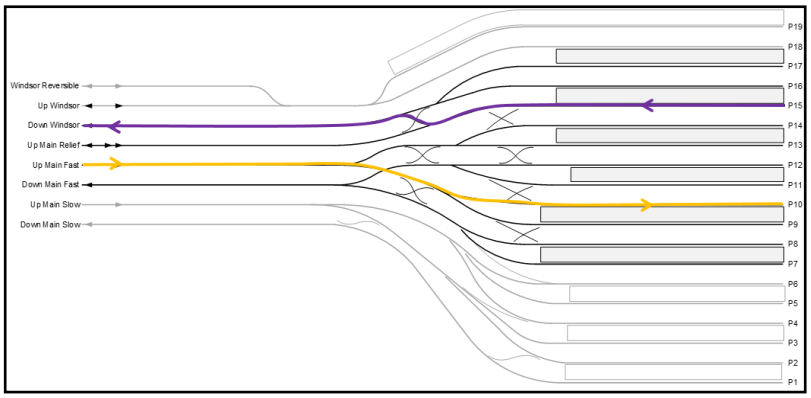


*Figure 37 - Potential train moves through the London Waterloo throat*

This would mean that the departing train, represented by the purple line, would not need to cross the throat to access the Down Main Fast line and therefore services arriving from the Up Main Fast line could continue to arrive without conflict. This could enable an additional 4tph (achieving 36tph in total).

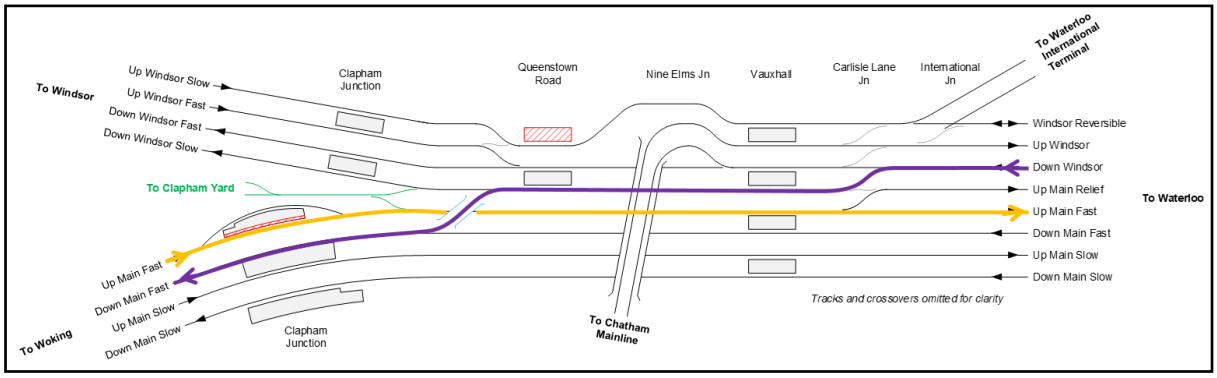


*Figure 38 - Potential train moves through the London Waterloo throat*

The layout shown above shows that once a Down Main Line service has departed a higher-numbered platform at London Waterloo via the Down Windsor Slow line (within the flow of Down ECS moves), it would then proceed towards Clapham Junction until a grade separated junction would provide access to the Down Main Fast line without conflicting with trains on the Up Main Fast line (or Up Main Relief). This avoids 'losing' a path each time a train needs to depart from the highest numbered platform. The potential location of a grade separated junction is described in section 7.2.

For the three main scenarios considered in this analysis, grade separation would be required to achieve the train service level in both scenarios 1 and 2 (the up to 85 % seats occupied scenarios), but not scenario 3 (where 100 % of seats would be occupied) or the three post-Covid scenarios. However, even with grade separation the full 44tph for scenario 1 and the 37tph for scenario 2 cannot be accommodated.

### 6.2.8 Contra-Peak and Evening Peak between London Waterloo and Clapham Junction

So far, this study has shown how demand can be met into London Waterloo in the high peak hour. As more trains come into London Waterloo there will be more trains coming out again and therefore an assessment of how the capability provided by the identified interventions could work in the AM contra-peak and the evening peak has also been undertaken.

In summary, the analysis shows that the interventions offer a credible level of:

- The interventions described above for the high peak hour service into London Waterloo also enable the required service in the contra and evening peak, meaning:
    - A Contra morning peak service to support the inward peak direction flow in terms of departing trains, and;

- An evening peak service that compares well with the morning peak (i.e. slightly less, but comparable, frequency over all to reflect traditionally more spread evening demand);
- The headway requirement for trains leaving London Waterloo in the contra and evening; peak is two minutes through the station throat and then 90 seconds once those trains have joined the Down Main Fast line.

The ability to meet this two-minute headway requirement is influenced by both the time taken to dispatch trains and the linespeed that can be achieved in the station throat. In order to support a reduced technical headway between consecutive departures, in addition to that purely provided by the signalling capability, this means that in addition to the previously identified interventions there would be the need to reduce the dispatch time at London Waterloo and/or increase the linespeed capability through the station throat from 15mph to 25mph.

### 6.2.9 Clapham Junction Interventions

In addition to the core interventions, described above, that are required to meet the 85 % and/or 100 % seats occupied scenarios, the analysis also addressed what would be required to allow Main Line services to call at Clapham Junction in the high peak. As described in section 4.1.2, the quantum of trains, the current headways, curvature of the platforms (particularly Platform 8) and the slow speed into Platform 7 mean that no Main Line services currently call at Clapham Junction in the high-peak hour.

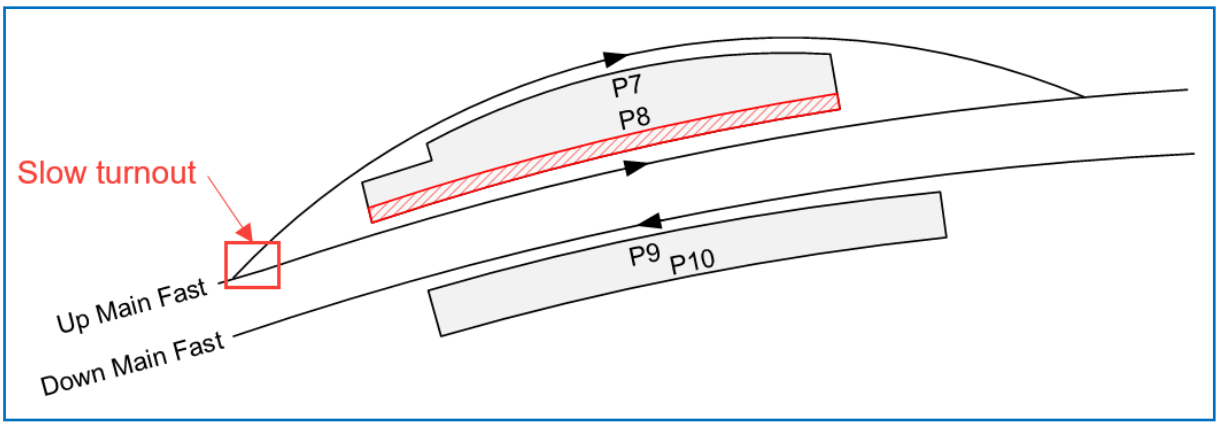


Figure 26 Current Clapham Junction SWML layout

The analysis looked at what level of capacity would be achievable through the current layout at Clapham Junction using current capability but adjusting the number of services that stop in the high-peak hour. This can be seen below.

| Scenario | Maximum Throughput | Stopping | Non-Stopping |
|---|---|---|---|
| Current (No trains stop) | 24tph – 26tph | - | 24tph -26tph |
| All trains stop (Using Platform 7) | 15tph | 15tph | - |
| Alternate stopping / non-stopping Trains (Using Platform 7) | 18tph | 9tph | 9tph |
| Each stopping train (Platform 7) overtaken by a non-stopping train (Platform 8) during dwell time | 16tph | 8tph | 8tph |

This shows that based on current theoretical capacity , and with Fast Line services continuing to non-stop Clapham Junction in peak periods,  up to an additional 2tph could be achieved above the current 24tph, but it should be made clear that this would have significant adverse consequences on performance and resilience. It is for this reason that this level of service is not run today.

Trying to use both Platform 7 and 8 reduces the number of services that can be operated as both the loop through Platform 7 and the line through Platform 8 join back up on to the Up Main Fast line. Therefore, stopping a train in Platform 7 (and then re-starting towards Waterloo) requires the following train in Platform 8 to also stop (to avoid a conflict on departure). As Platform 8 cannot currently be used by stopping trains, it costs a train path to perform this move

Therefore, on current infrastructure, stopping all trains or calling some trains but not others, has the inevitable consequence of limiting the overall number of trains that can run to significantly less than the current peak frequency.

In the AM contra-peak or evening peak, when trains in the Down direction are considered, the ability to stop additional trains at Clapham Junction, above those that already call there, is impeded by there being only one platform (Platform 9) that can be utilised. Therefore any train stopping requires both its path, and also the potential path of a following train, due to physically occupying the main line for the required dwell time (plus time needed to decelerate and accelerate to line speed).

Therefore, the main constraints that need to be resolved to permit all or some trains to call at Clapham Junction in both directions are:

- The ability to stop trains freely in both Platforms 7 and 8 (in the Up direction), ideally without requiring Selective Door Opening (SDO) in either platform or fouling the country end set of points so consecutive trains can alternate between platforms;
- The ability to stop in Platform 8 at all, which is not currently possible;
- The ability to call a train in one platform whilst another train runs non-stop through the other platform thereby enabling some flexibility in how trains do or don't call at Clapham Junction;
- The ability for a train to arrive in one platform (Platform 7 or 8) whilst a train is departing from the other platform, which is not currently achievable owing to a signalling overlap;
- The act of stopping a train in on platform (particularly P7) not having an adverse impact on the headway to the following train, due to the low speed entry and approach control;
- The lack of platforms available for down direction services; currently only Platform 9 can be used.

With these constraints in mind several concept options have been identified to provide the capability to call peak time services at Clapham Junction.

### *Clapham Junction Option 1*

The diagram below shows an 'ideal' operational layout for four Main Line platforms at Clapham Junction, increased from the current three platforms.

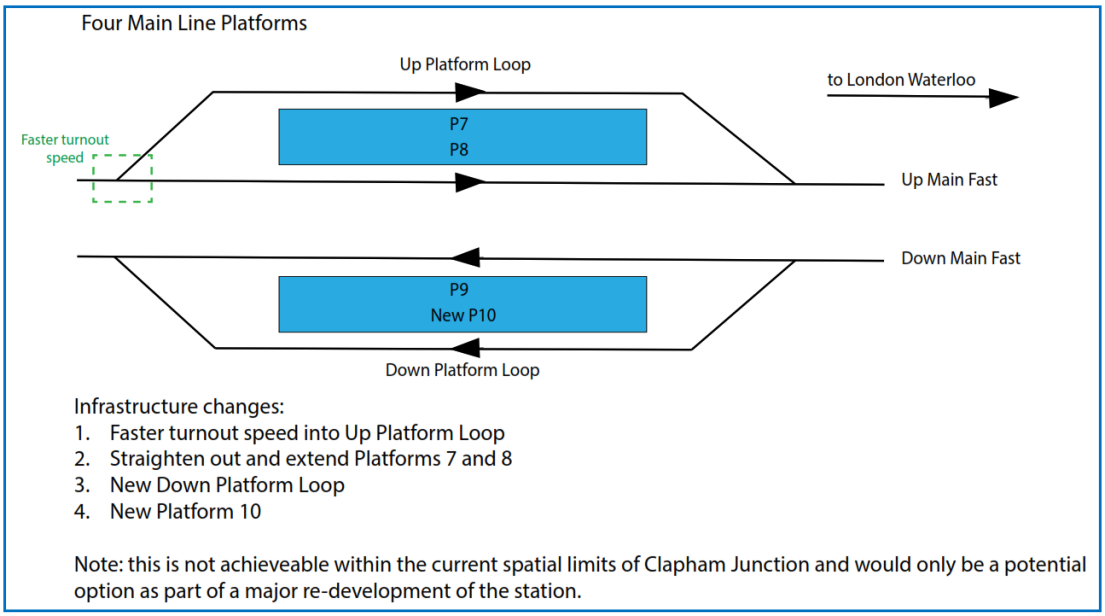


Figure 27 Clapham Junction Option 1

The optimal, operational solution at Clapham Junction would be to have two useable platforms in the Up direction, for services into London Waterloo (as described in section 6.2.8), and two useable platforms in the Down direction. This would mean two platforms in each direction, each lengthened to accommodate 12-car trains and straightened to mitigate platform curvature and stepping distance issues; as well as benefitting dwell times and passenger circulation more generally.

This arrangement means that all services could call at Clapham Junction or no services could call at Clapham Junction. The fact that the Up and Down Platform Loops connect back into the Up and Down Main Fast respectively means that a more flexible approach of stopping some service and not others is not achievable without a loss of peak hour throughput.

Owing to spatial constraints at Clapham Junction, this option is unachievable without a wider redevelopment of the station area.

### *Clapham Junction Option 2*

The two diagrams below show how Platform 8 could be used in a tidal way in the morning peak and evening peak. This arrangement would provide two platforms in the peak direction and one platform in the contra-peak direction; the direction of use of Platform 8 (middle platform) would match the peak direction.

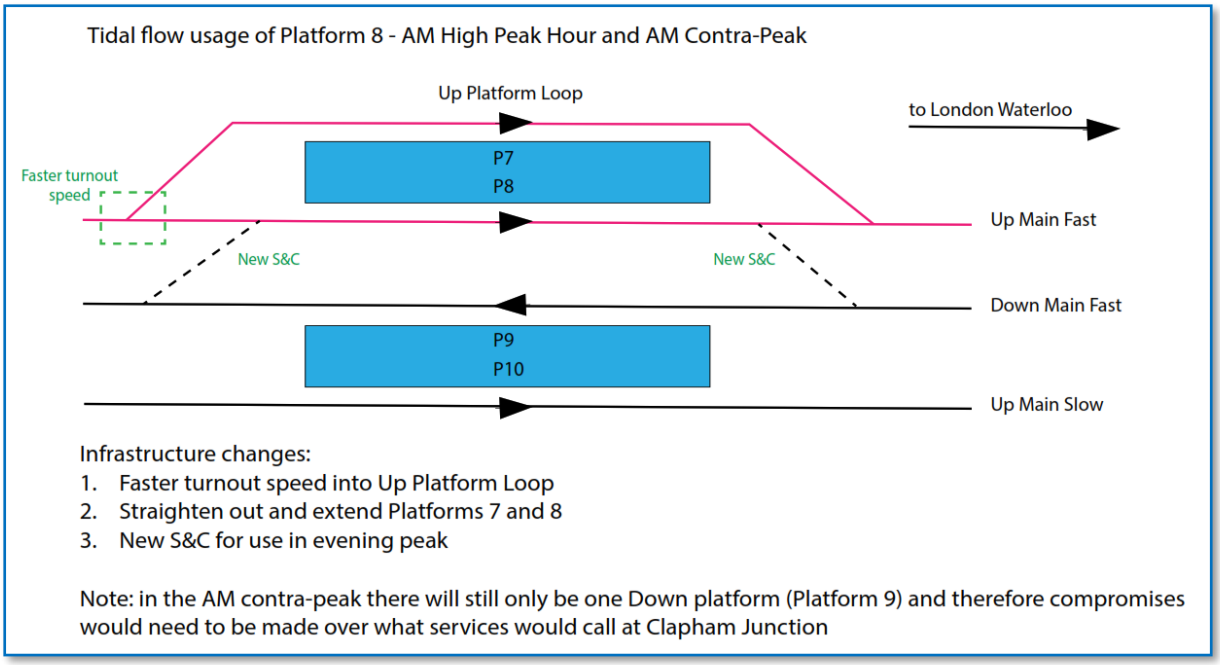


Figure 27 Clapham Junction Option 2 – Morning Peak

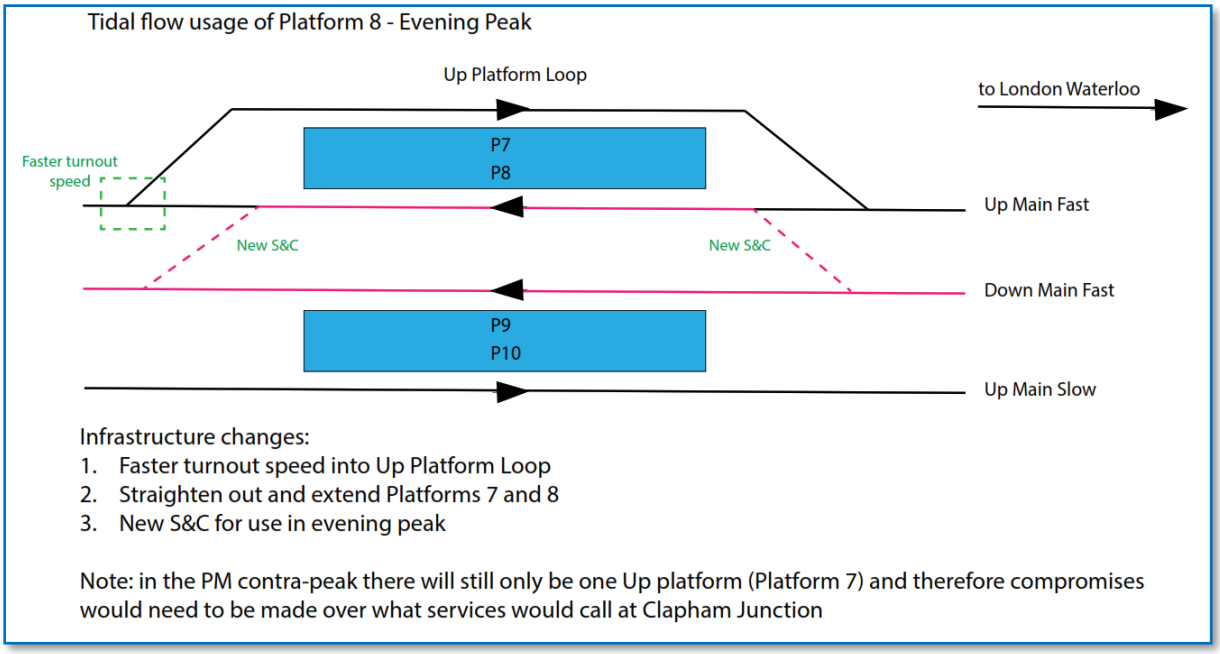


Figure 28 Clapham Junction Option 2 – Evening Peak

This arrangement means that all services could call at Clapham Junction or no services could call at Clapham Junction in the peak direction. The fact that the Up and Down Platform Loops connect back into the Up and Down Main Fast respectively means that a more flexible approach of stopping some service and not others is not achievable without a loss of throughput.

However, in the both contra-peaks, only one platform is available and therefore compromises would need to be made on what trains call at Clapham Junction and it is unlikely that all trains in both directions could stop in peak periods. This would be similar to off-peak periods today, where some but not all trains stop using a single platform.

In conjunction with these options there is the opportunity to modify the track layout through Queenstown Road to provide additional benefit which is described below.

### *Queenstown Road Option 3*

The need for both a dedicated Empty Coaching Stock (ECS) line into Clapham Yard as well as providing the fullest flexibility and capability to stop peak services at Clapham Junction will require something slightly different than Queenstown Road Options 1 and 2, as can be seen below.

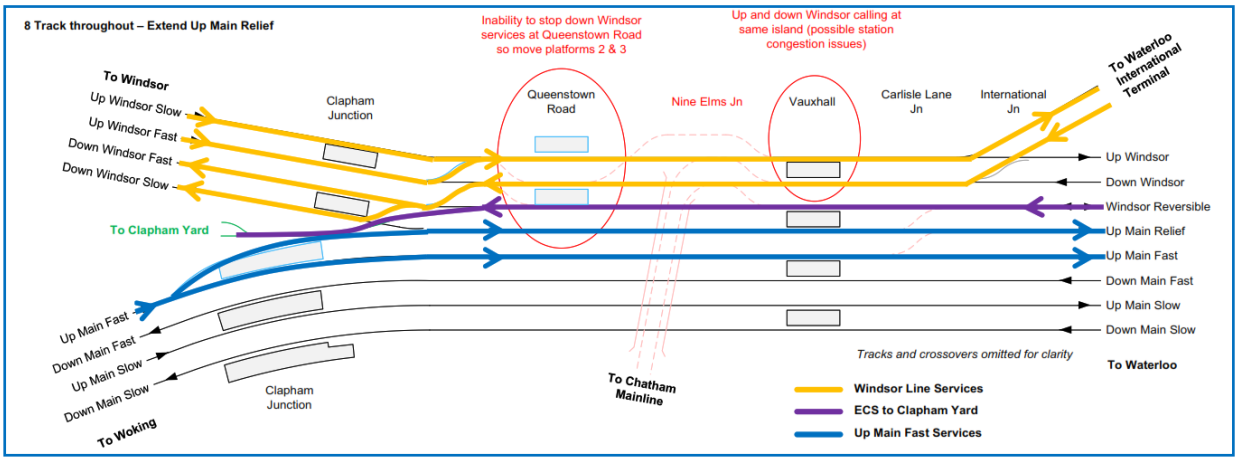


Figure 29 Queenstown Road Option 3

The changes through Queenstown Road are:

- Platform 1 will be reinstated to allow Up direction trains to call there;
- Platforms 2 and 3 will need to be rebuilt to allow Down trains to call at the station as the Windsor Line services would use the lines in a different configuration;
- The eighth track is reinstated through Queenstown Road to enable:
    - A dedicated ECS line to be used to access/exit Clapham Yard;
    - To extend the functionality of the Up Main Relief line from Carlisle Lane Junction back to include Clapham Junction Platform 7 (described below).
- Various crossover / track layout changes to provide the required operational functionality and parallel moves (i.e. access from the revised layout at Queenstown Road into the required Windsor / Main Line platforms at Clapham Junction, and interface with Clapham Yard track layout).

The Up Main Relief is a line that starts at Carlisle Lane Junction between Vauxhall and London Waterloo. It allows Main Line services to use two tracks as they approach London Waterloo and then fan out to the appropriate platforms used for Main Line services. To achieve the extension of the Up Main Relief the tracks through Queenstown Road are re-allocated and an additional track is reinstated as follows.

| Current Track Allocation | New Track Allocation | Notes |
|---|---|---|
| **Windsor Reversible** | Up Windsor | Reinstate Platform 1 |
| **New track** | Down Windsor | Reinstatement of 8-tracks, plus relocated Platforms 2 and 3 |

| | | |
|---|---|---|
| **Up Windsor** | Windsor Reversible | For ECS movements into and out of Clapham Yard |
| **Down Windsor** | Up Main Relief | With connection into Clapham Junction Platform 7 |
| **Up Main Fast** | Up Main Fast | No change |
| **Down Main Fast** | Down Main Fast | No change |
| **Up Main Slow** | Up Main Slow | No change |
| **Down Main Slow** | Down Main Slow | No change |

The extension of the Up Main Relief would change the track layout in both Clapham Junction Options 1 and 2 as shown in the following diagrams.

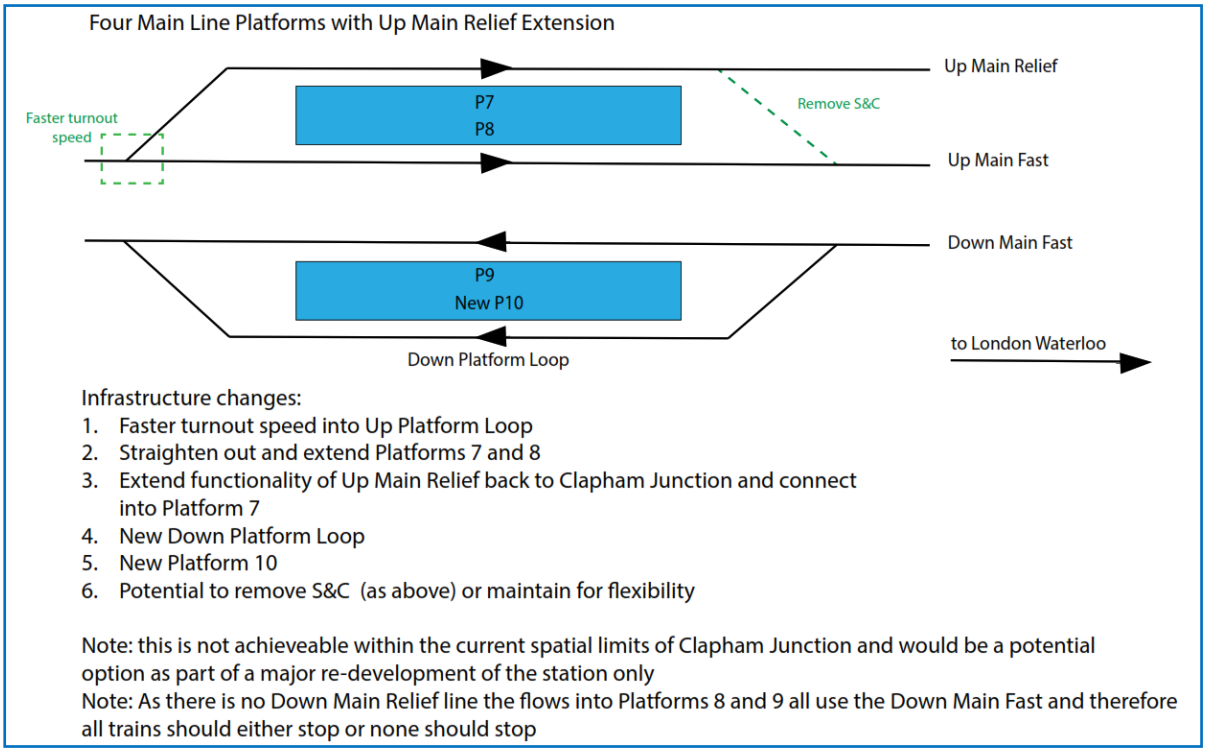


Figure 30 Clapham Junction Option 1a Layout (with extension of Up Main Relief)

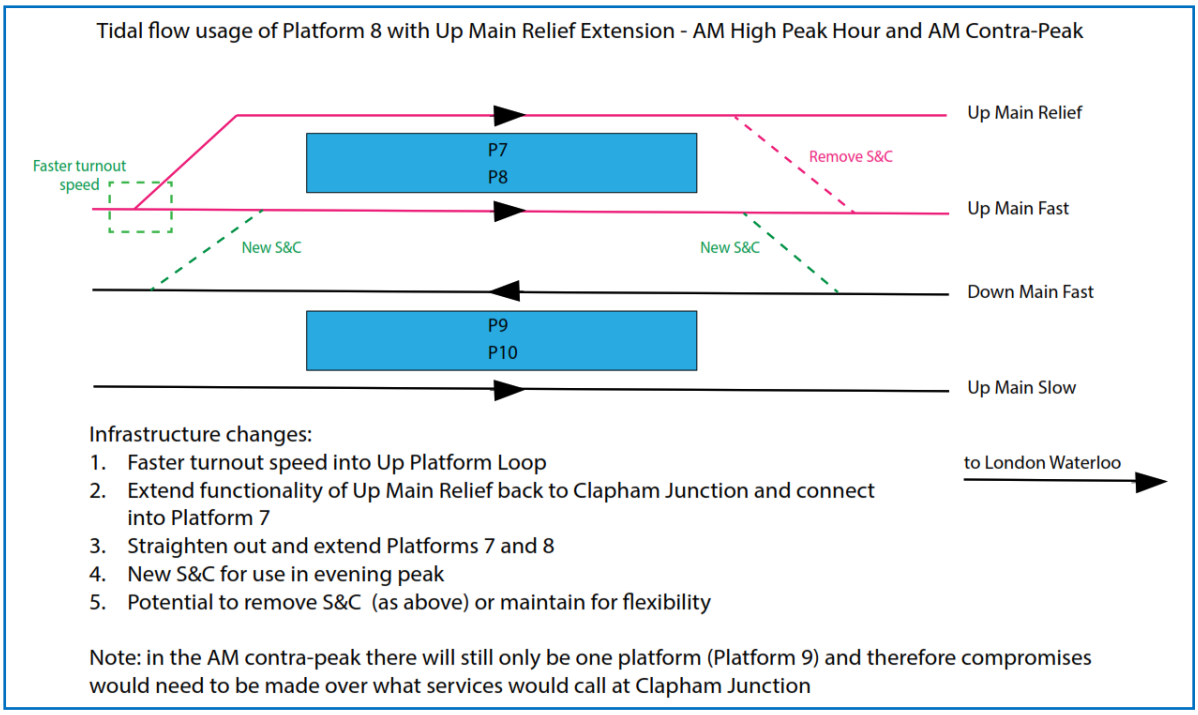


Figure 31 Clapham Junction Option 2a Layout (with extension of Up Main Relief) – Morning Peak

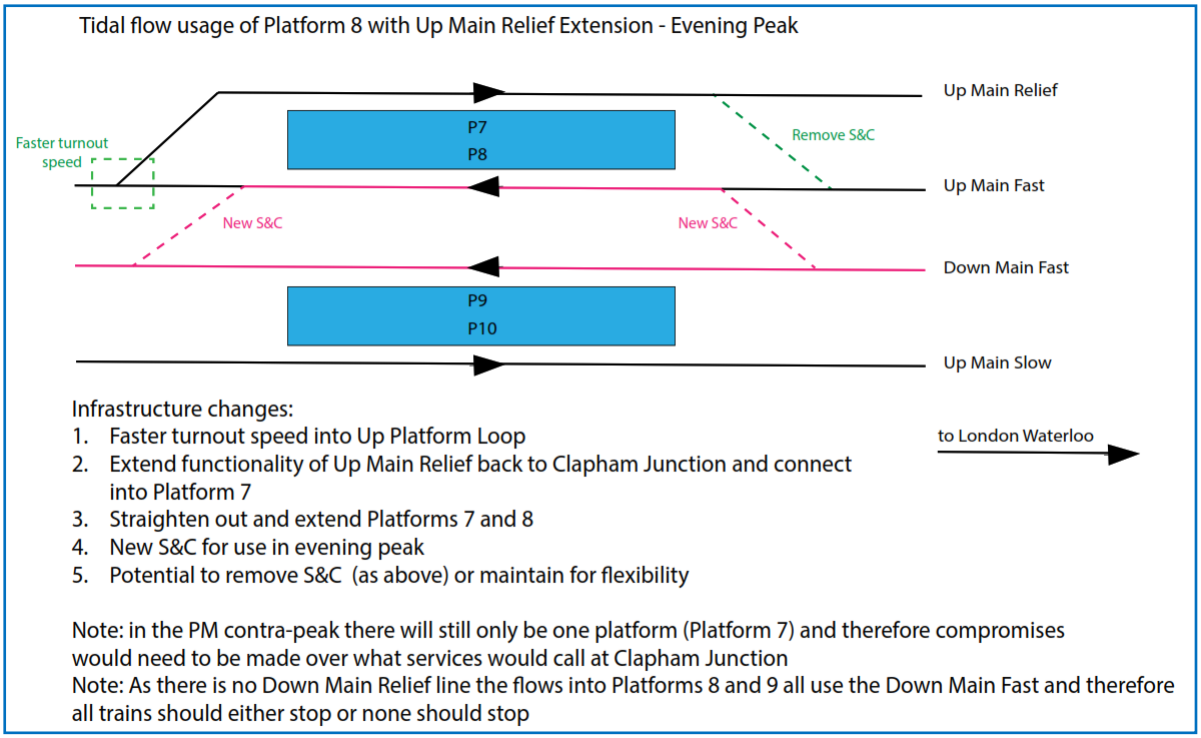


Figure 32 Clapham Junction Option 2a Layout (with extension of Up Main Relief) – Evening Peak

The key benefits of Queenstown Road Option 3 are:

- Allows maximum utilisation of London Waterloo by allowing ECS movements into Clapham Yard, via a dedicated line, to free up platforms at London Waterloo for the use of incoming trains;
- Allows both stopping and non-stopping services at Clapham Junction in the AM high-peak hour; thereby providing the most flexibility at Clapham Junction.

The main drawbacks are:

- A major infrastructure intervention is required, including the removal of the Nine Elms Flyover to facilitate the 8th track through Queenstown Road;
- Reduces the Windsor Lines from three to two, therefore constraining future growth in combination with other infrastructure constraints on the Windsor Lines (such as level crossing down time), and potentially introducing a performance constraint;
- Queenstown Road Platforms 2 and 3 need to be relocated to allow Down Windsor Line services to call at Queenstown Road;
- At Vauxhall station the Up and Down Windsor lines would be sharing an island platform which could exacerbate congestion issues that are already a concern at Vauxhall

The changes at Clapham Junction to extend the Up Main Relief allow flexibility in the Up direction but owing to a lack of a Down Main Relief, does not offer the same benefit in the contra-peak or evening peak.

# 7.0 Intervention Feasibility

As outlined in previous sections, the core strategy to increase network capacity and enable addition train services to run on the SWML are:

- a planning headway reduction to c.90 seconds;
- relieving the flat junction constraint at Woking via Woking Area Capacity Enhancement;
- an intervention at Queenstown Road to increase the ability to run ECS moves out of London Waterloo and free up platform capacity in the terminal.

A further increase in capacity would be achieved, along with a wide range of other benefits, by delivery of the Crossrail 2 programme.

Should Crossrail 2 not be delivered, or demand is above the 32 Main Line trains that London Waterloo is capable of accommodating in the high peak hour, then grade separation between Clapham Junction and London Waterloo could be considered.

Woking Area Capacity Enhancement and Crossrail 2 are established programmes of work, so their feasibility has not been explored as part of this study. The headway reduction will require development by specialist operational and signalling technology teams; and has therefore not been further developed as part of this study. Instead a key recommendation is that a workstream is launched to examine how such a headway could be delivered on the route.

Therefore, early-stage concept development as part of this Strategic Study has concentrated on the following areas:

- Queenstown Road – Option 1 and 2 looking at segregating out the Windsor Line services from the Main Line ECS moves to enable fuller use to be made of the existing platform capacity at London Waterloo Station;
- Grade Separation – Beyond the initial core option set described above, grade separation between London Waterloo and Clapham Junction would provide access from higher numbered platforms at London Waterloo to the Down Main Fast line without conflicting with trains on the Up Main Fast line (or Up Main Relief) to release paths in/out of London Waterloo. This would likely only be considered should passenger demand return to pre-COVID levels of growth and it is decided that Crossrail 2 will not be progressed;
- Clapham Junction Enhancements – A set of enhancements relating to allowing Main Line trains to call at Clapham Junction without impacting the number of trains able to run through to London Waterloo in the high-peak and how this works with the wider Queenstown Road area.

The work undertaken does not carry out full scheme development but provides an early indication of feasibility and scale of construction implications. The following sections summarise the key findings of this workstream.

## 7.1 Queenstown Road Interventions

Both the Queenstown Road interventions involve re-instating the currently disused Platform 1 at the station to enable trains to call on what is currently a through line. As the platform and canopy structures are still there it is a relatively straightforward undertaking to reinstate the platform and extend to 10-car length, acknowledging that there may be some work required to bring the platform and station building up to modern standards. If the Windsor Lines were to be enhanced to a 12-car railway in the future this would involve more complex works to alter signalling and track works. This

would however be no different to many other stations on the Windsor Line network that cannot currently accommodate 12-car operation.

Queenstown Road Option 1 alters the usage of the current seven tracks and brings the Windsor Reversible track into regular use to provide the additional Main Line ECS capacity. This option limits the track work required to one additional crossover to provide flexible access to Vauxhall. This option is therefore the most straightforward to deliver though as described in section 6.2.6, may require later changes to accommodate future Windsor Line growth, in terms of train frequency or train length.

Queenstown Road Option 2 provides not only the additional platform at Queenstown Road but an additional track through the area to fully segregate the Main Line ECS moves from the Windsor Line services without the potential implications on the Windsor Lines and provide additional operational resilience. It would require approximately 1.3km of new track from Nine Elms Junction through to west of Queenstown Road and the removal of the redundant Nine Elms Junction flyover ramp to create space for the track resulting in possessions for the demolition works.

The new track also needs to run underneath the Brighton Main Line Overbridge, the supporting structures of which would need re-configuring to accommodate the new alignment. Crossover and signalling alterations would also be required.

## 7.2 Grade separation

Grade separation of the Down Main Fast from the Up Main Fast line (and Up Main Relief) could be implemented in one of two locations, either the London or country end of Queenstown Road station. Either option would involve a c.550m long new structure and a significant number of weekend possessions with a difficult staged construction methodology. Both would also require track remodelling and signalling alterations.

The London end proposal would require complete removal of the redundant Nine Elms flyover ramp and box. Demolition of the box is challenging and would likely require several extended possessions of six of the seven lines that approach London Waterloo. Additionally, several track layout stages would be required with temporary civils work to facilitate the construction of the new flyover structure.

The country end option would again involve extensive temporary track realignment to create sufficient space to construct the grade separation. For this option it is believed that a diveunder structure (as opposed to a flyover) would likely be the preferred solution due to the physical constraints of the site. Either option would be costly and highly complex with an extensive period of construction.

## 7.3 Clapham Junction Interventions

Capacity analysis also considered what would be required to allow Main Line services to call at Clapham Junction in the high-peak hour. Due to the existing linespeeds and signalling constraints through Platforms 7 and 8, an operational headway that can support the desired train service cannot be provided without major infrastructure intervention. This work would involve the straightening of Platforms 7 and 8 in combination with one of the proposed Clapham Junction options described in 6.2.9.

Undertaking any works at Clapham Junction is challenging due to the constraints of the site and works to straighten Platforms 7 and 8 and release the operational limitations of the Main Line

layout would also involve rebuilding Platforms 9 and 10 with associated track reconfiguration. It is unlikely this scale of work would be undertaken in isolation to allow the Main Line trains to call at the station and these Clapham Junction interventions should instead be considered as part of a wider programme looking at a comprehensive redevelopment of the station and surrounding area.

# 8.0 Emerging Strategic Advice

This study has focused on the provision of Main Line capacity into London Waterloo because pre-Covid overcrowding was such an issue that standing was being seen on some services that were far in excess of the accepted 20 minutes of maximum standing time that passengers may expect on their journey. Since the Covid-19 pandemic there has been a drop in patronage and a series of scenarios for how passengers may return have been identified. This strategic advice will provide a road map towards providing the requisite amount of capacity whilst providing adaptability to take account of how passengers return to the railway following the Covid-19 pandemic.

As passengers return to the railway, post-Covid, this study recommends that the strategic advice and road map towards providing capacity is kept under review. As the Government and rail industry's understanding of how passengers are returning to the railway becomes clearer over time, the study will be reassessed against the demand and updated forecasts/ scenarios. This will influence when the recommendations, contained here, may be required or adopted.

As stated in the Demand section of this document, several scenarios were looked at to reflect pre-Covid growth and high, medium and low growth return of passengers post-Covid in the high peak hour (08:00 to 08:59). In all cases there was some requirement for additional services to meet demand; with that demand growing at different rates over the period to 2050.

In addition, it is clear that operating the pre-Covid level of service robustly and resiliently has been extremely challenging. Attempts to operate an additional (25th) service in the high-peak hour and therefore ease some of the overcrowding experienced by passengers resulted in poorer performance. It is not acceptable for the railway to return to the overcrowding and poor performance that was experienced pre-Covid. As passengers return to the railway it is essential that measures to ensure that the service can be operated robustly and resilient are identified and implemented. This post-Covid period provides an opportunity to reintroduce trains in a way that better balances capacity and performance.

## 8.1 The Core Strategy and Road Map

There are a series of interventions that have been identified through the timetable analysis, some of which have subsequently been tested for engineering feasibility, as described in sections 6.0 and 7.0. These interventions form the core of the road map towards meeting the emerging service requirements as we come out of the Covid-19 pandemic; this is summarised below.

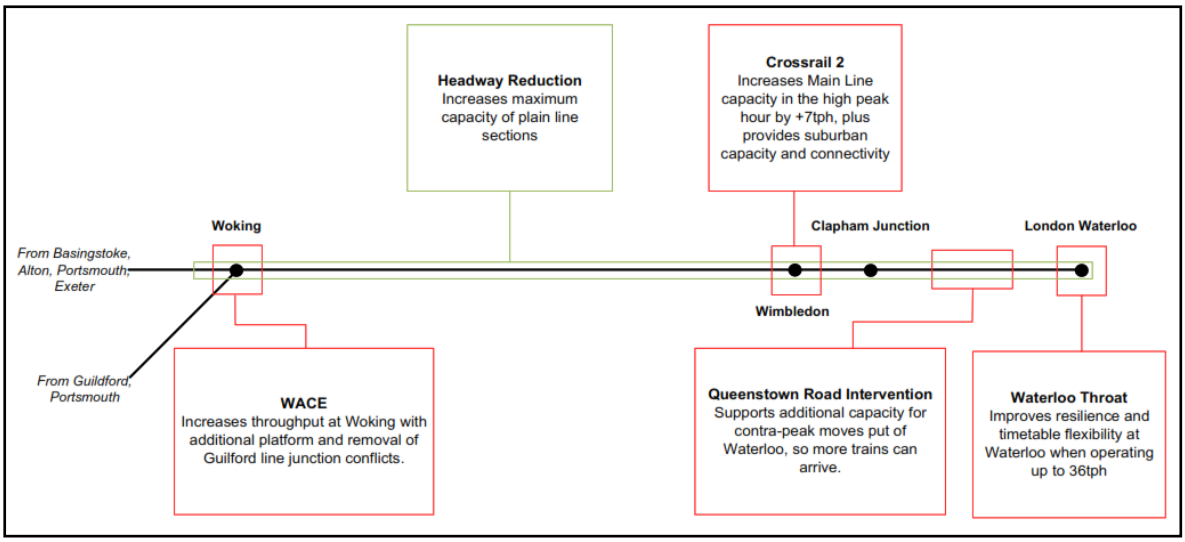


*Figure 39 - Roadmap of Interventions*

### 8.1.1 The Short to Medium-Term Strategy

Further developing our understanding of how to reduce the headways between consecutive trains is key to the delivery of future capacity and the operation of all services in a resilient and robust way. In the very short term a reduction in service, aligned to how passengers are returning to the railway, may be appropriate and is being considered by the rail industry. It is possible that a reduction in service could provide the ability to operate a more resilient and robust timetable as has be shown during the pandemic.

This possible period of service reduction could provide the opportunity for Network Rail to understand what is required to provide the 90 second headways that have been identified through this study and to look at what incremental reductions in headway could be achieved to facilitate the reintroduction of services as demand increases again. It should not be forgotten that headways between Clapham Junction and London Waterloo were a performance resilience problem before the Covid-19 pandemic.

The opportunity to implement a full headway solution between Woking and London Waterloo is likely to be through a re-signalling scheme in the area. The Wimbledon signalling area, that includes London Waterloo, will require renewal in the medium term and the development of this renewal should include the requirement for 90s headways to improve resilience and accommodate future growth.

Providing these headway improvements is only part of the solution to performance resilience and capacity through the area between Clapham Junction and London Waterloo. When demand results in the need for additional trains to be operated and the headway reductions are implemented to enable this, the question of what to do with the trains once they arrive at London Waterloo arises. Some of these trains will go back out as passenger services but some will go out as Empty Coaching Stock (ECS) to Clapham Yard or Wimbledon. As described earlier in this document, this is already a constraint and will be a worsening constraint as more services are needed.

To solve this issue, it is recommended that improvements are made through Queenstown Road, where the number of tracks drops from eight to seven. This study recommends pursuing one of two potential solutions to this constraint, one that involves the addition of an eighth track through the

area and one that involves a reallocation and change in use of current tracks through Queenstown Road. Both would require the reintroduction of Queenstown Road Platform 1. There is a third solution which is tied into changes at Clapham Junction to enable Main Line services to call at Clapham Junction in the high-peak hour, although this is deemed to be an optional intervention that is not required to meet the main performance, resilience and capacity objectives of this study.

These two enhancements, the headway reduction and one of the Queenstown Road interventions, are both required if the full benefits of performance, resilience and capacity are to be realised. In combination, and with no other interventions, these enhancements would enable up to an additional 8tph to be operated in a robust and a resilient way between Woking and London Waterloo.

Demand for these additional 8tph is not between Woking and London Waterloo, as no services stop at any stations after Woking in the high-peak hour. There is potential growth in capacity at Woking itself, but the majority of the growth is expected from locations beyond Woking. This makes the development and delivery of Woking Area Capacity Enhancement (WACE) in combination with headway reduction and a Queenstown Road intervention key to providing for the resilient operation of current and future services.

The enablers to operating any future additional services beyond Woking will be identified and assessed through the second phase of this study to be completed subsequently in 2021/22.

### 8.1.2 The Long-Term Strategy

The implementation of the headway reduction, WACE and a Queenstown Road intervention will provide improved performance, resilience and the capacity to operate additional services; should demand continue to grow beyond the additional c.8tph that these interventions provide then a further intervention would be required.

The analysis conducted through this Strategic Study has shown that of the current 24tph that were operated on the Up Fast line in the high-peak hour pre-Covid there are seven trains that are actually Main Suburban services. This means that they would usually be operated as stopping services on the Up Slow line, however, these seven trains use the Up Fast line to run fast from Surbiton. These trains take up paths on the Up Fast line that could otherwise be used for long distance Main Line services. As described in 6.2.3, Crossrail 2 would divert these Main Suburban services onto the slow lines, freeing up capacity on the Up Fast.

Section 6.2.7 of this document shows that even with the implementation of the headway reduction, WACE and a Queenstown Road intervention the theoretical capacity of London Waterloo is 32tph Main Line services in the high-peak hour.

If Crossrail 2 is not delivered and the 7tph Main Suburban services remain on the Up Fast line, then the 38tph that would be required in a pre-Covid <100 % of seats occupied scenario (24tph + 14tph) is not achievable at London Waterloo even with the implementation of a grade separation solution (to enable up to 36tph at London Waterloo). This shows that being able to move the 7tph Main Suburban services off the Up Fast line via Crossrail 2 is key to enabling the higher of Tthe demand scenarios (the pre-Covid and any post-Covid growth above the Medium scenario). This is demonstrated in Figure 47 in, below.

| | Fast Line | | Slow Line | Main Line Uplift | <85% Seats (2050) | <100% Seats (2050) | Medium post-Covid |
|---|---|---|---|---|---|---|---|
| | Main Line | Main Sub | | | | | |
| Current Service | 17 | 7 | 18 | - | -20 | -14 | -8 |
| | | | | | | | |
| Headway Reduction, WACE & Queenstown Road | 25 | 7 | 18 | +8 | -12 | -6 | 0 |
| Grade separation between Clapham Junction and London Waterloo | 29 | 7 | 18 | +12 | -8 | -2 | +4 |

*Figure 40 - Train service level in scenarios without Crossrail 2*

It can be seen that in both the <85 % and <100 % seats occupied scenarios, even with the implementation of a grade separation solution, the pre-Covid demand cannot be accommodated. The Medium (and Low) post-Covid scenario is achievable without grade separation.

Previous analysis relating to Crossrail 2 has shown that the implementation of Crossrail 2 infrastructure, including the tunnel portal at Wimbledon and the provision of six tracks between New Malden and Wimbledon, would enable capacity to be released on the Up Slow line which in turn allows the 7tph Main Suburban services that use the Up Fast line to be transferred across. This is demonstrated in the table, below.

| | Fast Line | | Slow Line | Main Line Uplift | <85% Seats (2050) | <100% Seats (2050) | Medium post-Covid |
|---|---|---|---|---|---|---|---|
| | Main Line | Main Sub | | | | | |
| Current Service | 17 | 7 | 18 | - | -20 | -14 | -8 |
| | | | | | | | |
| Headway Reduction, WACE & Queenstown Road | 25 | 7 | 18 | +8 | -12 | -6 | 0 |
| Crossrail 2 | 32 | 0 | 16* | +15 | -5 | +1 | +7 |
| Grade separation between Clapham Junction and London Waterloo (post-Crossrail 2) | 36 | 0 | 16* | +19 | -1 | +5 | +11 |
| *the 16tph on the Slow line is made up of the 7tph transferred from the Fast line plus a residual Main Suburban service to London Waterloo of 9tph, with all other suburban services entering the tunnel portal at Wimbledon. | | | | | | | |

*Figure 41 -Train service levels in scenario with Crossrail 2*

It can be seen that the <85 % seats occupied scenario cannot be achieved even with both Crossrail 2 and grade separation. The <100 % seats occupied scenario is achievable with Crossrail 2 and without grade separation. The Medium post-Covid scenario is achievable without Crossrail 2 or grade separation. Therefore, grade separation should be considered as an optional intervention should <85 % seat occupation be desired by the funder or if Crossrail 2 is unlikely to happen.

The final part of the core strategy, or road map, relates to the throat at London Waterloo. As has been shown, the track layout in the throat of London Waterloo is not ideal for the resilient operation and utilisation of the station.

As more services are required to accommodate demand the need for flexibility at times of perturbation and the ability to plan and operate services resiliently under normal operations becomes increasingly important. This study has identified a series of operational requirements that

could be implemented to improve performance, resilience and train operation into and out of London Waterloo.

### 8.1.3 Summary

The uncertainty around how passengers will return to the railway post-Covid, means that it will be important to track passenger numbers and changes to travel behaviour over the coming months and years; this is essential in recalibrating the demand forecasts and allowing a clearer understanding of when any interventions may be required.

Although in all demand scenarios there is the potential need for additional services by the mid to late 2020s, it is recognised that there is unlikely to be the funding or the time to deliver any of the enhancements identified through this study in that period. The inability to operate a robust service prior to the Covid-19 pandemic shows that the SWML has reached the limits of its operation. Therefore, it is key that as passengers return to the railway and additional services are required, over and above the reduced service that has been operated during the pandemic, they are reintroduced with resilience mitigations in mind so that the service does not fall back to pre-Covid levels of poor performance.

The priority for implementation, based on these interventions, is the need to reduce headways as this provides not only capacity but much needed performance resilience as well. This will require alignment with the signalling renewals programme, particularly in relation to the Wimbledon signalling area, which covers the network between London Waterloo and Berrylands. Although analysis was carried out as part of this study to understand how the European Train Control System (ETCS) could help to achieve the desired 90 second headways, it is the recommendation of this study that a focused piece of analysis is carried out by signalling specialists within Network Rail to understand in more detail how this could be achieved and what the incremental steps may be.

Further development of the proposed options at Queenstown Road to enable additional trains into London Waterloo to get back out again without constraining capacity or impacting performance is also recommended. This is to focus particularly on how incremental changes through the area may be able to deliver performance and capacity improvements with the ultimate goal being to implement the full capability suggested through the options identified in this study.

It is clear from previous analysis that the service operated prior to the Covid-19 pandemic was at the limits of what could be run through Woking Junction and station in a robust and resilient way. This study therefore recommends that Woking Area Capacity Enhancement (WACE) remains a future infrastructure intervention for when demand is sufficient that additional trains above what was previously operated are required.

Depending on the level of demand, Crossrail 2 should still be considered as a part of the road map/ strategy for growth on the Main Line. It should also be remembered that Crossrail 2 has wide ranging benefits outside of its impact on Main Line demand into London Waterloo. The Crossrail 2 scheme should be considered as a solution for direct connectivity into and across central London from both the Wessex and Anglia Routes; is an enabler of wider regeneration and development; and provides for any future suburban capacity requirements.

Improvements to the throat at London Waterloo should also be considered as a long-term aspiration for performance resilience and the robust operation of service uplifts as they are introduced.

The building blocks of the Core Strategy or Road Map are summarised over the page, along with the benefits they could provide. These interventions can be initiated, when required, as the post-Covid demand picture emerges and becomes clearer.

| | WACE | Headway Reduction | Queenstown Road Option 1* | Queenstown Road Option 2* | Crossrail 2 | London Waterloo Throat Remodelling |
|---|---|---|---|---|---|---|
| Benefits | Unlocks greater throughput of trains at Woking, increases resilience and platform capacity | Creates additional paths on SWML and increases resilience in conjunction with a Queenstown Road intervention + WACE etc. | Enables more services to stop at London Waterloo (up to 32tph) and increases resilience | Enables more services to stop at London Waterloo (32tph), improves Windsor Lines Capacity and increases resilience | Creates additional paths on SWML, suburban connectivity and capacity and wider development opportunities | Increases resilience at London Waterloo by providing more parallel moves and linespeed improvements would help deliver the contra and evening peak timetable |
| Drawbacks | Unlikely to provide any additional paths on its own | A major infrastructure and rolling stock investment | Constrains future Windsor Line growth in combination with other Windsor Line constraints | A major infrastructure investment | A major infrastructure investment | Track geometry highly constrained by geography |
| Compatibility | Compatible and required for and with all other interventions | Compatible and required for and with all other interventions | Compatible and required with WACE, Headway Reduction and Crossrail 2 and is compatible with Grade Separation | Compatible and required with WACE, Headway Reduction and Crossrail 2 and is compatible with Grade Separation | Compatible with all other interventions | Compatible with all other interventions |
| Growth Scenarios | Required for all pre-Covid and post-Covid growth scenarios | Required for all pre-Covid and post-Covid growth scenarios | Required for all pre-Covid and post-Covid growth scenarios | Required for all pre-Covid and post-Covid growth scenarios | Required for all pre-Covid scenarios but only post-Covid growth between the Medium and High scenarios | Allows the introduction of additional capacity in a robust and resilient way and some specific interventions may be required for the contra and evening peak |

***Chose of either QTR Option 1 or QTR Option 2 – not both**

*Figure 42 – Intervention Summary*

Other interventions have been identified through this Strategic Study that do not form part of the core road map or strategy for Main Line services into London Waterloo, these include:

- Grade separation between London Waterloo and Clapham Junction – this may only be required if demand at London Waterloo exceeds the theoretical capacity of 32tph Main Line services or if Crossrail 2 is not implemented;
- Clapham Junction interventions – these are related to the ability to call high-peak hour Main Line services at Clapham Junction, something that cannot currently be achieved. This is optional should funders wish to address this aspiration;
- Queenstown Road Option 3 – this is the required Queenstown Road option if Clapham Junction Option 2 is implemented but is not required in any other scenario (see core road map and strategy for the preferred Queenstown Road options).

Other potential infrastructure interventions that may be required beyond Woking will be identified through the next phase of the Main Line study work in 2021/22.

## 8.2 Rolling Stock

The majority of South Western Railway (SWR) Main Line services are operated using 'Desiro' electric multiple units; the Class 450s and Class 444s. These trains were brought into use in 2004 to replace British Rail 'slam-door' stock. They are operated at a maximum 12-car (20m carriages) and 10-car (23m carriages) respectively. This maximum length of train is consistent with other services operating into central London via other routes.

However, there is still some diesel rolling stock which continues to run on the South West Main Line; these are the Class 158/159s that serve the West of England Line. There is an aspiration to replace these with more carbon friendly stock as the existing trains will soon need replacing with modern units. Full electric rollout would require electrification of the West of England line and therefore a bi-mode rolling stock option may be appropriate in the medium term. Power capability, both High Voltage (HV) and 3rd Rail, should be considered when decisions are made on the replacement of the diesel fleet.

The analysis carried out through this study has applied the concept of a 'train' being a 12-car Class 450 as the 3+2 seating arrangement provides the most seating capacity for long distance Main Line travel. When the 'Desiro' fleet is ready for replacement, consideration of how to provide the most seating capacity for longer journeys without compromising on passenger experience will be necessary.

Suitable depot and stabling space is scarce and will continue to be so as additional trains are required and as new rolling stock requires different facilities; for instance, the depot facilities at Salisbury for the Class158/159 diesel fleet may not fit the requirements for a future electrified train fleet.

It is therefore essential that any discussion about additional services considers when replacement of the current fleet is required and what the impact would be on the availability of suitable depot and stabling capability.

## 8.3 Performance and Resilience

The infrastructure interventions outlined in this study propose to solve the long-term concerns anticipated on the SWML relating to performance resilience and capacity, however, there are

several other workstreams already underway to help address issues with performance and resilience in the shorter-term. It is expected that these workstreams will continue to play an important role when developing the solutions from this study.

These workstreams include:

- The Network Rail and SWR Joint Performance Improvement Centre (JPIC) – looking at incremental performance improvements;
- Long-Term Berthing Strategy – looking at depot, stabling and berthing capability in the longer-term to address future requirements;
- Future Timetables Group – an industry level group that discusses timetable changes to ensure that a whole system approach is taken.

Ongoing engagement between Network Rail's Southern Regional Strategic Planning and these groups will be essential. Any future service changes need to be made with performance resilience at the forefront of decision making if the performance issues experienced pre-Covid are not to be repeated.

This Strategic Study also recommends that the suggested specifications for an improved throat at London Waterloo, that were identified through the capacity analysis work, are considered through the JPIC to understand how they could be achieved, if considered appropriate.

## 8.4 Network Maintenance

Every day on Wessex Route, the Network Rail Maintenance Teams inspects infrastructure assets at between 80-100 locations completing an average of 623 inspections across the Track, Signalling, Electrification, Plant, Off-Track, Level Crossings and Telecoms disciplines to make sure all assets are in a safe and compliant condition. This covers over 500 working hours of lineside activity in a 24hour period.

Disruptive activities are scheduled to be carried out during the night where possible to limit the effects on operational activities, but daytime inspections are sometimes unavoidable due to the nature of the inspection process or failure of infrastructure assets. These inspections and associated remedial works have to be accommodated around timetabled passenger services with disruptive access being required to ensure the safety of the front line teams completing the tasks

Additionally, longer periods of access are scheduled at regular intervals to allow the Maintenance Teams to carry out repairs and more intensive maintenance activities to ensure asset reliability remains as high as possible at each location. This activity is generally undertaken at night or at weekends unless it is an unplanned emergency.

This Strategic Study looks at how to robustly increase the number of train services between London Waterloo and Woking in order to meet future demand. A key element of making these additional services feasible and deliverable will be to ensure Network Rail can continue to safely maintain the network as more services are introduced.

Network Rail Wessex is already looking to reduce (and ultimately remove) daytime inspections and access via increased use of technology and alternative inspection methods (e.g. Plain Line Pattern Recognition Trains to enable the inspections to be done remotely). This both reduces disruptive daytime access and keeps Maintenance staff safe by removing any interface with train services.

Key strategic Maintenance issues on the SWML corridor between London Waterloo and Woking are as follows:

- First/Last trains – The regular night access required for repairs and inspections can only take place once passenger trains have finished running and before the morning service starts. It will be vital that this window to undertake essential maintenance activity is protected and earlier/later trains are not run at the cost of this access;
- Weekend access – There are repair and replacement works that can not be undertaken in the weeknight windows between last and first trains. This involves taking longer possessions at weekends and disrupting the passenger train services.
- Stabling – Insufficient stabling on the inner section of the SWML means that trains are currently stabled in station platforms overnight. This currently happens at both London Waterloo and Clapham Junction, though this is also the case further out such as at Guildford. This means the Maintenance teams cannot inspect the platforms and track where these trains are stabled and need to arrange for them to be moved. As discussed in section 8.2, it will be vital to make sure any service increases are supported by adequate depot and stabling facilities to make sure they can be berthed off the main network overnight.
- Signal design – A key recommendation of this Strategic Study is to progress a workstream looking at the feasibility of the aspired headway reduction from 2-minutes to c.90-seconds. Maintenance access will be a key consideration in this workstream to enable the signalling to be designed to run trains more flexibly and allow shorter sections of line blockages;
- Infrastructure access and lighting – Any new infrastructure on the railway should be designed with maintainability and safe access at its core. This includes walking routes, adequate lighting for night inspections and access points.

The other key point to note is that increasing the number of train services on the rail infrastructure will consequently increase the need for inspections and maintenance in some locations. This is why it is even more vital to make sure the strategy for future freight and passenger services on the route is joined up with the Wessex future maintenance strategy to make sure both can be effectively delivered.

## 8.5 Main Line Stations

The Main Line fast services predominantly call at three stations in the Phase One Study geography – Woking, Clapham Junction (in the off-peak) and London Waterloo. This Study has not re-examined the capability of these three stations as they all have established strategies which are summarised below.

### 8.5.1 Woking

Woking Station sees c.7.4 million entries and exits every year (2018/19 pre-COVID ORR station usage data) and 14 of the current 25tph peak service call or start at Woking.

Both gatelines experience regular crowding at peak times and this would only be exacerbated should additional services be introduced on the South West Main Line as proposed in this Strategy. A pre-requisite of any peak service uplift on the line is the freeing up of the flat junction capacity constraint at Woking Junction. There is a project in the development pipeline that would address this constraint and provide additional platform capacity. This would involve the reconstruction of the Platform 5 (town centre) side entrance to accommodate the new platform

and would likely also address the Platform 1 gateline at the same time as it would be most efficient to do this as part of the same project.

### 8.5.2 Clapham Junction

In the off-peak, most SWML services call at Clapham Junction. The station serves the Main Lines to London Waterloo, London Victoria and the London Orbital rail networks. The station is used to access the rail network by passengers from nearby Battersea and Clapham along with the surrounding areas of Wandsworth, Putney, Balham in a busy urban part of South West London.

The excellent opportunities for connections between rail lines result in Clapham Junction being the busiest interchange station in the country, and the fourth busiest for interchange and entries/exits combined. The station saw c.56m passenger movements in 2019/20 and also has to accommodate exceptional passenger demand during event days at Twickenham, Wimbledon and Ascot.

The station currently has three entrances and two main interchange routes - a subway and a footbridge.

The existing station is not fit for purpose for the passenger numbers that Clapham Junction sees on a day-to-day basis. The station currently operates in congested conditions and is regularly subject to overcrowding, even more so when the network is experiencing disruption.

There is a Network Rail programme looking at Clapham Junction station and what interventions are required in both the short- and long-term to accommodate demand, future trains service requirements, optimise passenger experience and how the station can best interface with developments in the local area. The Clapham Junction related interventions explored in this Study will be passed over to that programme for further consideration.

### 8.5.3 London Waterloo

London Waterloo is the busiest train station in the country with c.93 million passenger movements in 2018/19. This is 18% higher than the second busiest station, London Victoria. The station provides commuters access to central London via walking routes, bus routes and connections to the Bakerloo, Jubilee, Northern and London Waterloo and City Lines.

The station has the largest concourse of any terminal station and yet still sees daily congestion and crowding due to the sheer volume of passengers. This crowding is most acute at Exit 2 which is both the route to the Jubilee Line and the entrance/exit to London Waterloo Road. This area sees severe crowding every weekday and is frequently subject to active crowd control measures.

The congestion issues at London Waterloo will worsen if the train service levels are increased in the coming years. There are several initiatives currently in development to address this along with aiming to improve passenger experience at the station:

- Station environment and Exit 5 congestion – a package of work connected to the development of Elizabeth House which is adjacent to the station. This comprises initiatives to improve the station environment as well as relieve the evening peak congestion at Exit 5 which connects the station to London Waterloo Road and South Bank. The former includes improvements to passenger information systems, a new entrance to station in the lower level by Platforms 20 – 24, and refurbishment of Victory Arch (Exit 5);

- Exit 2 Congestion Relief – A workstream is in development to examine options to address the crowding and congestion experienced daily at Exit 2;
- Exit 1 Connections – A workstream is considering how passenger access between Spur Road and the station could be improved via Exit 1 (adjacent to Platform 1).

## 8.6 Power Supply

Providing the power to operate any proposed service changes is important for the robust and resilient operation of that service. There are some proposed power upgrades in the process of seeking funding that will provide the resilience in both High Voltage (HV) and 3rd Rail (DC) power for sections of the Main Line network beyond Woking. This will form a solid basis on which to operate additional services but will not necessarily provide the power capability required for the future.
Additionally, changes to the current fleet, such as the replacement of the diesel Class 158s and 159s with bi-mode vehicles will require increased power capability for the same level of service that was operated pre-Covid.

It is the recommendation of this Strategic Study that schemes in development, such as South London HV, are continued and that the findings of this Strategic Study are considered so that any power modelling takes account of potential future service changes, including rolling stock changes.

## 8.7 Recommendations and Next Steps

Based on the strategic road map described above this Strategic Study proposes the following recommendations and immediate next steps:

1. Quarterly reviews of SWML demand levels and how the return of passengers post-Covid is proceeding against the forecast range of scenarios – this is a key action for understanding when additional train services would be required to accommodate passenger demand and therefore when to look to implement the interventions described in this Study. It should be noted that enhancements of this type take several years to develop and design and several more to deliver;
2. Progress a study on the feasibility, cost and timescales associated with achieving a c.90 second headway between Woking and London Waterloo and the potential interface with Wimbledon Re-signalling;
3. Progress a workstream looking at the Queenstown Road interventions and whether operational and performance benefits would warrant delivering the new platform as a first phase of work in advance of train paths being released by completion of the headway reduction and Woking Area Capacity Enhancement;
4. Progress the strategic power supply interventions described in Section 8.5 to support the future uplifts in train service outlined in this Study;
5. Pass the Clapham Junction interventions over to the Clapham Junction Programme for consideration as part of the wider workstream;
6. Undertake a second phase of this SWML Strategic Study looking at the outer area to identify where the additional future train services described in this first phase should operate beyond Woking and whether the network could accommodate them.

# Appendix A – Safety Baseline

| Slips, Trips and Falls | Source: SMIS |
|---|---|
| There were 117 slips, trips and fall incidents in the study area in 19/20.<br>This formed 59 % of all slips, trips and falls on the Wessex Route.<br><br>Of the 117 slips, trips and falls recorded, 59 % of these were reported at London Waterloo and 27 % were reported at Clapham Junction. Recognising the volume of passengers travelling through these stations, it is not surprising that these two locations account for such a high proportion of the incidents. | |
| **Suicide/Attempted Suicide** | **Source: TRUST** |
| There were 23 suicide incidents reported in the study area in 19/20.<br>This formed 37 % of all suicide incidents on the Wessex Route.<br><br>The number of suicide incidents at New Malden accounts for 22 % of this figure, with Weybridge accounting for 17 %. The remaining 61 % is distributed fairly evenly across 7 other locations along the SWML inwards of Woking. | |
| **Near Misses** | **Source: SMIS** |
| There were five near misses reported in the study area in 19/20.<br>This formed 6 % of all near misses on the Wessex Route. | |
| **Signal Passed at Danger** | **Source: SMIS** |
| There were nine signal passed at danger (SPAD) incidents in the study area in 19/20.<br>This formed 26 % of all signal passed at danger (SPAD) incidents on the Wessex Route.<br><br>Of the 9 SPADs recorded, 4 of these were recorded at Wimbledon. The remaining 5 incidents were reported at 4 other locations. | |
| **Staff Accidents** | **Source: SMIS** |
| There were 51 staff accidents reported in the study area in 19/20.<br>This formed 26 % of all staff accidents on the Wessex Route. | |
| **Trespass/Vandalism** | **Source: SMIS** |
| There were 88 incidents of trespass and vandalism reported in the study area in 19/20.<br>This formed 7 % of all trespass and vandalism incidents on the Wessex Route.<br><br>The locations with the highest number of reported incidents include Woking (18 %), Wimbledon (11 %) and Surbiton (10 %). | |
| **Weather** | **Source: TRUST** |
| There were 14 weather related incidents in the study area in 19/20.<br>These formed 6 % of all weather related incidents on the Wessex Route. | |

| **Level Crossing Interface** | **Source: SMIS** |
|---|---|
| There were no LX interface incidents in the study area in 19/20 as there are no level crossings between London Waterloo and Woking. | |
| **Fly-Tipping Cases** | **Source: SMIS** |
| There were no fly-tipping incidents in the study area in 19/20. | |
| **Staff Assault** | **Source: SMIS** |
| There were nine staff assaults reported in the study area in 19/20.<br>This formed 45 % of all assaults on the Wessex Route. | |
| **Bridge Strike** | **Source: TRUST** |
| There were 17 bridge strikes in the study area in 19/20.<br>This formed 15 % of all bridge strikes on the Wessex Route.<br><br>Five locations had reported bridge strikes, with 41 % of the incidents in the study area occurring at Woking. Others included Weybridge (29 % ), Surbiton (18 % ), London Waterloo (6 % ) and Clapham Junction (6 % ). | |

# Appendix B – Development of pre-COVID baseline demand forecasts

## B.1 General Model Structure

### Network Definition

Throughout the SWML Strategic Study, the network was defined at the arc level, for the whole of the London Victoria high peak. Defining the network at the arc level means that all demand is represented as the sum of the loads on all trains between two stations, with all trains divided between inner and outer services, and defined as the services arriving at London during the high peak.

Capacity is defined in the same way, as the sum of all of the seats and m2 standing area, on either all inner or outer services in the peak hour, between two stations.
The result of this is two networks – the total interstation load and capacity for the inner suburban and orbital market, and the total interstation load and capacity for the outer suburban & long-distance market. Key to note here is that this definition does not consider the origin-destination demand but is focussed on the typical experiences of passengers on trains into London during the high peak.

## B.2 Base Year Demand and Capacity

### 2016 Demand

#### *MOIRA demand profile*[15]

Count data is required by the DfT to be recorded for all services at arrival or departure from the city centre (the cordon point), and at the busiest point on the service (the critical load point). Sometimes further load points are recorded, such as (in London) services that offer multiple points of interchange onto London Underground services. However, our network requires arc loads for the entirety of the service, not just at a few locations near/at the terminus.

To get a representation of how demand rises over the whole of a service, we used the train loadings reports from MOIRA to generate a picture of load over a service. While the magnitude of the load in MOIRA over a service will not be accurate, MOIRA represents the best readily available source of data the shape of how loads rise over a service.

#### *Scaling demand with count data*

To fix the demand profiles from MOIRA to the observed count data, the following algorithm was used for each arc on a service

- If the arc has count data, find the scaling factor required to change the MOIRA load to the count data load, and multiply the MOIRA load by this scale factor such that the new load is the observed count data load;
- If the arc has no count data, the MOIRA load is scaled by the scaling factor from the closest count data arc in the Up direction. Note that services are travelling in the Up direction – towards London;

[15] MOIRA2 is rail industry standard software, used widely for estimating how rail demand on trains changes in response to internal factors (e.g. improved service), and external factors (e.g. background population growth).

- If the arc has no count data and is after the last count arc, the MOIRA is scaled by the scaling factor from the closest count data point in the Down direction.

Then, the scaled demand over all arcs was summed to get the total load on each arc from inner or outer services into London in the peak hour.

### 2016 Capacity

Capacity on each arc in the model is taken to be the total seats and total $m^2$ standing area, from either inner or outer services, arriving in London in the high peak. Capacity was represented at the service level by the rolling stock unit type and number of units. The capacity of each rolling stock type was taken from count data.

## B.3 Future Year Demand and Capacity

### 2016 and Future Year Railplan Demand Forecasts

#### *Use of Railplan*

Railplan is the primary model used by TfL for modelling demand on public transport in London and the south-east. The Railplan forecasted loads s were not directly applied and will vary from the observed 2016 count data loads, as Railplan is a model. Instead, the work has taken the percentage growth in arc Railplan demand between 2016 and each future year and applied that percentage increase to the 2016 arc loads. Railplan as a model

#### Railplan model structure

Railplan is a multi-modal public transport model, looking at bus, National Rail, Underground, Overground, DLR, and Tramlink services, along with walk access to and between services. Public transport services in the Railplan model are modelled as a transit line – a service pattern with a frequency, and not as a timetabled set of services. Forecasting with Railplan

Demand on Railplan follows from advice in TAG. Railplan uses as input both aggregate forecasts of central London employment and DfT forecasts, and specific planning data from TEMPro and the 2016 London Plan.

#### Railplan Version

The version of Railplan used was version 7.2. The scenarios run were the AM, under the Funded Reference Case, for 2016, 2031, 2041, and 2050.

#### *Interpreting Railplan data to arc loads*

In general terms, the same method was used as for the base year demand. The transit lines relevant to this study were identified, and demand aggregated on each arc over the three-hour AM peak. Future year demand growth is taken as the percentage growth in Railplan demand between modelled years.

### Future Year Capacity through Committed Schemes

In order to see forecast passenger outcomes, the future arc capacity for both inner and outer services is required. Future capacity is not taken as the timetable in any specific year, but rather the capacity when all committed schemes are realised.

The Senior Strategic Planners responsible for the routes into London were asked for the expected service patterns given committed schemes. Committed schemes in this context are schemes in the final investment stage, or in Franchise agreements. This was then converted into expected rolling stock on services arriving in London in the peak hour, in terms of seats and $m^2$ standing area. This was then aggregated to find the future year total seats and $m^2$ standing area on each arc, from services.

## Future Year Outcomes

Base year (2016) arc demand and capacity is used directly from the method described in B.2. Future year arc capacity is used directly from the method in B.3. Future year arc demand starts with the base year demand and scales it up by the change observed in the Railplan arc loads. This results in future year arc demand, based on MOIRA demand profiles, scaled by count data, and grown by Railplan forecasting. Taken in conjunction with rolling stock from future committed schemes, this produces the forecast passenger outcomes in terms of average passengers per seat and passengers per $m^2$, averaged over all services arriving in London in the AM high peak, for inner and for outer London services.

## Risks with Future Year Methodology

- The Railplan future year service pattern that does not exactly align with the future year service pattern assumed. The discrepancies have been sent to TfL for their use in updating their models. They may cause some locations to be forecast poorly in terms of passenger outcomes, where a future year service is routed one way by Railplan, and a different way in our future year capacity provision.
- The Railplan model was run as unconstrained, such that no passengers are crowded off trains. This is necessary to provide a picture of future year passenger outcomes without further interventions and enable prioritisation by the most crowded arcs. However, in certain locations (such as around Crossrail), unrealistic standing densities of > 6 passengers/$m^2$ are forecast, where some of these passengers would certainly be taking other less congested routes.

# Additional Technical Information

## Model Suite Structure Diagram

The figure below shows the general model structure, and flow of data between models.

*London Rail Strategy Model Suite Structure*