West Coast Main Line Capacity Assessment 2020

Capacity Analysis – System Operator

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Part A: **Executive Summary**

A.01 Background

A.01.01 The Office of Rail and Road (ORR) has asked Network Rail to carry out an appraisal of the West Coast Main Line (WCML) capacity and the potential impact on performance that would result from running any additional services.

A.01.02 A cross-industry group met in December 2019 where the remit for this work was consulted and subsequently updated. The final remit was published at the end of December 2019 in line with ORR's request. It was agreed that this analysis would refresh a report written in October 2013, *West Coast Main Line and Trans-Pennine Capacity and Performance Assessment,* which identified potential capacity on the Fast Lines (FL) of the WCML.

A.01.03 The analysis carried out identified which, if any, of the FL arrival and departure paths into and out of London Euston found in the 2013 report still exist in the May 2020 timetable, with a view to identifying whether any additional FL paths on the WCML can be found in the May 2020 timetable.

A.01.04 The 2013 report was used as a basis because the fundamental structure of the FL timetable has not changed and it was the last holistic piece of work that considered performance as well as pathing of trains.

A.02 Key Findings

A.02.01 There is no available capacity without significantly impacting performance and causing a reduction in timetable resilience due to the resulting requirement for successive services to run on minimum headway (see C.01.09 for an explanation of headway). This means that there is insufficient capacity to support additional FL paths without a recast of the WCML timetable. Further work would be required to understand if a recast could deliver further capacity.

A.02.02 With reference to the punctuality levels that are currently being observed; coupled with a desire to have a robust and reliable timetable, which can recover and mitigate lateness, whilst also managing capacity in the best way possible, it is advisable from a performance point of view to develop a timetable from scratch rather than adding further services to the existing timetable structure.

A.02.03 From the 3 paths per hour in each direction identified in the 2013 report there were no remaining slots offering a consistent service pattern in all hours analysed within the May 2020 timetable.

A.02.04 The Down departure slot at XX:57 from London Euston identified in the 2013 report still exists with TPR (Train Planning Rules) compliant paths[1] from London Euston to Ledburn Junction in all hours between 10:00 and 16:00. By Ledburn Junction they reach minimum headway with the trains to either side and would therefore have a significant impact on performance and cause a reduction in timetable resilience. These paths do not exist further north than Ledburn Junction.

A.02.05 The Up arrival slot at XX:43 into London Euston identified in the 2013 report was found to exist in 4 of the 6 hours between 10:00 and 16:00 with TPR compliant paths from Milton Keynes Central to London Euston. These paths do not exist further north than Milton Keynes Central.

A.02.06 Pockets of capacity were identified on other sections of the WCML however no continuous paths could be found to link capacity along the entire route to create an end-to-end journey. A timetable recast would be required to investigate whether the capacity for longer continuous paths exists.

A.02.07 Using any portion of slot that has been identified on the WCML would reduce the firebreaks currently available for recovery of service during operation of the timetable.

A.02.08 An uplift in freight of one class 4 path per hour across each two-track section of the WCML between Brinklow and Preston was found to be achievable in the majority of hours between 10:00 and 16:00.

A.02.09 The main structure of the base timetable on the FL on the WCML has not changed significantly between that used in the 2013 report and the May 2020 timetable. The notable changes relevant to this piece of analysis are the addition of the Grand Central (GC) and Avanti operated Blackpool North services and alterations to the West Midlands Trains (WMT) operated Liverpool services.

A.02.10 A 110mph path requires the capacity of two 125mph paths for the journey from London Euston to Milton Keynes Central. Running additional paths at 110mph within a timetable structure predominantly constructed with 125mph trains is not an efficient use of capacity.

A.02.11 The theoretical maximum capacity of the Fast Lines south of Rugby is reduced by running 110mph services within a timetable structure predominantly constructed with 125mph trains, by calling services on the Fast Lines at Watford Junction and by undertaking crossing moves between fast and slow lines, at Ledburn Junction in particular.

[1] See C.01.05 for TPR compliance

A.03 Summary of Analysis

A.03.01 The report written for the ORR in October 2013 identified 3 hourly paths on the FL in each direction into and out of London Euston between the hours of 10:00 and 16:00. These comprised departures at XX:33, XX:36 and XX:57 in the Down direction and arrivals at XX:02, XX:30 and XX:43 in the Up direction. It reported that 1 of the 3 paths per hour in each direction could be supported but that the other two could not due to performance risk.

A.03.02 This 'refresh' of the 2013 report was carried out in order to determine which, if any, of the FL arrival and departure paths into and out of London Euston identified in the 2013 report still exist in the May 2020 timetable. This was done with a view to identifying whether any additional FL paths on the WCML could be found in the May 2020 timetable.

A.03.03 Prior to this 2020 analysis work being undertaken, an uplift of one class 4 freight path per hour across key sections of the WCML was included where possible. This was done to ensure that future freight growth is accommodated in the findings of this report.

A.03.04 Of the 3 departure slots out of London Euston identified in the 2013 report, only the XX:57 was found to still exist in all 6 of the scope hours, as outlined above in section A.02.04. The XX:33 and XX:36 departure slots are no longer available due to the inclusion of the GC Blackpool services which use both paths due to them comprising 110mph capable rolling stock.

A.03.05 Of the 3 arrival slots into London Euston identified in the 2013 report, only the XX:43 was found to offer TPR compliant paths from Milton Keynes Central in 4 of the 6 scope hours, as outlined above in section A.02.05. The majority of the XX:02 and XX:30 slots have been utilised by amended WMT operated services from Liverpool Lime Street or have been 'eroded' by successive timetable changes.

A.03.06 Either 110mph capable or 125mph capable rolling stock may offer TPR compliant paths for the availability identified in this report outlined under C.01.06 and C.01.07. This is due to both the stopping pattern and speed of adjacent trains, and to the path availability being limited to short sections of the WCML, the longest of which is between London Euston and Milton Keynes Central.

A.03.07 There is a significant difference between 110mph and 125mph capable rolling stock, as a 110mph path utilises the capacity of multiple 125mph paths. Between London Euston and Milton Keynes Central a 110mph essentially uses the capacity of two 125mph paths. This is a cumulative effect that is more significant over larger distances.

A.04 Risks

A.04.01 Utilisation of remaining capacity on the WCML would remove much of the current timetable resilience and has the potential to significantly further impact performance.

A.04.02 Reduction in platforms at London Euston from 18 to 16 is already a major timetabling constraint in the current timetable so any additional paths identified would also be constrained by this. Platforming at London Euston has not been assessed as part of this study.

A.04.03 Future infrastructure projects and changes may have an impact on the availability of any currently remaining capacity in the timetable and therefore change the outputs of this analysis.

A.04.04 Future timetable changes to rolling stock, service quantum and service patterns could have the potential to change the outputs of this analysis. Examples of future changes that might impact on the outputs can be found under sections C.11 and C.12.

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Part B: Introduction

B.01 Background

B.01.01 On 11 October 2019 the ORR wrote to the industry setting out their approach to taking forward several aspirations to run additional services on the WCML. The ORR asked for formal applications by Friday 15 November. The applications received were as follows:

- The new franchisee First Trenitalia West Coast Rail Limited (FTWC, now operating as Avanti West Coast) for rights from December 2022 for additional 125mph capable (assumed class 390) London Euston – Liverpool Lime Street services to increase its service from 1 to 2 trains per hour;
- Prospective Open Access Operator Virgin Trains (VT) for rights from December 2022 for an hourly return service between London Euston and Liverpool Lime Street, running with 125mph capable class 221 rolling stock, calling at Nuneaton, Tamworth, Lichfield Trent Valley and Liverpool South Parkway;
- Prospective Open Access Operator Grand Union Trains (GUT) for rights from May 2021 for 4 return services per day between London Euston and Stirling, running with 110mph capable class 91 rolling stock, calling at Milton Keynes Central, Nuneaton, Crewe, Preston, Carlisle, Lockerbie, Motherwell, Whifflet, Greenfaulds and Larbert;
- Franchisee West Midlands Trains (WMT) for rights from December 2020 to run an additional return service in certain hours between Northampton and London Euston with an assumed 110mph capable class 350 rolling stock; and
- Existing Open Access Operator Grand Central North West (GCNW) to turn the contingent right that it holds to run a fifth service on Wednesday every 8 weeks between London and Blackpool into a firm right; this was assumed to be running with 110mph capable class 91 rolling stock.

B.01.02 The ORR has asked Network Rail to carry out an appraisal of WCML capacity and the potential impact on performance that would result from additional services.

B.02 Aims and Objectives

B.02.01 In order to deliver an output in the timescales required the analysis was targeted around undertaking a 'refresh' of relevant sections of the 2013 report. This approach was taken as the 2013 report identified a number of unused FL slots. This refresh focuses on the following areas of investigation in order to answer the questions set out below.

B.02.02 As part of this work a small amount of flex to the current timetable was considered, but re-ordering of services, changes to calling patterns or multiple re-timings of multiple services was not considered.

B.02.03 Collate and categorise all aspirations:

- What are the aspirations and which elements of each aspiration can be considered as 'similar' or 'different' for the purposes of the capacity analysis?
- How much additional capacity would be needed in order to accommodate all aspirations?

B.02.04 From the assessment that was undertaken in 2013:

- To what extent is the baseline timetable different?
- What other changes have happened since 2013 which may have a material impact on the capacity of the timetable, including freight growth, plans associated with High Speed 2 (HS2) and available platform capacity at Euston?
- Could the additional paths that could be accommodated within the timetable structure in 2013 still be accommodated within today's timetable and if not, what has changed?
- To what extent has the underlying performance of the WCML changed since 2013 and what are the implications of that change?

B.02.05 There are a number of other changes to the timetable or infrastructure in various stages of development which did not form part of this analysis. These are listed below as there may be dependencies between them and the proposed additional services.

- East-West Rail (EWR)
- Arriva Rail North franchise commitments in the Stockport area (3 additional trains per hour through Stockport)
- Transport for Wales franchise commitment for a revised service into Liverpool, splitting/joining at Chester to serve Llandudno and Cardiff
- Ongoing work to improve performance on the Castlefield Corridor
- HS2 and the associated Materials by Rail (MBR) services
- Crewe Hub

Part C: Findings

C.01 Capacity Analysis May 2020

C.01.01 There was limited capacity identified in both the Down direction and the Up direction for additional paths.

C.01.02 From the 3 paths per hour in each direction identified in the 2013 report there were no remaining slots offering a consistent service pattern in all hours analysed within the May 2020 timetable.

C.01.03 Of the small amount of availability identified, there would be a decrease in timetable resilience and performance due to the resulting requirement for successive services to run on minimum headway (see C.01.09 for explanation of headway).

C.01.04 The following sections will provide further breakdown of the investigation and potential TPR compliant paths identified in each direction independently.

C.01.05 The term TPR compliant in this report is used to refer to a path that does not conflict with the rules set out in the TPRs, with particular consideration given to minimum headways. Where paths have been identified as TPR compliant, this does not make any comment on the possible performance risk of operating the path, and as such it may not be able to operate without significantly impacting performance and causing a reduction in timetable resilience.

C.01.06 Table 1 summarises the availability in the May 2020 timetable of the Down paths that were identified in the 2013 report.

Departure from Euston	10:xx	11:xx	12:xx	13:xx	14:xx	15:xx
XX:33	Rugby	Used by GC Blackpool	Used by GC Blackpool	Colwich	Rugby	Used by NMT[2]
XX:36	Used by Avanti Blackpool	Ledburn Junction	Ledburn Junction	Rugeley Trent Valley	Rugby	Used by NMT
XX:57	Ledburn Junction	Ledburn Junction	Ledburn Junction	Ledburn Junction	Ledburn Junction	Ledburn Junction

Table 1: Summary of the availability in May 2020 of Down paths identified in the 2013 report

[2] New Measurement Train

C.01.07 Table 2 summarises the availability in the May 2020 timetable of the Up paths that were identified in the 2013 report.

Arrival into Euston	10:xx	11:xx	12:xx	13:xx	14:xx	15:xx
XX:02	Used by GC Blackpool	Tring	Hillmorton Junction	Ledburn Junction	Used by Avanti Liverpool	Eroded by 1A83 / 1A35
XX:30	Used by WMT Liverpool	Used by WMT Liverpool	Eroded by 1W10 / 9M50	Used by WMT Liverpool	Used by WMT Liverpool	Eroded by 1A37 / 1W16
XX:43	Used by WMT Liverpool	Eroded by 1A19 / 1A82	Milton Keynes Central	Milton Keynes Central	Milton Keynes Central	Milton Keynes Central

Table 2: Summary of the availability in May 2020 of Up paths identified in the 2013 report

C.01.08 In all of the above it should be noted that the inclusion of any additional services will 'push the limits of timetable robustness'. Trains would be running at or near to minimum headway, vastly reducing the performance buffer time and therefore producing a less resilient timetable with increased performance issues.

C.01.09 The WCML has a specified minimum headway value of 3 minutes from London Euston to Crewe. This headway applies to all of the paths identified in Table 1 and Table 2. Minimum headway values such as these are specified in the TPRs for every route to ensure all trains are planned to operate at a safe distance apart. This means that trains travelling in the same direction must be timed to pass the same location at least 3 minutes apart, although in practice a larger separation than this is preferable to aid the recovery of delays. Several consecutive services spaced at this minimum distance is viewed as a performance risk.

C.02 Comparison of May 2014 to May 2020 Timetables

C.02.01 The service pattern on the WCML between London Euston and Carnforth North Junction (towards Scotland) in May 2020 was compared to that in the 2013 report and was found to have a similar structure. The service groups in the May 2020 timetable were compared to those detailed in Appendix A of the 2013 report. Four changes in the service pattern on the WCML were identified which has had an impact on the availability of new paths in and out of London Euston, otherwise the timetable was largely unchanged.

C.02.02 The differences in the timetable structure identified between the 2013 report and May 2020 are:

- A two-hourly WMT Liverpool Lime Street to Birmingham New Street, and its return service, has been extended to run to and from London Euston
- The WMT Birmingham New Street to Birmingham International shuttle has been incorporated into a Rugeley to Birmingham International service which then forms a Birmingham International to Liverpool service.
- The inclusion of new GC and Avanti London Euston to Blackpool North services in the XX:33 departure slot from Euston
- The inclusion of the WMT London Euston to Liverpool Lime Street services in the XX:30 arrival slot at Euston

C.02.03 The addition of the Euston to Blackpool services and the amended WMT Liverpool services utilise a path in each direction identified in the 2013 WCML capacity study.

C.03 Future Considerations – Freight Growth

C.03.01 Prior to reviewing the timetable to identify the availability of potential paths for aspirant open access services, we were asked to include freight growth to the end of Control Period 6 (CP6) as part of the baseline. This amounted to an expected uplift to 5 freight paths per hour.

C.03.02 To represent this, where possible, an increase of one class 4 freight service per hour through key locations along the WCML where freight services would interact with fast line passenger services was added to the May 2020 base timetable before assessing the potential for new TPR compliant paths.

C.03.03 This additional freight was timed to use a class 66 locomotive limited to 75 mph and with an assumed trailing load of 1600 tonnes.

C.03.04 The key locations that were considered in this uplift were the two-track sections of the WCML and any interaction points where freight services would cross the FL.

C.03.05 The portion of the WCML south of Brinklow was not included in the freight uplift consideration since it is assumed that any additional freight services will run on the Slow Lines (SL) south of Brinklow and therefore not interact with FL services.

C.03.06 Table 3 shows the availability of an additional class 4 freight path at the key locations along the WCML in each off-peak hour between 10:00 and 16:00 in the Down direction. Each cell represents a potential slot within the timetable at one of the key locations in isolation; one row does not represent one train.

C.03.07 The colours represent the following:

- Green – Capacity for an additional class 4 freight path was identified.
- Red – Capacity for an additional class 4 freight path was not identified.
- Grey – An uplift in freight was not required as the quantum of freight already met the required threshold of 5 trains per hour.

Time Period	Brinklow to Attle-borough Junction	Colwich Junction to White-house Junction	Crewe	Winsford South Junction to Weaver Junction	Winwick Junction to Golborne Junction	Wigan North Junction to Balshaw Lane Junction	Preston
10:00 – 11:00							
11:00 – 12:00							
12:00 – 13:00							
13:00 – 14:00							
14:00 – 15:00							
15:00 – 16:00							

Table 3: Table showing the availability identified for an additional class 4 freight path at the key locations along the WCML in each off-peak hour between 10:00 and 16:00 in the Down direction

C.03.08 The general conclusions in relation to the Down direction which may be drawn from Table 3 are:

- Capacity was identified over these portions of constrained infrastructure that was TPR compliant, so there is the potential for an additional class 4 freight from Colwich Junction to Preston in approximately 3 consecutive hours, the first of which passing Colwich Junction before 10:00 and the last of which passing Colwich Junction between 11:00 and 12:00.
- Between the hours of 13:00 and 16:00 there is a significantly lower capacity for additional freight services north of Crewe through each of the two track sections of the route, however there is some scope for two additional freight paths between Colwich Junction and Crewe between these hours.

C.03.09 It was found that an additional off-peak hourly class 4 freight path in the Down direction is available between Colwich Junction and Crewe, however additional paths

in the same time period between Crewe and Preston were found not to be available across the majority of the route, with only a small number of partial paths available, due to the multiple two-track sections of the WCML north of Crewe.

C.03.10 It was found that additional freight paths travelling further north than Preston (from Carnforth North Junction) were not TPR compliant due to the slower running times.

C.03.11 Table 4 shows the availability of an additional class 4 freight path at the key locations along the WCML in each off-peak hour between 10:00 and 16:00 in the Up direction. Each cell represents a potential slot within the timetable at one of the key locations in isolation; one row does not represent one train.

C.03.12 The colours are defined in the same way as the above Table 3 defined under C.03.07.

Time Period	Preston	Balshaw Lane Junction to Wigan North Junction	Golborne Junction to Winwick Junction	Weaver Junction Winsford South Junction	Crewe	White-house Junction to Colwich Junction	Brinklow to Attle-borough Junction
10:00 – 11:00							N/A
11:00 – 12:00							N/A
12:00 – 13:00							N/A
13:00 – 14:00							N/A
14:00 – 15:00							N/A
15:00 – 16:00							N/A

Table 4: Table showing the availability identified for an additional class 4 freight path at the key locations along the WCML in each off-peak hour between 10:00 and 16:00 in the Up direction

C.03.13 The section between Brinklow and Attleborough Junction was not included in the consideration of a freight uplift in the Up direction since this section is a 3-track section comprising a Down FL, an Up FL and an Up SL. It was assumed that any additional freight in the Up direction would run on the SL as does the existing freight.

C.03.14 The general conclusions in relation to the Up direction which may be drawn from Table 4 are:

- As capacity was identified over these portions of constrained infrastructure that was TPR compliant, there is reasonable possibility for a freight uplift of one per hour passing from Preston to Winwick Junction between 10:00 and 13:00.

- In the Up direction traffic in and out of Crewe is a limiting factor in the possibility for freight growth, with the section between Weaver Junction and Winsford South Junction being at or near capacity in the May 2020 timetable.

- Like the Down direction, there is a much lower capacity for additional freight services north of Crewe between 13:00 and 16:00 due to the limitations of the multiple two-track sections between Crewe and Preston.

C.03.15 It was found that an additional off-peak hourly class 4 freight path in the Up direction is available between Preston and Winwick Junction between 10:00 and 13:00. Additional paths to and from Crewe within the scope hours were either not available or not required due to the number of freight trains in some hours already meeting the required threshold of 5 per hour.

C.03.16 Similar to the Down direction, there was more difficulty in identifying additional class 4 paths further north due to the multiple two-track sections.

C.03.17 It was found that additional freight paths travelling from further north than Preston (to Carnforth North Junction) were not TPR compliant due to the significantly slower acceleration, lower maximum speed and higher trailing weight (1600t) of the class 4 freight service compared to passenger services.

C.03.18 A more detailed timetabling exercise is required to understand whether these portions of paths identified can be linked together to provide a viable end-to-end path.

C.04 London Euston Departures (Down)

C.04.01 There were 3 fast line departure slots identified in the 2013 report at XX:33, XX:36 and XX:57 in each hour between 10:00 and 16:00. Of these, there was one departure slot from Euston remaining in the May 2020 timetable in all 6 scope hours, between Euston and Ledburn Junction. Further detail of the analysis of each of these time slots can be found in the following sections C.04.02 to C.04.06, which fully outline where portions of TPR compliant paths have been found.

C.04.02 The hourly breakdown of the XX:33 Down departures from London Euston are shown in Table 5.

Departure Time	Notes on availability of a TPR compliant path
10:33	TPR compliant to Rugby before conflicting with 1S52 or 1H65. This assumes some flexing to 1S52 and/or 1P93 to allow a path in between. This would pose a performance risk as these services would be running on minimum headway. The following 5 FL departures from Euston are on minimum headway, so any delay could rapidly accumulate.
11:33	**Path no longer available** due to it being used by 1P52, a GC departure to Blackpool North.
12:33	**Path no longer available** due to it being used by 1P53, a GC departure to Blackpool North.
13:33	TPR compliant to Colwich (or Rugeley Trent Valley) Runs between 1S69 and 1H68 which are at least 9 minutes headway separated at all locations between Euston and Colwich. Inclusion of this path still adds a degree of risk to timetable resilience, as the following 4 departures from Euston are on minimum headway. However, having at least 3 minutes buffer at any one point allows a degree of recovery time.
14:33	TPR compliant to Rugby before conflicting with 6H91 between Brinklow and Attleborough Junction. Runs between 1S72 and 1H69 which are at least 9 minutes headway separated at all locations between Euston and Rugby. Inclusion of this path still adds a degree of risk to timetable resilience, as the following 4 departures from Euston are on minimum headway. However, having at least 3 minutes buffer at any one point allows a degree of recovery time.
15:33	**Not TPR compliant** as in the path of 1Q27/1Q28 (WO[3]) NMT from Euston.

[3] Wednesday Only

Departure Time	Notes on availability of a TPR compliant path
	Because of the path of the NMT, it occupies the space of 2 paths which has eroded the capacity. The NMT runs 1 in every 8 eight weeks. GC have firm rights to the remaining 7 in 8 weeks and contingent rights for the 8th, which is reserved for the NMT.

Table 5: Table showing the hourly breakdown of the XX:33 Down departures from London Euston

C.04.03 The hourly breakdown of the XX:36 Down departures from London Euston are shown in Table 6.

C.04.04 The XX:36 departure slots are potentially available in 4 of the 6 scope hours, but are at the limits of TPR compliance. The paths do not reflect a consistent service group and would also rely on viable return journeys being available.

Departure Time	Notes on availability of a TPR compliant path
10:36	**Path no longer available** due to it being used by 1P93, an Avanti departure to Blackpool North.
11:36	TPR compliant to Ledburn Junction This exists between 1P52 and 1H66, however this is on minimum headways, so would pose a significant performance risk. Some flexing to existing services would be required in order to utilise this path. The following 4 FL departures from Euston are on minimum headway, so any delay could rapidly accumulate.
12:36	TPR compliant to Ledburn Junction This exists between 1P53 and 1H67, however this is on minimum headways, so would pose a significant performance risk. Some flexing to existing services would be required in order to utilise this path. The following 4 FL departures from Euston are on minimum headway, so any delay could rapidly accumulate.
13:36	TPR compliant to Rugeley Trent Valley Path between 1S69 and 1H68 with a minimum headway gap of 9.5 minutes between these services at any point between Euston and Rugeley. Inclusion of this path still adds risk to timetable resilience, as the following 4 departures from Euston are on minimum headway. However, having 3.5 minutes additional headway as a buffer would aid the recovery of delays.
14:36	TPR compliant to Rugby Not TPR compliant any further due to 6H91 joining the FL between Brinklow and Attleborough Junction.

Departure Time	Notes on availability of a TPR compliant path
	Path between 1S72 and 1H69 with a minimum headway gap of 9 minutes between these services at any point between Euston and Rugby. Inclusion of this path still adds risk to timetable resilience, as the following 4 departures from Euston are on minimum headway. However, having 3 minutes additional headway as a buffer would aid the recovery of delays.
15:36	**Not TPR compliant** as it merges into the path of 1Q27/1Q28 (WO) NMT from Watford Junction onwards. Departure would be between 1Q27/1Q28 and 1H70, however due to slower speed of 1Q27/1Q28, it essentially takes up a second 125 mph path between Euston and Milton Keynes Central merging into the path that would have been occupied by the 15:36 departure, eroding this capacity. The NMT runs 1 in every 8 eight weeks. GC have firm rights to the remaining 7 in 8 weeks and contingent rights for the 8th, which is reserved for the NMT.

Table 6: Table showing the hourly breakdown of the XX:36 Down departures from London Euston

C.04.05 **The hourly breakdown of the XX:57 Down departures from London Euston are shown in Table 7.**

C.04.06 In all of the six hours there exists a path between London Euston and Ledburn Junction, however by Ledburn Junction the path reaches minimum headway with the services either side. This would have a significant impact on timetable resilience and performance as the following departures are all on or near[4] minimum headway.

Departure Time	Notes on availability of a TPR compliant path
10:57	TPR compliant to Ledburn Junction. Path between 1Y51 and 1H20 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.
11:57	TPR compliant to Ledburn Junction. Path between 1Y53 and 1H23 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.

[4] Within one minute of being on minimum headway

Departure Time	Notes on availability of a TPR compliant path
12:57	TPR compliant to Ledburn Junction. Path between 1Y55 and 1H26 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.
13:57	TPR compliant to Ledburn Junction. Path between 1Y57 and 1H29 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.
14:57	TPR compliant to Ledburn Junction. Path between 1Y59 and 1H32 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.
15:57	TPR compliant to Ledburn Junction. Path between 1Y54 and 1H35 but reaching minimum headway by Ledburn Junction. This poses a significant performance risk on the following 4 departures from Euston which are all on or near minimum headway.

Table 7: Table showing the hourly breakdown of the XX:57 Down departures from London Euston

C.05 London Euston Arrivals (Up)

C.05.01 There were 3 fast line arrival slots identified in the 2013 report at XX:02, XX:30 and XX:43 in each hour between 10:00 and 16:00. Of these, none was left available across all six scope hours. Arrivals were identified in three XX:02 paths and four XX:43 paths, TPR compliant up to Ledburn Junction/Milton Keynes Central. Further detail of the analysis of each of these time slots can be found in the following sections C.05.02 to C.05.08, which fully outline where paths may be TPR compliant and where they are not.

C.05.02 **The hourly breakdown of the XX:02 Up arrivals from London Euston are shown in Table 8.**

C.05.03 The XX:02 arrival slots are partially in use in the May 2020 timetable, however there is some availability for TPR compliant paths in 3 of the 6 hours.

Arrival Time	Notes on availability of a TPR compliant path
10:02	**Path no longer available** due to it being used by 1A81, a GC arrival from Blackpool North.
11:02	TPR compliant from Tring to Euston Path between 1A15 and 1A16 which are separated by a 7 minute headway. The path cannot be extended north of Tring due to 1Y11 crossing from the Down FL to the Down SL at Ledburn Junction. As this path will be on a near minimum headway with the services either side, it will reduce timetable resilience and compromise performance. The following 3 FL arrivals are on minimum headway, so any delay could rapidly accumulate.
12:02	12:02 arrival time is not possible as this is occupied by 1A21 from Manchester. An arrival slot at 12:05:00 from Hillmorton Junction/Rugby exists between 1A21 and 1M08. Note that 1Y13 is crossing from the Down FL to the Down SL at Ledburn Junction one minute before the FL 12:05 Euston arrival path passes Ledburn Junction on the Up FL. The minimum headway between 1A21 and 1M08 at any point between Rugby and Euston is 8 minutes, leaving 2 minutes additional headway for the 12:05:00 arrival path. This still poses a degree of risk to performance; however the 2 minute buffer would provide a small degree of recovery time.
13:02	13:02 arrival time is not possible as this is occupied by 1A26 from Manchester. An arrival slot at 13:05:00 from Ledburn Junction may be TPR compliant between 1A26 and 1M09 provided that 1M09 could arrive 1 minute later. Since this path is on minimum headway with the surrounding services, it would have a significant impact on performance and reduce timetable resilience. Similar to the previous hour, 1Y15 is crossing from the Down FL to the Down SL at Ledburn Junction; this would need to be considered and likely reduces the availability of this path.
14:02	**Not TPR compliant** as in the path of 1A30, a WMT arrival from Liverpool.
15:02	**Path no longer available.** Capacity has been removed by 1A83, a GC arrival from Blackpool North at 15:01:00 and 1A35, an Avanti arrival from Liverpool at 15:04:00.

Table 8: Table showing the hourly breakdown of the XX:02 Up arrivals from London Euston

C.05.04 **The hourly breakdown of the XX:30 Up arrivals from London Euston are shown in Table 9.**

C.05.05 None of the XX:30 arrival slots is available in the May 2020 timetable due to changes to WMT services.

Arrival Time	Notes on availability of a TPR compliant path
10:30	**Not TPR compliant** as in the path of 1U22, a WMT arrival from Crewe
11:30	**Not TPR compliant** as in the path of 1W08, a WMT arrival from Liverpool
12:30	**Path no longer available.** Capacity has been removed by 1W10, a WMT arrival from Liverpool at 12:29:00 and 9M50, an Avanti arrival from Edinburgh at 12:33.
13:30	**Not TPR compliant** as in the path of 1W12, a WMT arrival from Liverpool
14:30	**Not TPR compliant** as in the path of 1W14, a WMT arrival from Liverpool
15:30	**Path no longer available.** Capacity has been used by 1W16, a WMT arrival from Liverpool

Table 9: Table showing the hourly breakdown of the XX:30 Up arrivals from London Euston

C.05.06 **The hourly breakdown of the XX:43 Up arrivals from London Euston are shown in Table 10:**

C.05.07 Arrival slots from Milton Keynes Central to London Euston were identified in four of the six scope hours. However, it should be noted in all of these four cases that despite these services being TPR compliant and on greater than minimum headway, inclusion into the timetable will significantly reduce performance and timetable resilience by utilising the majority of the time that currently exists to alleviate delays.

C.05.08 The remaining two arrival slots (10:43 and 11:43) are no longer available due to changes to arrivals from Liverpool and Manchester the inclusion of additional arrivals from Blackpool North.

Arrival Time	Notes on availability of a TPR compliant path
10:43	**Not TPR compliant** as in the path of 1W06, a WMT arrival from Liverpool
11:43	**Path no longer available** Capacity has been removed by 1A19, an Avanti arrival from Manchester at 11:42:00 and 1A82, a GC arrival from Blackpool North at 11:49:00, which are headway separated from Milton Keynes Central/Bletchley

Arrival Time	Notes on availability of a TPR compliant path
12:43	TPR compliant from Milton Keynes Central Path between 1A24 and 1U26 with a minimum headway gap of 8 minutes between these services at any point between Milton Keynes Central and Euston. Inclusion of this path still adds a degree of risk to timetable resilience at Euston by occupying most of the time that currently exists to alleviate delays. However, having a 2 minute buffer still provides some recovery of delay.
13:43	TPR compliant from Milton Keynes Central Path between 1A29 and 1U28 with a minimum headway gap of 8 minutes between these services at any point between Milton Keynes Central and Euston. Inclusion of this path still adds a degree of risk to timetable resilience at Euston by occupying most of the time that currently exists to alleviate delays. However, having a 2 minute buffer still provides some recovery of delay.
14:43	TPR compliant from Milton Keynes Central Path between 1A34 and 1U30 with a minimum headway gap of 8 minutes between these services at any point between Milton Keynes Central and Euston. Inclusion of this path still adds a degree of risk to timetable resilience at Euston by occupying most of the time that currently exists to alleviate delays. However, having a 2 minute buffer still provides some recovery of delay.
15:43	TPR compliant from Milton Keynes Central Path between 1A39 and 1U32 with a minimum headway gap of 8 minutes between these services at any point between Milton Keynes Central and Euston. Inclusion of this path still adds a degree of risk to timetable resilience at Euston by occupying most of the time that currently exists to alleviate delays. However, having a 2 minute buffer still provides some recovery of delay.

Table 10: Table showing the hourly breakdown of the XX:43 Up arrivals from London Euston

C.06 Rolling Stock Runtime Comparisons

C.06.01 Prior to the path analysis, the journey times of the 4 types of rolling stock[5] outlined by the applications in section B.01 were compared in each direction between London

[5] 390, 221T (maximum speed: 125mph) and 350, 91 (maximum speed: 110mph)

Euston and Weaver Junction and between London Euston and Carnforth North Junction. The purpose of this was to gauge which rolling stock may be more suitable for any available paths.

C.06.02 The routes were truncated at Weaver Junction for paths towards Liverpool and at Carnforth North Junction for paths towards Stirling as these were the boundaries of the geographic scope.

C.06.03 It was found that the fastest rolling stock of the 4 options analysed is the class 390 and the slowest is the class 350. Table 11 shows the difference in journey time between these two types of rolling stock.

Origin	Destination	Journey Time Difference between Class 390 and Class 350 – Non-Stop (minutes)	Journey Time Difference between Class 390 and Class 350 – Stopping[6] (minutes)
Euston	Weaver Junction	12.5	11.5
Weaver Junction	Euston	14.0	11.0
Euston	Carnforth N Junction	16.5	14.0
Carnforth N Junction	Euston	18.0	14.0

Table 11: Difference in journey times along the WCML between a 110mph capable class 350 and a 125mph capable class 390 for both a non-stop and stopping pattern

C.06.04 Given that the paths identified were all between London Euston and Milton Keynes Central, more detailed analysis was undertaken to compare the runtimes of each of the 110mph and 125mph capable rolling stock between these two locations.

C.06.05 Path utilisation of 125mph vs 110mph capable rolling stock:

C.06.06 Figure 1 demonstrates the difference in journey time from London Euston to Milton Keynes Central between a 125mph capable path and a 110mph capable path. Both pairs of orange and blue bands represent 125mph paths and their 3 minute headway behind them; they are departing London Euston 9 minutes apart in each case.

[6] Euston – Weaver Junction and reverse journeys stopping at Nuneaton, Tamworth and Lichfield Trent Valley. Euston – Carnforth North Junction and reverse journeys stopping at Milton Keynes Central, Nuneaton, Crewe and Preston.

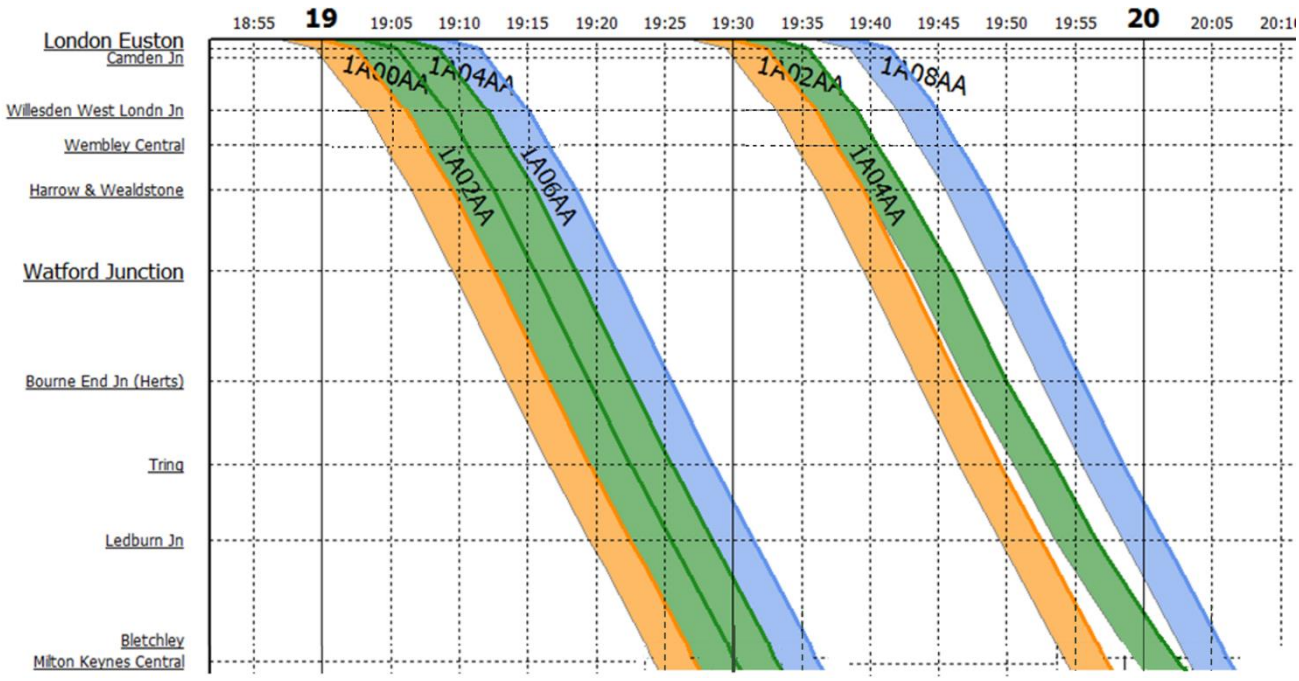


Figure 1: Graph showing the difference in journey time and path utilisation of a 110mph capable rolling stock compared to that of a 125mph capable rolling stock, between London Euston and Milton Keynes Central

C.06.07 The pair of green bands on the left-hand graph show two 125mph paths departing on and travelling at the 3 minute minimum headway between the orange and blue services. Since all four services on the left-hand graph have the same maximum speed, they arrive at Milton Keynes Central in the same time.

C.06.08 The single green band on the right-hand graph shows a 110mph path departing London Euston 3 minutes (the minimum headway of 3 minutes) after the 125mph orange train and shows that by the time it has reached Milton Keynes Central the 125mph blue train has caught up with it. In effect, the 110mph path requires the capacity of two 125mph paths for the journey from London Euston to Milton Keynes Central. Running additional paths at 110mph within a timetable structure predominantly constructed with 125mph trains is not an efficient use of capacity.

C.06.09 From Figure 1 it can be seen that:

- The greater the distance travelled, the more likely a 125mph capable rolling stock would be required for a TPR compliant path. This is due to the 110mph paths utilising more capacity – in effect, the greater the distance covered, multiple 125mph paths are required to run one 110mph path.

- Capacity is most efficiently utilised either with all paths comprising rolling stock of the same capabilities or by flighting[7] services to increase capacity in the event that paths are using differing rolling stock.

C.06.10 In the case of the departures to Milton Keynes Central from London Euston that were identified, either a 125 mph or 110mph capable rolling stock was found to be TPR compliant. This was due to an 11 minute departure window available at London Euston between FL services either side of the XX:57 departure slot. This departure window would allow a 110mph service to depart approximately 3 minutes earlier than a 125mph service but merge paths to pass Ledburn Junction at the same time.

C.06.11 For this reason, the overall difference between 125mph or 110mph rolling stock was very small in terms of specific paths identified in C.01.06 and C.01.07. However, a 125mph path would still offer greater timetable robustness and better performance as it would be better able to recover from delay.

C.07 Capacity North of Rugby

C.07.01 The above sections (C.04 to C.06) focus solely on the potential for paths originating from and terminating at London Euston, however this analysis has also considered whether any unused capacity exists north of these paths.

C.07.02 No possibilities were found to connect any paths from London Euston to paths north of Rugby.

C.07.03 The paths identified north of Rugby were very short, passing only 1 or 2 stations before terminating. None of these paths were able to be connected to form any longer paths without use of excessive pathing being required.

C.07.04 **Rugby to Preston:**

C.07.05 No opportunities were found for continuous paths to run from Rugby to Preston. Any paths that may be possible would require significant flexing to work around busy areas which is likely to significantly increase journey times.

C.07.06 Limited opportunities were found for services to run from Rugby to Crewe and separately Crewe to Preston, typically requiring significant added time to be included in a schedule.

[7] Grouping of services along a route to allow trains with the same or similar characteristics such as speed and stopping pattern to pass in succession. See 0 for further detail on flighting.

C.07.07 More opportunities were found for significantly shorter paths, typically only passing through 1 or 2 stations before terminating at a significant junction or one of the sections of the WCML where all traffic is required to use the same two tracks.

C.07.08 **Preston to Carnforth North Junction:**

C.07.09 There is some limited path availability for either 110mph or 125mph capable rolling stock, however this section of the WCML is predominantly two-track, providing little opportunity for faster services to overtake slower ones, typically freight.

C.07.10 Other major limitations in this area were found to be services to and from Morecambe using the main lines, services turning around at Lancaster and the extra volume of services from adjoining lines at Carnforth.

C.07.11 All capacity that was identified was determined to be equally suitable for 125 mph and 110 mph rolling stock. No consideration has been given to possible stopping patterns in this area.

C.08 Capacity Required for all ORR Applications to be Accommodated

C.08.01 **Theoretical maximum capacity:**

C.08.02 The 2013 report considered capacity in terms of potential class 390 paths (Standard paths, as described in E.09) that could use the FL in both directions per hour and this section will take the same approach.

C.08.03 This 3 minute minimum value means that there is a theoretical maximum of 20 class 390 paths per hour. This theoretical maximum is unchanged from the report written in 2013.

C.08.04 In the current timetable not all rolling stock used is capable of running at 125 mph, such as the class 350 services that have a maximum speed of 110 mph. This heterogeneity of rolling stock effectively reduces the theoretical maximum number of paths that can be accommodated within an hour.

C.08.05 Some services also perform activities that further reduce this theoretical maximum. FL calls at Watford Junction and services crossing between the FL and SL (particularly at Ledburn Junction), combined with the rolling stock mix described above reduce the theoretical maximum number of FL paths per hour to 15.

C.08.06 This 15 trains per hour value is the result of the analysis done in the 2013 report. As the May 20 timetable has been analysed and found to be largely the same in composition as in the timetable used for that analysis it has been assumed that this is still a valid figure.

C.08.07 Table 12 below shows arrivals and departures at London Euston via the FL for the 6 hours from 10:00 to 16:00 on a normal Wednesday.

C.08.08

Total paths per hour	10:00 – 11:00	11:00 – 12:00	12:00 – 13:00	13:00 – 14:00	14:00 – 15:00	15:00 – 16:00
Departures	13	13	13	12	12	12
Arrivals	13	13	12	13	13	13

Table 12: The number of arrivals and departures at London Euston on the Fast Lines (FL) between 10:00 and 16:00 on a normal Wednesday

C.08.09 The 12 arrivals and departures in every hour match the timetable used in the 2013 analysis that identified potential for 3 extra paths per direction per hour. The 13th service that is present in some hours is an additional service between London Euston and Blackpool North, operated in different hours by either GC trains or Avanti West Coast.

C.08.10 GC operates rolling stock with a maximum speed of 110mph. This is slower than the 125mph rolling stock that was used to measure capacity and identify potential paths in the 2013 analysis, and as such could be viewed as occupying 2 class 390 paths instead of 1.

C.08.11 This means that the current timetable is operating a minimum of 12 paths and a maximum of 14 in each hour.

C.08.12 The theoretical maximum of 15 trains per hour leaves the potential for only a single path remaining in some hours, which may not exist due to the structure of the current timetable.

C.08.13 **Capacity needed to accommodate all the current applications:**

C.08.14 The current off-peak timetable contains 12 FL arrivals and departures per hour, excluding the Euston-Blackpool services.

C.08.15 The existing Open Access operator GC currently has firm rights to 5 Euston-Blackpool paths and have applied to turn one further path currently with contingent rights into one with firm right. It can be assumed that this service would not be in an hour in which they already operate, therefore the current timetable including the Euston-Blackpool services can be assumed to require 14 FL paths as detailed in the previous section.

C.08.16 The remaining applications can be split as follows:

- 110 mph paths: West Midlands Trains (WMT), Grand Union Trains (GUT)
- 125 mph paths: Virgin Trains (VT), First Trenitalia West Coast (FTWC)

C.08.17 Due to the slower speed of the 110mph rolling stock compared to the 125mph capable class 390, the 110mph service will require 2 class 390 paths to be operated between Euston and Milton Keynes Central.

C.08.18 This means that with their current applications 2 class 390 paths would be required for each of the WMT and GUT applications and 1 class 390 path would be required for each of the VT and FTWC applications.

C.08.19 This then gives a total number of 20 FL paths required to accommodate all of these applications in a single hour. There may be potential for this to be reduced slightly if flighting is possible, but this is unlikely without a recast of the current timetable.

C.09 Performance

C.09.01 With reference to the punctuality levels that are currently being observed; coupled with a desire to have a robust and reliable timetable, which can recover and mitigate lateness, whilst also managing capacity in the best way possible - it is advisable from a performance point of view to develop a timetable from scratch rather than adding further services to the existing timetable structure.

C.09.02 Performance data from the first 37 Monday – Friday (SX) days of the December 2019 timetable has been collected to show the punctuality of services against the Working Timetable (WTT).

C.09.03 Punctuality of current services against the WTT has been assessed based on:

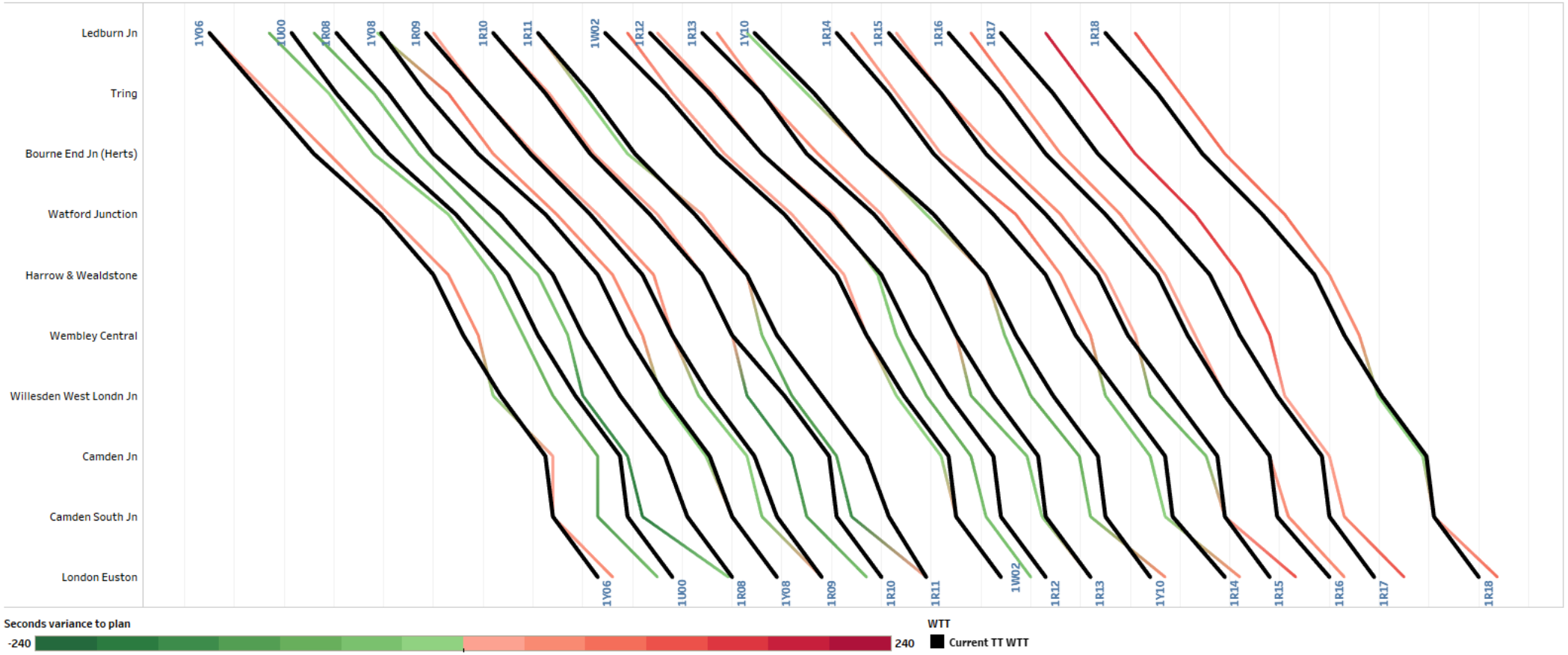
- London Euston arrivals between 08:00 and 09:00
- London Euston arrivals between 11:00 and 12:00
- London Euston arrivals between 17:00 and 19:00
- London Euston departures between 08:00 and 09:00
- London Euston departures between 11:00 and 12:00
- London Euston departures between 17:00 and 1900

C.09.04 For each of the above six time periods, a path variance chart is provided below detailing the WTT Path, in black, overlaid with the observed punctuality performance. The level of observed performance that is shown is based on the 25th percentile across the 37 SX days captured. The 25th is representative of what was achieved on the best

9 days since the December 2019 Timetable commenced; and can be considered as a relatively good performing set of days within the context of the overall timetable.

C.09.05 The following three charts show how punctual London Euston arrivals have been from the point at which the trains are planned to present at Ledburn Junction.

Ledburn Jn to London Euston (SX) - Showing trains that are planned to arrive in London Euston between 08:00 and 09:00
Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.
Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



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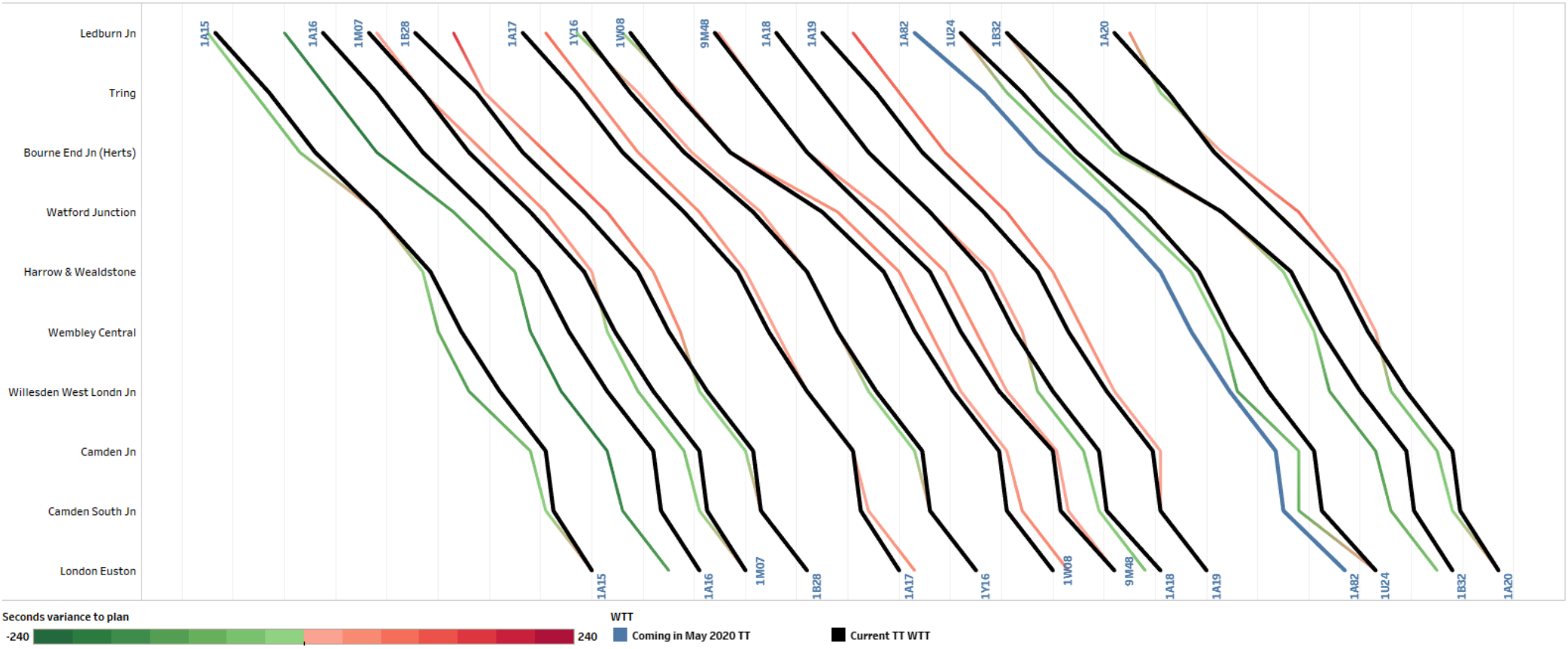
Ledburn Jn to London Euston (SX) - Showing trains that are planned to arrive in London Euston between 11:00 and 12:00

Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.

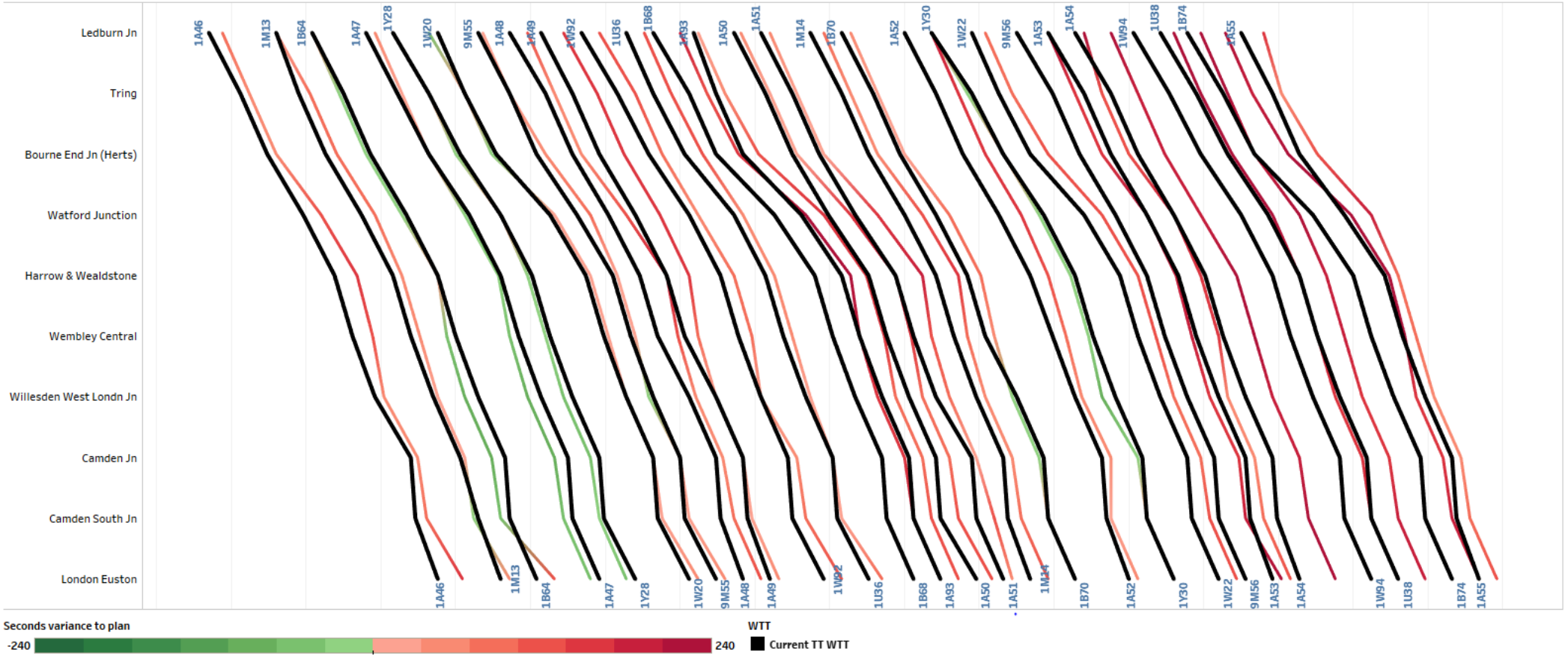
Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



Ledburn Jn to London Euston (SX) - Showing trains that are planned to arrive in London Euston between 17:00 and 19:00

Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.

Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



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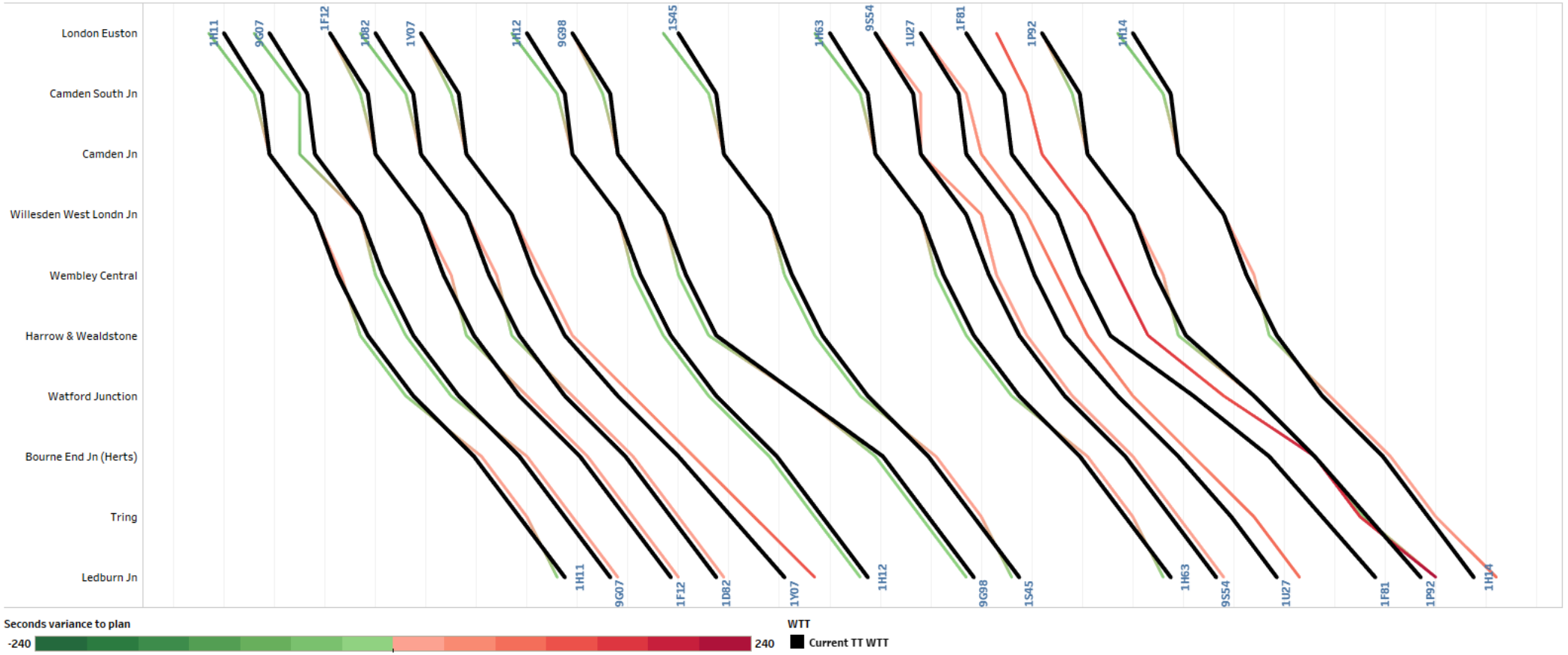
C.09.06 The following three charts show how punctual London Euston departures have been up until the point at which the trains are planned to present at Ledburn Junction.

London Euston to Ledburn Jn (SX) - Showing trains that are planned to depart London Euston between 08:00 and 09:00
Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.
Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



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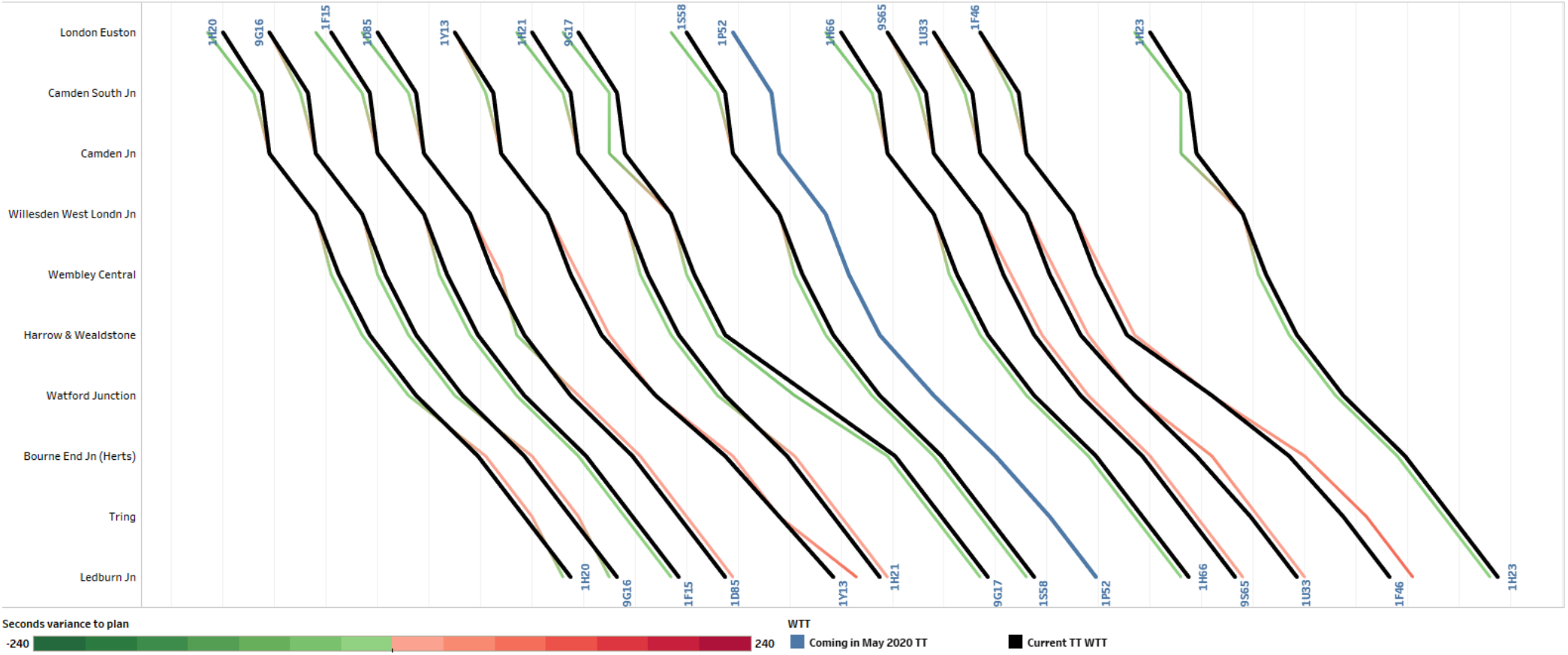
London Euston to Ledburn Jn (SX) - Showing trains that are planned to depart London Euston between 11:00 and 12:00
Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.
Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



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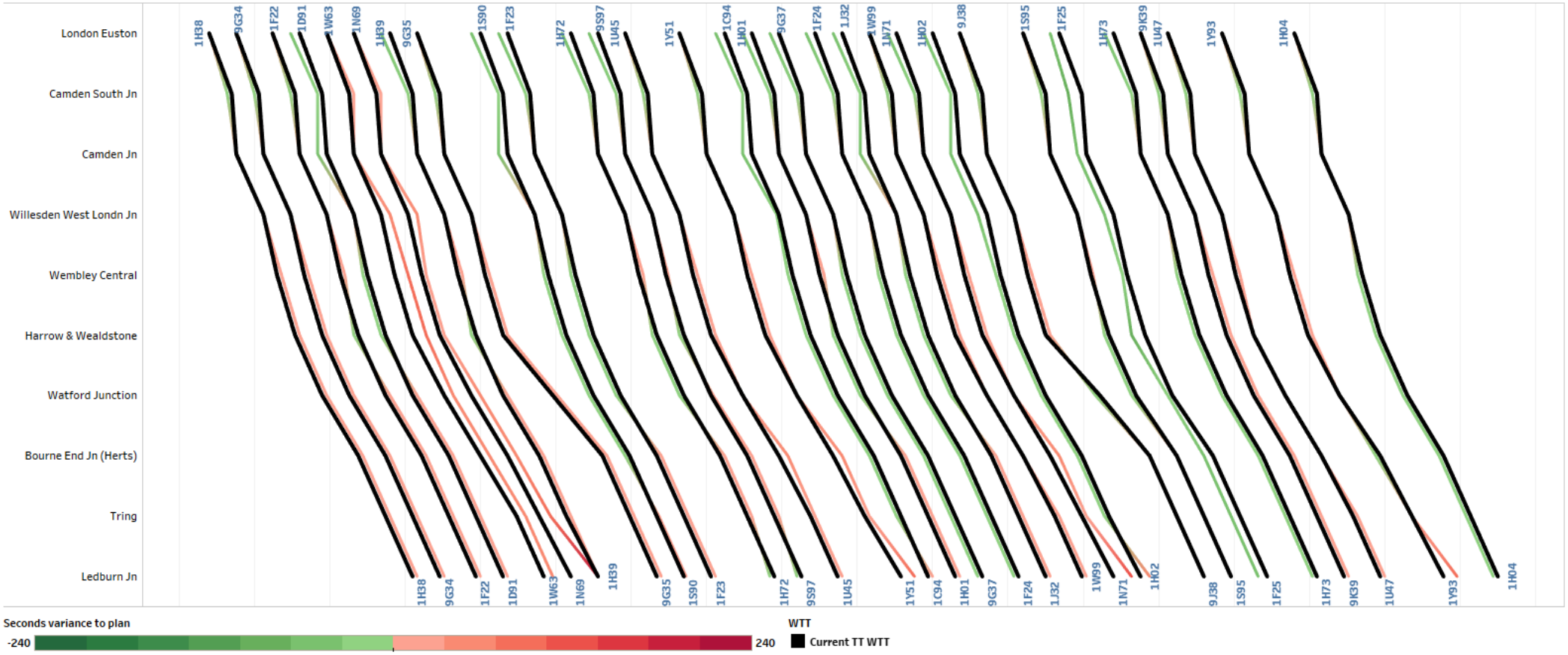
London Euston to Ledburn Jn (SX) - Showing trains that are planned to depart London Euston between 17:00 and 19:00

Punctuality against the WTT based on the 25th Percentile (Good Day) of PSS/TRUST Performance data.

Observed data is from the Dec 2019 Timetable. Additional paths offered are shown for May 2020.



C.09.07 Block Charts (showing lateness against the 25th percentile) have been created to show punctuality in the morning and evening peaks, in both the Up and Down directions. The below four tables, in order refer to:

- London Euston departures between 08:00 and 12:00 (Down trains)
- London Euston departures between 16:00 and 19:00 (Down trains)
- London Euston arrivals between 08:00 and 12:00 (Up trains)
- London Euston arrivals between 16:00 and 19:00 (Up trains)

Block Chart for services planned to depart London Euston on the Down Fast Line between 08:00 and 12:00

Lateness is based on the 25th Percentile across the December 2019 SX TT

	London Euston - O	Camden South Jn - D/P	Camden Jn - D/P	Willesden West Londn Jn - D/P	Wembley Central - D/P	Harrow & Wealdstone - D/P	Watford Junction - A	Watford Junction - D/P	Bourne End Jn (Herts) - D/P	Tring - D/P	Ledburn Jn - D/P	Leighton Buzzard - A	Leighton Buzzard - D/P	Bletchley - A	Bletchley - D/P	Milton Keynes Central - A	Milton Keynes Central - D/P	Hanslope Jn - D/P	Weedon - D/P	Hillmorton Jn - D/P	Rugby - A	Rugby - D/P
721H11MC - London Euston (08:00)	-1.0	-0.5	0.0	0.0	0.3	-0.5		-0.5	0.5	0.5	-0.5				0.0		-0.5	-0.5	-1.0	-1.0		0.3
729G07MC - London Euston (08:03)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				0.0		1.0	0.5	1.0	0.0	1.0	0.5
721F12MC - London Euston (08:07)	0.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				1.0	1.5	1.5	0.0	0.5	-0.5		-1.0
721D82MC - London Euston (08:10)	-1.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				1.8	1.0	1.5	2.0	2.5	1.0		1.5
721Y07MC - London Euston (08:13)	0.0	-0.5	0.0	0.0	0.5	0.5		1.0	1.0	1.5	2.0	2.5	2.5	2.5	2.5	1.0	1.0	0.5		-0.5	-0.5	-0.5
721H12MC - London Euston (08:20)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0	0.5	0.5	0.0	-0.5	-1.5		-1.0
729G98MC - London Euston (08:23)	0.0	-0.5	0.0	0.0	-0.5	-0.5	-0.5	0.0	-0.5	-0.5	-0.5				0.0		0.5	-1.0	-0.5	-1.5		-1.0
721S45MD - London Euston (08:30)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	-0.5				0.0		0.5	-1.0	-0.5	-1.5		-1.0
721H63MD - London Euston (08:40)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	-0.5				0.0		0.5	-0.5	0.0	-1.0		-1.5
729S54MD - London Euston (08:43)	0.0	0.5	0.0	1.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0	0.5	0.5	0.0	-0.5	-1.5		-1.0
721U27MD - London Euston (08:46)	0.0	0.5	1.0	1.0	1.5	1.5		1.0	1.0	1.5	1.5				2.0	2.5	2.0	0.0	1.0	0.5	0.5	0.5
721F81MD - London Euston (08:49)	2.0	1.5	2.0	2.0	2.5	2.5	2.0	2.0	3.0	2.5	4.0			4.5	4.0	3.5	3.5	4.0		1.3	1.3	-0.5
721P92MD - London Euston (08:54)	0.0	-0.5	0.0	0.0	0.5	-0.5		0.0	0.0	-0.3	1.0				0.5		2.0	1.3	1.5	1.5	3.0	2.0
721H14ME - London Euston (09:00)	-1.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	1.5				2.0		1.5	1.5	1.5	1.0		1.5
729G10ME - London Euston (09:03)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				2.0		1.5	1.5	1.0	1.0	1.5	1.5
721F13ME - London Euston (09:07)	0.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				1.0		0.5	-0.5	0.0	0.0		1.0
721D83ME - London Euston (09:10)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0	1.5	2.0	0.5	1.0	-0.5		0.0
721Y09ME - London Euston (09:13)	-1.0	-0.5	0.0	0.0	0.5	0.5		0.0	0.5	0.0	-0.5	0.0	0.0	-0.5	0.0	-1.5	-0.5	0.0		-0.5	-0.5	-0.5
721H15ME - London Euston (09:20)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0	0.5	0.5	-1.0	-0.5	-1.5		-1.0
729G11ME - London Euston (09:23)	-1.0	-0.5	0.0	0.0	-0.5	-0.5	-0.5	0.0	-0.5	-0.5	-0.5				0.0		-0.5	-1.0	-0.5	-1.5		-2.0
721S48MF - London Euston (09:30)	-1.0	-0.5	-1.0	-1.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-1.0	-0.5	-1.5		-1.0
725B86MF - London Euston (09:33)	-1.0	-1.5	-1.0	-1.0	-0.5	-0.5		-1.0	-1.0	-0.5	0.0			-0.5	-3.5							
721H64MF - London Euston (09:40)	-1.0	-0.5	0.0	0.0	0.5	-0.5		-0.5	0.5	0.5	0.5				0.0		-0.5	-0.5	0.0	-1.0		-1.5
729S55MF - London Euston (09:43)	0.0	0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				0.0	0.5	0.5	-0.3	-0.5	-1.5		-1.0
721U29MF - London Euston (09:46)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	0.5				1.0	1.5	1.0	0.0	0.0	-0.5	0.5	0.5
721F83MF - London Euston (09:49)	0.0	-0.5	0.0	0.0	0.5	0.5	0.0	1.0	1.0	1.5	2.0			2.5	2.0	-1.0	0.0	-0.5		-0.5	-0.5	-0.5
721H17MG - London Euston (10:00)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	0.0	-1.0		-0.5
729G13MG - London Euston (10:03)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				0.0		0.5	0.3	0.0	-0.8	0.0	0.5
721F14MG - London Euston (10:07)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	0.5	-0.5				0.0		0.5	-0.5	0.0	0.0		0.0
721D84MG - London Euston (10:10)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0	1.5	1.0	0.5	1.0	-0.5		0.0
721Y11MG - London Euston (10:15)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	-0.5	0.0	0.5	0.8	0.0	0.5	1.0	0.5	0.5	0.0		0.5	0.5	0.5
721H18MG - London Euston (10:20)	0.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				0.0	0.5	0.5	-1.0	-0.5	-1.5		-1.0
729J14MG - London Euston (10:23)	-1.0	-0.5	0.0	0.0	0.5	-0.5	0.5	0.0	0.5	0.5	0.5				1.0		0.5	0.5	0.5	-0.5		0.0
721S52MH - London Euston (10:30)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.0	0.0	0.0				0.5		0.0	0.0	0.5	-1.0		-0.5
721P93MH - London Euston (10:36)	-1.0	-1.5	-1.0	-1.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				-1.0		-0.5	-1.5	-1.0	-2.0	-1.5	-0.5
721H65MH - London Euston (10:40)	0.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-1.0		-1.5
729S60MH - London Euston (10:43)	0.0	-0.5	0.0	0.0	0.0	-0.5		-0.5	0.0	0.0	-0.5				0.0	0.5	0.5	-1.0	-0.5	-2.0		-2.0
721U31MH - London Euston (10:46)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	0.5				1.0	1.5	1.0	-1.0	0.0	-0.5	-0.5	-0.5
721F44MH - London Euston (10:49)	0.0	0.3	0.0	0.0	0.5	0.5	0.8	1.0	1.0	1.5	1.5				2.0	2.5	2.5	1.0		-0.5	-0.5	-0.5
721H20MI - London Euston (11:00)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	-0.5				0.0		0.5	-0.5	0.0	-1.0		0.0
729G16MI - London Euston (11:03)	0.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	-0.5				0.0		0.5	-0.5	0.0	-1.0	0.5	-0.5
721F15MI - London Euston (11:07)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-1.0		-1.0
721D85MI - London Euston (11:10)	-1.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				1.0	0.5	1.0	0.5	1.0	-0.5		0.0
721Y13MI - London Euston (11:15)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	0.5	0.0	1.5	2.0	1.0	1.5	1.0	0.5	0.5	0.0		-0.5	-0.5	0.0
721H21MI - London Euston (11:20)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				0.0	0.5	0.5	0.0	-0.5	-1.5		-1.0
729G17MI - London Euston (11:23)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5	-0.5	-1.0	-0.5	-0.5	-0.5				-1.0		-0.5	-1.0	-0.5	-1.5		-1.0
721S58MJ - London Euston (11:30)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		0.5	-1.0	-0.5	-1.5		-1.0
721H66MJ - London Euston (11:40)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-2.0		-1.5
729S65MJ - London Euston (11:43)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0	1.5	1.0	0.5	0.5	-1.0		-1.0
721U33MJ - London Euston (11:46)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	0.5				1.0	1.5	1.0	0.0	0.0	-0.5	-0.5	0.5
721F46MJ - London Euston (11:49)	0.0	-0.5	0.0	0.0	0.5	0.5	0.0	0.0	1.0	1.5	1.5				1.0	2.5	2.0	0.5		-0.5	-0.5	-0.5
721H23MK - London Euston (12:00)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-2.0		-0.5

Block Chart for services planned to depart London Euston on the Down Fast Line between 16:00 and 19:00

Lateness is based on the 25th Percentile across the December 2019 SX TT

	London Euston - O	Camden South Jn - D/P	Camden Jn - D/P	Willesden West Londn Jn - D/P	Wembley Central - D/P	Harrow & Wealdstone - D/P	Watford Junction - A	Watford Junction - D/P	Bourne End Jn (Herts) - D/P	Tring - D/P	Ledburn Jn - D/P	Leighton Buzzard - A	Leighton Buzzard - D/P	Bletchley - A	Bletchley - D/P	Milton Keynes Central - A	Milton Keynes Central - D/P	Hanslope Jn - D/P	Weedon - D/P	Hillmorton Jn - D/P	Rugby - A	Rugby - D/P
721H35MS - London Euston (16:00)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-1.0		-0.5
729G31MS - London Euston (16:03)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		0.5	-0.5	0.0	-1.0	0.5	0.5
721F20MS - London Euston (16:07)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	0.0	-1.0		-2.0
721D90MS - London Euston (16:10)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.8	1.5	1.8	1.3	1.0	0.5		0.0
721Y23MS - London Euston (16:15)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	1.0	1.5	1.5	2.0	2.5	2.0	2.0	2.5		2.0	2.0	1.0
721H36MS - London Euston (16:20)	0.0	-0.5	0.0	0.0	0.5	-0.5		-0.5	0.5	0.5	0.5				0.0	0.5	2.0	0.5	1.0	0.0		-0.5
729G32MS - London Euston (16:23)	0.0	-0.5	0.0	0.0	-0.5	-0.5	-0.5	0.0	0.5	0.5	0.3				0.0		1.5	0.5	1.0	0.0		0.5
721S82MT - London Euston (16:30)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	0.5	-0.5				0.0		0.5	0.5	1.0	0.0		0.5
721P21MT - London Euston (16:33)	0.0	-0.5	-1.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	-0.5				1.0		0.5	0.5	1.0	0.5	2.0	1.5
721H71MT - London Euston (16:40)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	-1.0	-1.0		0.5
729S93MT - London Euston (16:43)	0.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				1.0	1.0	1.5	1.0	1.5	0.0		0.5
721U43MT - London Euston (16:46)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	0.5				1.0	2.5	2.0	1.0	1.0	0.5	0.5	-0.5
721Y85MT - London Euston (16:52)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	0.5	0.0	1.5	2.0	2.0	2.5	2.8	1.5	2.3	2.5		1.5	2.0	2.0
721S87MT - London Euston (16:57)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	0.5				0.0		0.5	-0.5	0.0	0.0		0.0
721H38MU - London Euston (17:00)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0		0.5	0.5	1.0	0.0		0.0
729G34MU - London Euston (17:03)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				1.0		1.5	0.5	1.0	0.0	1.5	1.5
721F22MU - London Euston (17:07)	0.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.5				1.0		0.5	0.5	0.0	0.0		0.0
721D91MU - London Euston (17:10)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5		0.5	0.5	0.5	0.5				1.0	1.5	2.0	1.5	1.0	-0.5		0.0
721W63MU - London Euston (17:13)	0.0	0.5	0.0	1.0	1.5	1.5		1.0	1.0	1.0	1.0				1.5	1.0	1.0	1.5		1.0	2.0	2.0
721N69MU - London Euston (17:16)	0.0	0.5	0.0	1.0	0.5	0.5		1.0	1.0	1.3	3.0	3.5	3.5		3.3	2.0	2.3	2.0				
721H39MU - London Euston (17:20)	-1.0	-0.5	0.0	0.0	0.5	-0.5		0.5	0.5	0.5	0.0				0.5	2.0	1.5	1.0	1.5	0.5		0.0
729G35MU - London Euston (17:23)	0.0	-0.5	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5				0.0		1.5	2.0	1.5	1.0		1.0
721S90MV - London Euston (17:30)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5		-0.5	-0.5	0.3	0.3				1.0		1.5	1.0	1.5	0.5		1.0
721F23MV - London Euston (17:33)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				1.0		1.5	1.0	0.5	0.5	2.0	2.0
721H72MV - London Euston (17:40)	-1.0	-0.5	0.0	0.0	0.5	-0.5		-0.5	0.5	0.5	-0.5				0.0		0.5	-0.5	0.0	-1.0		1.5
729S97MV - London Euston (17:43)	-1.0	-0.5	0.0	0.0	0.3	-0.5		0.3	0.5	0.5	-0.5				0.0	0.5	0.3	-0.3	-0.5	-1.5		-1.0
721U45MV - London Euston (17:46)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	0.5				1.0	1.5	1.0	0.0	0.0	-0.5	0.5	0.0
721Y51MV - London Euston (17:52)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	1.5	1.5	1.8		2.0	1.0	1.0	1.5		1.0	1.0	1.0
721C94MV - London Euston (17:57)	-1.0	-0.5	-1.0	-0.3	-0.5	-0.5		-0.5	-0.5	-0.5	0.5				0.0		0.5	0.5	1.0	0.8		0.0
721H01MW - London Euston (18:00)	-1.0	-0.5	0.0	0.0	0.5	-0.5		-0.5	0.5	0.5	0.5				0.0		0.5	-0.5	0.0	0.0		0.0
729G37MW - London Euston (18:03)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		0.3	-0.5	0.0	1.0	1.5	1.5
721F24MW - London Euston (18:07)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-1.5	-1.0	-1.0		0.5
721J32MW - London Euston (18:10)	-1.0	-0.5	-1.0	0.0	-0.5	-0.5		-0.5	0.5	0.5	0.5				0.0	0.5	1.0	0.0	0.0	-1.5		-1.0
721W99MW - London Euston (18:13)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	0.0	0.5	0.5				1.0	0.5	1.5	0.5		-3.5	-3.5	0.0
721N71MW - London Euston (18:16)	-1.0	-0.5	0.0	0.0	0.5	0.5		0.0	1.0	0.5	2.0	2.5	3.5		1.5	0.5	0.0	-0.5				
721H02MW - London Euston (18:20)	-1.0	-0.5	-1.0	-1.0	-0.5	-0.5		-0.5	-0.5	-0.5	1.0				1.5	2.0	2.5	2.0	1.5	0.5		1.0
729J38MW - London Euston (18:23)	0.0	-0.5	0.0	0.0	0.5	0.5	0.5	-0.5	0.0	0.0	0.0				0.5		2.0	2.0	2.0	1.0		0.5
721S95MX - London Euston (18:30)	0.0	-0.5	0.0	0.0	0.3	-0.5		-0.5	0.0	0.0	0.0				0.5		1.0	1.0	1.5	0.5		0.8
721F25MX - London Euston (18:34)	-1.0	-1.5	-1.0	-1.0	-0.5	-1.5		-0.5	-1.0	-1.0	-1.0				-1.5		0.0	0.0	0.5	0.5	1.0	1.5
721H73MX - London Euston (18:40)	-1.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				-1.0		-0.5	-1.5	-1.0	-1.5		0.0
729K39MX - London Euston (18:43)	0.0	-0.5	0.0	0.0	0.5	0.5		0.5	0.5	0.5	0.5				0.0	0.5	1.0	0.5	0.5	-0.5		0.0
721U47MX - London Euston (18:46)	0.0	-0.5	0.0	0.0	0.5	0.0		0.0	0.0	0.5	0.5				1.0	2.5	2.0	1.0	1.0	0.5	1.0	-0.5
721Y93MX - London Euston (18:52)	0.0	-0.5	0.0	0.0	0.5	0.5		0.0	-0.5	0.0	1.5	1.3	2.0	2.5	2.0	0.5	1.0	0.5		0.5	0.5	0.5
721H04MY - London Euston (19:00)	0.0	-0.5	0.0	0.0	-0.5	-0.5		-0.5	-0.5	-0.5	-0.5				0.0		-0.5	-0.5	0.0	-1.0		

Block Chart for services planned to arrive at London Euston from the Up Fast Line between 08:00 and 12:00

Lateness is based on the 25th Percentile across the December 2019 SX TT

	Rugby - A	Rugby - D/P	Hillmorton Jn - D/P	Weedon - D/P	Hanslope Jn - D/P	Milton Keynes Central - A	Milton Keynes Central - D/P	Bletchley - A	Bletchley - D/P	Leighton Buzzard - A	Leighton Buzzard - D/P	Ledburn Jn - D/P	Tring - D/P	Bourne End Jn (Herts) - D/P	Watford Junction - A	Watford Junction - D/P	Harrow & Wealdstone - D/P	Wembley Central - D/P	Willesden West Londn Jn - D/P	Camden Jn - D/P	Camden South Jn - D/P	London Euston - T
691Y06M6 - Coventry (06:22)	-1.5	-1.0	-0.5		0.0	0.5	0.0		0.0	1.0	0.5	0.0	0.5	1.0		0.5	1.0	1.0	-0.5	0.5	0.0	1.0
421U00M5 - Crewe (05:47)	-0.5	-0.5	-1.0	0.0	-0.5		0.0		0.0			-1.5	-0.5	-1.0		-0.5	-1.0	-1.0	-1.5	-1.5	-2.0	-1.0
321R08M5 - Manchester Piccadilly (05:55)		-1.0	-1.5	-0.8	-1.0		0.0		0.0			-1.5	-1.0	-1.0		-1.5	-1.0	-1.0	-2.5	-2.5	-3.0	-0.3
701Y08MA - Northampton (07:15)					0.0	0.5	0.0		0.0	1.0	1.0	-0.3	1.5	1.0		0.8	1.0	1.0	-0.3	-0.3	0.0	0.0
651R09M6 - Wolverhampton (06:27)		-1.0	-0.5	-0.5	0.0	0.3	1.0		1.0			0.5	0.0	0.3		0.5	0.8	0.0	-0.8	-0.5	-1.0	0.0
321R10M6 - Manchester Piccadilly (06:10)	0.0	0.0	-1.0	0.0	-0.5		0.5		0.5			0.0	0.3	0.3		0.5	0.0	0.0	-2.5	-2.5	-2.0	-1.0
361R11M6 - Liverpool Lime Street (06:05)		-0.5	-1.0	-1.0	-0.5		-0.5		0.3			0.0	-0.5	-0.5		0.5	0.0	-1.0	-2.0	-2.0	-2.5	0.0
651W02M6 - Walsall (06:02)	-0.5	-0.5	0.0		0.5		1.0		1.0			1.5	0.5	0.5		0.5	0.5	0.0	-0.5	-0.5	0.0	0.0
651R12M6 - Wolverhampton (06:45)		-2.0	-1.5	-0.8	0.0		0.0		0.8			0.5	0.3	0.0		0.3	-0.3	-1.0	-1.5	-1.5	-1.0	-1.0
401R13M4 - Holyhead (04:48)		-1.5	-0.5	-1.0	-0.5		0.5		0.5			1.0	0.0	0.8		0.5	0.0	0.0	-1.5	-0.8	-0.3	0.0
651Y10M5 - Wolverhampton (05:53)	-1.5	-1.0	-0.5		0.0	0.5	0.0	0.5	0.0	0.0	0.0	-0.5	-0.5	0.0		-0.5	0.0	-0.8	-1.5	-1.3	-1.0	1.0
651R14MA - Wolverhampton (07:05)		-0.5	0.0	0.0	0.5		0.5		0.5			1.0	0.5	0.5		1.5	1.0	1.0	-1.0	-1.0	-0.5	1.0
321R15M6 - Manchester Piccadilly (06:35)	2.0	0.5	0.3	0.5	0.0		1.0		1.0			0.5	0.0	0.8		1.0	0.5	0.5	-1.5	-0.8	0.0	1.8
691R16MB - Birmingham International (07:4..		0.0	0.5	0.5	1.0		1.0		1.0			1.5	1.0	1.0		1.0	0.5	0.5	0.0	0.0	0.8	1.0
321R17M6 - Manchester Piccadilly (06:43)		1.5	2.0	1.8	1.5		2.5		2.5			3.0	2.5	2.5		2.5	2.0	2.0	0.5	0.5	1.0	2.0
321R18MA - Manchester Piccadilly (07:01)		0.3	0.5	0.5	1.0		1.5		1.5			2.0	1.5	1.5		1.5	1.0	1.0	-0.3	-0.3	0.0	1.3
361R19MA - Liverpool Lime Street (07:00)		0.0	0.5	0.5	0.0		0.5		0.5			0.5	1.0	1.0		2.0	1.5	0.5	0.0	0.0	0.5	1.0
071R20M4 - Glasgow Central (04:28)		0.0	-0.5	-0.5	0.0		0.0		0.8			1.5	1.0	1.8		1.8	1.5	1.5	0.0	0.0	1.3	1.8
641R21M6 - Shrewsbury (06:39)	1.5	1.0	1.0	1.5	2.0		2.5		2.5			4.0	3.0	2.5		2.0	1.5	0.5	0.0	0.0	0.0	0.0
321R22MA - Manchester Piccadilly (07:15)		0.5	1.0	1.0	1.5	2.5	3.0		3.0			2.5	2.0	2.0		2.0	1.5	1.5	1.0	1.0	1.5	1.0
421Y12M6 - Crewe (06:05)	-1.0	0.0	-0.5		0.0	-0.5	0.0	-0.5	-1.0	-1.0	-1.0	-1.0	-0.5	0.0		0.5	0.0	0.0	-0.5	-0.5	0.0	-1.0
651W04MA - Walsall (07:02)	2.3	2.5	2.0		2.0	3.8	4.0		3.8			2.5	2.0	2.3	2.5	2.5	2.5	2.5	1.8	1.8	1.5	1.8
329R23M6 - Manchester Piccadilly (06:27)		0.5	1.5	1.0	1.0		3.0		3.0			2.5	3.0	3.0	4.5	5.0	4.5	4.0	3.0	3.0	3.5	3.5
421U20MA - Crewe (07:14)	1.0	1.5	2.0	2.0	2.5	3.0	1.0		1.0			0.5	0.5	1.0		1.5	1.0	1.0	0.5	0.5	1.0	1.0
401R24M5 - Holyhead (05:51)	-0.5	-0.5	-0.8	-0.5	0.0		2.0		1.0			1.3	0.5	0.0		1.5	1.5	1.3	0.8	0.8	1.3	2.0
321R25MB - Manchester Piccadilly (07:35)		-1.5		-1.0	-0.5		0.5		0.5			1.0	0.5	0.5	2.5	2.0	1.5	1.5	0.0	0.0	-0.5	0.0
651R26MD - Birmingham New Street (08:30)		0.5	0.5	0.5	1.0	1.0	1.0		1.0			0.5	0.0	0.0		1.0	0.5	0.5	-1.0	-1.0	-0.5	1.0
361R27MB - Liverpool Lime Street (07:48)		-1.5	-1.0	-1.0	-1.5		-0.5		-0.5			0.0	-0.5	-1.5		-0.5	0.0	-1.0	-1.5	-1.5	-1.0	-1.0
071M06M5 - Glasgow Central (05:40)		-2.0	-1.5	-1.5	-1.3		-1.0		-1.0			-0.5	-1.0	-1.0		-1.0	-1.5	-1.5	-3.5	-3.5	-2.3	-2.0
651B29MD - Birmingham New Street (08:50)	-0.5	0.5	-0.5	0.5	0.0		0.5		0.5			0.5	0.0	0.0		0.5	0.5	-0.5	-1.0	-1.0	-0.5	0.0
321R28MB - Manchester Piccadilly (07:55)		-0.5	-1.5	-1.0	-1.5		-1.5		-0.5			-1.0	-1.5	-1.5		-1.5	-2.0	-2.0	-2.5	-2.5	-2.0	-1.0
431Y14MA - Rugeley Trent Valley (07:10)	-1.5	-0.5	-1.0		0.0	0.5	-0.5	-1.0	-0.5	-1.0	-1.5	-0.5	-0.5	-1.0		-0.5	-1.0	-1.0	-1.5	-1.5	-1.0	0.0
321A12MC - Manchester Piccadilly (08:15)		0.5	-1.5	-1.0	-0.5	0.5	0.5		0.5			-1.0	-2.0	-2.5		-2.0	-2.5	-2.5	-3.0	-3.0	-2.5	-2.0
421U22MC - Crewe (08:16)	-1.0	-0.5	-0.5	0.5	0.0	0.5	0.0		0.0			0.5	-0.5	0.0		-0.5	-1.0	-1.0	-1.5	-1.5	-1.0	-1.0
119A31M6 - Lancaster (06:58)		-0.5	-0.5	-0.5	-1.0	0.8	0.8		0.3			-1.0	-0.5	-0.5		-0.5	-1.0	-1.0	-1.8	-2.0	-1.5	0.0
401A13M6 - Holyhead (06:55)		-1.5	-1.5	-0.5	-1.0	0.5	1.0		0.5			1.5	0.5	0.5		0.5	0.0	0.0	-0.5	-0.5	0.0	0.0
651W06MD - Birmingham New Street (08:33)	-2.0	-0.5	-1.0		0.0	2.5	3.0		1.5			2.0	1.0	1.5	1.5	2.5	2.5	2.3	1.0	1.0	1.5	2.0
321A14MD - Manchester Piccadilly (08:35)		-1.0	-0.5	-0.5	0.0		2.0		2.0			0.0	-1.0	-1.5		-1.5	-1.5	-2.5	-3.0	-3.0	-1.5	-1.0
651B35MF - Birmingham New Street (09:30)		-0.5	-0.5	-0.5	0.0		-1.0		-1.0			-1.5	-2.0	-2.0	-1.5	-1.5	-2.0	-2.0	-3.0	-2.5	-2.5	-2.0
361A15MD - Liverpool Lime Street (08:47)		-1.0	-1.5	-1.5	-1.0		0.0		0.0			-0.5	-1.0	-1.0		0.0	-0.5	-1.5	-2.0	-1.0	-0.5	0.0
321A16MD - Manchester Piccadilly (08:55)		-1.0	-0.5	-0.5	-1.0		0.0		0.0			-2.5	-3.0	-3.0		-2.0	-1.5	-2.5	-3.0	-3.0	-2.5	-2.0
071M07M6 - Glasgow Central (06:30)		0.0	-0.5	-0.5	0.0		0.0		0.0			0.5	0.0	1.0		1.0	0.5	-0.5	-1.0	-1.0	-0.5	0.0
651B28MF - Birmingham New Street (09:50)	-0.5	-0.5	-0.8	-0.5	0.0		1.0		1.8			2.5	0.5	1.5		1.5	1.0	0.8	-0.5	-0.5	0.0	0.0
321A17ME - Manchester Piccadilly (09:15)		0.0	0.5	0.5	1.0	2.0	2.0		1.8			1.5	1.0	1.0		1.0	0.5	0.5	0.0	0.0	0.5	1.0
431Y16MC - Rugeley Trent Valley (08:20)	-2.5	-0.5	-1.0		0.0	-0.5	0.0	-0.5	0.0	-1.0	-1.0	-0.5	0.5	0.5		0.5	0.0	0.0	-0.5	-0.5	0.0	0.0
421W08MC - Crewe (08:01)	-1.5	-1.0	-0.5		-0.5	1.0	1.0		0.8			-0.5	0.3	0.0	0.8	1.0	1.0	1.0	0.5	0.5	1.0	1.0
079M48M5 - Glasgow Central (05:49)		-0.8	-0.3	0.5	1.0	1.3	1.0		0.5			0.3	0.0	0.0		1.0	1.0	1.0	0.5	0.3	0.5	0.0
401A18MF - Chester (09:35)		-2.0	-1.5	-0.5	-1.0	0.5	1.0		0.5			0.0	0.0	0.0		0.0	0.5	0.5	-1.0	-1.0	-0.5	-1.0
321A19MF - Manchester Piccadilly (09:35)		0.0	0.5	0.5	-1.0		2.0		2.0			2.0	1.5	1.5		1.5	1.0	1.0	0.5	0.5	0.0	0.0
421U24MF - Crewe (09:33)	-1.5	0.0	-0.5	0.5	0.0	0.0	-0.5		-0.5			0.0	-1.0	-0.5		-1.0	-0.5	-0.5	-2.0	-1.0	-1.5	0.0
651B32MH - Birmingham New Street (10:30)		0.0	0.0	0.0	0.5		0.5		0.5			0.0	-1.0	-0.5	-0.5	0.0	-0.5	-0.5	-2.0	-2.0	-1.5	-1.0
361A20MF - Liverpool Lime Street (09:47)		-0.5	-0.3	0.0	-0.5		0.5		0.5			1.0	-0.5	0.5		1.5	0.5	0.5	-1.0	-1.0	-0.5	0.0

Block Chart for services planned to arrive at London Euston from the Up Fast Line between 16:00 and 19:00

Lateness is based on the 25th Percentile across the December 2019 SX TT

	Rugby - A	Rugby - D/P	Hillmorton Jn - D/P	Weedon - D/P	Hanslope Jn - D/P	Milton Keynes Central - A	Milton Keynes Central - D/P	Bletchley - A	Bletchley - D/P	Leighton Buzzard - A	Leighton Buzzard - D/P	Ledburn Jn - D/P	Tring - D/P	Bourne End Jn (Herts) - D/P	Watford Junction - A	Watford Junction - D/P	Harrow & Wealdstone - D/P	Wembley Central - D/P	Willesden West Londn Jn - D/P	Camden Jn - D/P	Camden South Jn - D/P	London Euston - T
361A40MN - Liverpool Lime Street (13:47)		-1.5	-1.0	-1.3	-1.5		0.5		0.5			0.5	0.0	0.0		0.0	0.0	-0.5	-2.0	-1.0	-2.0	0.0
321A41MN - Manchester Piccadilly (13:55)		-1.5	-2.0	-2.0	-1.5		-0.5		0.5			0.5	0.0	1.0		2.0	1.0	0.5	-1.0	-1.5	-1.0	0.0
071M12MJ - Glasgow Central (11:40)		-0.3	-0.5	-0.5	-0.3		0.8		0.8			1.5	0.8	0.8		1.0	0.5	0.5	-0.3	-0.5	0.0	0.0
651B58MP - Birmingham New Street (14:50)	-2.5	-1.0	-1.0	-1.0	-0.5		-0.5		-0.5			0.0	-0.5	-0.5		0.3	-0.3	0.0	-1.5	-1.5	-1.0	0.0
321A42MO - Manchester Piccadilly (14:15)		0.3	0.3	0.0	0.5	1.5	1.5		1.5			1.8	1.3	1.3		1.3	0.8	0.0	-0.5	-0.5	0.0	0.8
431Y26MM - Rugeley Trent Valley (13:20)	-2.0	-1.0	-0.5		0.0	-0.5	0.0	-0.5	0.0	0.0	0.0	-0.5	0.5	0.3		0.8	0.3	0.3	-0.3	-1.3	-0.8	0.0
421W18MM - Crewe (13:03)	-1.5	-1.0	-0.5		1.3	2.0	2.0		2.0			0.5	1.5	1.0	2.0	2.0	2.0	2.0	1.5	1.5	2.0	2.0
049M54MH - Edinburgh (10:52)		-1.5	-1.5	-1.5	-1.5	0.0	0.0		0.0			0.5	0.0	0.0		1.0	1.5	0.5	0.0	0.0	0.5	1.5
401A43ML - Holyhead (12:53)		-1.0	-0.5	-0.5	0.0	1.5	1.8		1.3			1.8	1.0	1.0		2.0	2.3	1.5	1.0	0.8	1.3	3.0
321A44MP - Manchester Piccadilly (14:35)		1.0	0.5	0.5	0.0		2.0		2.0			1.5	0.5	0.5		1.5	1.0	1.0	-1.0	-1.0	-0.5	0.0
361W90MM - Liverpool Lime Street (13:05)	0.5	0.5	1.0		0.0		0.5		1.0			1.5	0.5	1.0		0.5	1.0	0.0	-0.5	-1.0	-0.5	1.0
421U34MP - Crewe (14:33)	-1.0	0.0	0.5	0.5	0.0	0.0	1.0		0.8			1.3	1.3	1.0		0.3	-0.3	0.0	-0.5	-1.5	-1.3	-1.0
651B62MR - Birmingham New Street (15:30)		-1.0	-0.3	0.0	-0.5		1.5		1.0			0.5	1.0	1.0	0.5	1.0	0.5	0.5	-0.5	0.0	0.0	1.0
361A45MP - Liverpool Lime Street (14:47)		-1.5	-1.0	-1.3	-1.5		0.0		1.0			0.5	1.0	1.0		1.0	1.3	0.5	0.0	0.0	0.3	2.0
321A46MP - Manchester Piccadilly (14:55)		0.5	1.0	1.0	0.5		1.0		1.0			1.5	1.0	1.0		2.0	2.5	2.3	1.0	0.8	1.3	2.8
071M13ML - Glasgow Central (12:40)		-0.5	0.0	0.0	0.5		1.3		1.3			0.0	1.3	1.3		1.5	1.0	1.0	0.5	0.5	-0.5	1.0
651B64MR - Birmingham New Street (15:50)	-1.5	0.0	0.0	0.0	0.5		0.5		1.5			0.0	-0.5	-0.5		-0.5	0.0	-1.0	-1.5	-1.5	-1.0	2.0
703A95MT - Bletchley C.S. (16:37)								-9.0	-9.0			-6.0	-5.5	-2.0		-1.5	-1.8	-1.8	-2.3	-1.5	-1.0	0.0
321A47MQ - Manchester Piccadilly (15:15)		-0.5	0.0	0.0	0.5	0.5	1.5		1.5			1.0	0.5	0.0		-0.5	-0.3	-1.0	-1.5	-1.5	-1.0	-1.0
431Y28MO - Rugeley Trent Valley (14:20)	-0.5	-0.5	-1.0		-2.0	-0.5	-0.5	-0.3	-0.5	-1.5	-1.5	0.0	0.0	-0.5		0.0	-0.5	-0.5	-1.0	-1.0	-0.5	-1.0
421W20MO - Crewe (14:01)	-1.5	-0.5	-1.0		-1.0	-0.3	0.5		-0.3			-1.0	0.0	-0.5	0.5	0.5	0.5	0.5	0.0	0.0	0.5	1.0
079M55MK - Glasgow Central (12:00)		-1.5	-1.5	-0.5	-1.0	0.0	1.0		1.0			0.5	0.0	1.0		1.5	0.5	0.5	-0.5	0.0	0.5	1.0
401A48MN - Holyhead (13:58)		-1.0	-0.5	0.3	0.8	1.5	1.8		1.3			2.0	1.0	1.0		2.0	3.0	2.3	0.8	0.8	1.5	2.0
321A49MR - Manchester Piccadilly (15:35)		0.0	0.3	0.3	0.0		3.0		3.3			2.5	2.8	2.8		2.8	2.5	1.5	0.0	0.0	0.5	1.0
361W92MO - Liverpool Lime Street (14:05)	2.0	2.0	1.5		0.0		1.5		0.5			2.0	2.0	1.5		1.0	1.5	1.5	0.0	1.0	1.5	2.0
421U36MR - Crewe (15:33)	-1.0	0.0	0.5	1.0	0.5	1.5	2.5		1.5			2.0	2.0	2.0		1.0	1.0	1.0	0.5	0.0	0.5	1.5
641B68MQ - Shrewsbury (15:24)		1.5	3.0	3.0	3.5		4.0		3.5			3.0	2.0	2.5	3.0	3.5	4.0	3.0	2.5	2.5	3.0	3.0
301A93MQ - Blackpool North (15:02)	-3.5	-0.5	-1.5	-0.5	-0.3		0.8		1.0			0.5	1.0	1.8		2.5	2.8	2.8	1.5	1.5	2.0	2.0
361A50MR - Liverpool Lime Street (15:47)		-1.5	-1.0	-1.0	-0.8		-0.5		0.3			0.8	0.5	0.5		2.5	3.0	2.8	1.5	1.5	2.0	1.8
321A51MR - Manchester Piccadilly (15:55)		-0.5	0.0	0.0	0.5		1.5		1.5			1.0	0.5	0.5		2.5	3.0	2.0	1.5	0.5	2.0	1.0
071M14MN - Glasgow Central (13:40)		-1.0	-0.5	-0.5	-1.0		1.0		1.0			1.5	1.0	1.0		2.0	2.5	1.5	1.0	1.0	1.5	2.0
651B70MT - Birmingham New Street (16:50)	-1.0	0.0	0.0	0.0	0.5		1.0		1.0			1.0	0.5	0.5		1.5	1.5	1.0	-0.5	-0.5	0.0	0.0
321A52MS - Manchester Piccadilly (16:15)		1.5	2.0	2.0	2.3	2.5	3.3		2.5			3.0	2.5	2.5		2.5	2.0	1.5	0.8	1.0	0.5	1.0
431Y30MQ - Rugeley Trent Valley (15:16)	-0.5	0.5	0.0		-1.0	-0.5	0.0	-0.5	0.0	-2.0	-1.5	0.0	-0.5	0.0		-0.5	-0.5	-0.5	-1.5	-0.5	0.0	0.0
421W22MQ - Crewe (15:01)	-2.0	0.0	-0.5		1.3	2.8	3.0		2.0			1.5	1.5	2.0	2.0	2.0	2.0	2.0	1.5	1.5	2.0	2.0
049M56ML - Edinburgh (12:52)		0.0	0.5	0.5	2.0	3.5	4.0		4.0			3.5	2.5	2.5		3.5	3.3	3.0	2.5	2.8	3.0	4.0
401A53MT - Chester (16:35)		-1.0	-0.5	-0.5	-1.0	3.5	3.0		2.5			4.0	2.0	2.0		3.0	2.5	2.5	1.0	1.0	1.5	2.0
321A54MT - Manchester Piccadilly (16:35)		2.0	1.5	1.5	2.0		5.0		3.5			4.0	3.0	3.0		3.0	3.5	3.5	3.0	3.0	3.5	4.0
361W94MQ - Liverpool Lime Street (15:05)	1.5	1.5	2.0		1.5	3.0	4.0		4.0			4.5	3.5	3.5		3.5	3.0	3.0	2.5	2.5	3.0	3.0
421U38MT - Crewe (16:33)	0.0	0.0	0.5	0.5	1.0	3.0	4.0		4.0			4.5	3.5	3.0		3.5	3.0	3.0	2.5	2.5	3.0	3.0
651B74MV - Birmingham New Street (17:30)		1.5	1.5	1.5	2.0		5.0		4.8			4.3	3.3	3.8	3.8	4.3	4.0	3.8	2.5	2.5	3.0	3.0
361A55MT - Liverpool Lime Street (16:47)		0.0	-0.5	-0.5	0.0	2.0	2.0		2.0			2.5	1.0	2.0		3.0	1.5	1.5	1.0	1.0	1.5	2.0

C.09.08 In summary considering the current December 2019 punctuality levels when looking at path variance and block charts we see that:

C.09.09 Even on a good performing day for the West Coast South, trains on the Up FL are running out of path and can be regularly seen in adjacent paths – instead of their own. This is particularly noticeable from the 1B68 (Shrewsbury to London Euston) service onwards in the Up.

C.09.10 Presentation on the Up FL between Ledburn Jn and London Euston indicates that as the day's operation progresses, lateness is kept in the system and recovery back to a steady state is not realised. Whilst the problems (attributable incidents, sub threshold delay etc) might not be directly occurring in the West Coast South, the effect of them is being realised here due to the crossing moves that are planned into the WTT (Bourne End / Ledburn Junction) and the quantum of services in the schedule allowing for minimal opportunity to recover and demonstrate resilience.

C.09.11 The poor presentation in the Up direction at Ledburn Junction, is causing On Time Down Trains that require to cross from Down FL to Down SL to lose time and perturb the network north of Leighton Buzzard on the SL. This is evidenced above in how the 1Y23, 1Y85, 1N69, 1Y51, 1N71 and 1Y93 performs.

C.09.12 It should be noted that the performance detailed above focuses on a perceived 'good' day (25th percentile across the SX December 2019 Timetable). The view of how the timetable is performing worsens when we talk about median punctuality levels.

C.10 Timetable Constraints

C.10.01 Table 13 lists the areas of constraint and their impact on the timetable which were previously identified in the 2013 report. The rightmost column has been updated to reflect the expected impact on future timetables from the May 2020 timetable onwards.

Area of Constraint	Capacity Impact	Expected to be a constraint in future timetables?
Euston	Euston reduced to 16 platforms from 18 in 2019, limiting platform availability particularly in morning peak.	Yes
Euston – Milton Keynes Central	Fast Lines comprise a mixture of 125 mph paths, 110mph paths and 100mph paths. This heterogeneity of paths constrains capacity south of Rugby.	Yes This may be resolved with new rolling stock, but it remains a constraint in the short term.

Area of Constraint	Capacity Impact	Expected to be a constraint in future timetables?
Brinklow – Attleborough Junction	Down FL shared with freight trains (max speeds 60-75mph) on the 3-track section.	Yes
Colwich Junction – Milford & Brockton / Whitehouse Junction	Two track section with flat junctions at each end. Mixed traffic with freight trains of maximum speed 60-75mph on this section.	Yes
Norton Bridge	Flat junction – Timetable constrained by crossing moves of trains on/off the Norton Bridge Branch to/from Stone Junction.	No This is now grade separated under completion of Norton Bridge remodelling.
Crewe	Flat junction moves with complex operation of services – limited spare platform capacity.	Crewe hub scheme will remodel and re-signal the area – currently planned for completion 2024/2025.
Winsford South Junction – Weaver Junction	Predominantly a two-track section with limited opportunity for overtaking. The mix of speeds between different services on this section limits the available capacity.	Yes Still a constraint.
20-minute frequency timetable between Euston – West Midlands and Euston – Manchester	Interaction with other services on the Coventry Corridor, Stoke-on-Trent route and between Cheadle Hulme – Manchester Piccadilly.	Yes Still a constraint.
New Measurement Train	This requires a path between Crewe – London Euston within the off-peak timetable once every 2 weeks (currently utilising the xx:30 arrival and xx:33 departure paths at London Euston).	Yes Impacts with new GC services (WO)
Barrow – Carlisle (via Cumbrian Coast)	Long sections of absolute block signalling and single-track railway between Barrow – Park South Junction and Sellafield – Bransty Junction (Whitehaven).	Yes

Table 13: Table outlining the areas of constraint and their impact on the timetable which were previously identified in the 2013 report

C.10.02 The following is a list of further constraints that have been identified as having a potential impact on capacity in current or future timetables:

- Loss of platforms 17 and 18 at London Euston.
- Ongoing and future HS2 works on the WCML.
- The introduction of Materials by Rail (MBR) services for the construction of HS2; the additional trains will put further strain on the infrastructure and network.
- Loss of flexibility in times of perturbation due to the removal of Watford North Junction.
- The power supply in the Crewe area is nearly at capacity.
- Crewe Hub resignalling.
- More WMT trains are splitting and joining at Euston.

C.10.03 **Timetable constraints outside of scope:**

C.10.04 No analysis has been done for areas further north that Carnforth North Junction and therefore no consideration has been given to the viability of any paths into and through Scotland. Previous studies which have stopped south of Lanark Junction have not taken into account the 10 flat junctions a train passes over on the way to Glasgow and the intense service that is operated.

C.10.05 Since 2013 services have been enhanced and there exist further planned service alterations when the additional feeder station is delivered at Curriehill (circa 2022-2023); this will enable a third Shotts path an hour and 1 train per hour via Carstairs.

C.10.06 The geographic scope of the analysis with respect to Liverpool Lime Street paths was bounded at Weaver Junction. Therefore, this analysis does not comment on path availability between Liverpool and Weaver Junction. Similarly, platform workings at Liverpool were not included in this analysis hence any potential paths identified on the WCML reaching Weaver Junction make no comment on platform availability at Liverpool Lime Street.

C.10.07 Station workings at London Euston were not included within the geographic scope of this analysis. In effect scope was bounded at Camden Junction and focused solely on the availability of FL paths in and out of Euston.

C.10.08 Further analysis would be required in order to determine the TPR compliance at Euston station if additional FL paths were to be included. Given the reduction of platforms at Euston from 18 to 16 in preparation for the construction of HS2, the opportunity for additional capacity at Euston is likely to be limited.

C.11 Capacity Enhancement Schemes

C.11.01 Table 14 is a list of capacity enhancement schemes which were identified in the 2013 report which at the time were considered to potentially have an impact on capacity on the WCML. It has been updated to reflect the predicted impact on capacity from the May 2020 timetable. It has also been updated to show which schemes have been completed and the impact on capacity that it has had.

Enhancement Scheme	Completion Date	Delivered?	Capacity Impact
Power upgrade between North Wembley – Whitmore (between Norton Bridge – Crewe) and between Whitmore – Great Strickland (between Tebay – Penrith)	Phase 3A in July 14. Phase 3B in Dec 15.	No	Supports an increase from 12 electric FL paths per hour to 15 between North Wembley and Whitmore.
Procurement of additional 10 x class 350 by WMT capable of 110mph operation	By Dec/14 Timetable	Yes	Delivered during 2014. Enables additional 110mph services and strengthening of existing services.
Stafford resignalling & conversion of old Royal Mail platform into a freight loop	For Dec/15	Yes	Resignalling scheme has no impact on capacity as it is replacement of life expired equipment which will deliver improved reliability. The freight loop provides additional capacity for recessing freight trains predominantly in the Down direction.
Norton Bridge grade separation	For Dec/16	Yes	Removes conflicts between crossing moves of trains on/off the Norton Bridge branch to/from Stone Junction. This will support the delivery of additional FL paths.
Line speed increase on SL from 75mph and 100mph: Doxey Junction – Norton Bridge. Norton Bridge – Crewe	For Dec/16	Yes	Allows more flexibility by enabling 100mph WMT services to operate on the SL without journey time penalty, freeing up capacity on the FL. Journey times between Stafford and Crewe on SL reduced by 4 minutes. Note that both 60mph and 75mph freight still runs along this section.
Procurement of 10 x class 350 by TransPennine	By May/14 Timetable	Yes	Enables the operation of an hourly electric service between Manchester Airport – Scotland with accelerated journey times.

Enhancement Scheme	Completion Date	Delivered?	Capacity Impact
Express (TPE) capable of 110mph operation			TPE have been operating Class 350s but are now planning on introducing class 397s on the route. Units are in the process of being transferred to WMT.
Preston – Blackpool North Electrification and journey time improvement scheme	For Dec/16	Yes	Delivers infrastructure to support electric through services from London Euston. Provides the opportunity for accelerated journey times between Preston and Blackpool North.
East West Rail	2024	No	Additional service running between Bletchley and Milton Keynes on the SL. Any additional services planned on the SL at Milton Keynes but join the FL further south (e.g. Ledburn Junction) could conflict with the paths that have been identified for East West Rail services.
Reduction in number of platforms at Euston from 18 to 16	2019	Yes	Limits platform availability, particularly in morning peak.
Coventry Station Platform	2021	No	Plan to build a bay platform at Coventry (linked to 2022 Commonwealth games). This building work may affect services through the station. Currently in the building plan stage.

Table 14: A list of capacity enhancement schemes which were identified in the 2013 report as ones that may impact on capacity, updated with the expected impact on capacity from May 2020

C.12 Future Considerations

C.12.01 A number of future considerations were identified in the 2013 report which were expected to have an impact on capacity in future timetables. The key considerations that are expected to impact upon the May 2020 and future timetables are:

- An increase in the number of strategic paths for freight in expectation of future freight growth.

- Work on HS2 including platform reduction at London Euston and major rework of Crewe station
- A revised WMT resource plan
- Changes to the Avanti fleet with a greater proportion of 110mph limited rolling stock on the WCML.

C.12.02 See E.08 for the complete list of future considerations from the 2013 report, updated to reflect the potential impact expected in May 2020.

C.12.03 **East West Rail:**

The EWR project to re-open the route from Oxford to Cambridge includes plans for services to run to Milton Keynes Central. These will join the WCML at Denbigh Hall South Junction, just north of Bletchley. The first of these services (2 trains per hour from Oxford to Milton Keynes Central) are currently due to commence in 2024. These services are planned to run on the SL between Denbigh Hall South Junction and Milton Keynes Central; as such, the introduction of these services should have no impact on trains running on the FL at this location. However, any additional services which are planned on the SL at Milton Keynes but join the FL elsewhere (e.g. Ledburn Junction) could conflict with the paths that have been identified for EWR services.

C.12.04 **HS2:**

- **Crewe Hub Configuration States:**

  There are a number of configuration states planned at Crewe by the Crewe Hub Programme which will significantly reduce capacity in the Crewe area. Work is planned to commence in 2023 with the re-signalling of the Independent Lines, followed by the re-development of the station area and connections to and from the HS2 network at the south and north of Crewe. As these changes are implemented, significant changes to the WTT will be required for the whole of the WCML route and probably further afield, as the various project delivery requirements will necessarily require access for construction.

- **Euston:**

  At London Euston the integration of HS2 will see further constraints placed upon the network with reductions in platforms and additional freight services (Material by Rail) associated with the construction of London Euston HS2 station. This will be followed by the reconstruction Euston Conventional Station works.

- **Stone (Crewe construction and Materials by Rail services):**

  HS2 route construction are also planning the development of a railhead at Stone (near Stoke-on-Trent). Freight services carrying spoil and construction material will be passing to and from this to various sites. Whilst exact service levels required are not known, these will put additional constraints upon the network.

Part D: Conclusion

D.01 Availability of Services Arriving/Departing London Euston Identified in May 2020

D.01.01 Pockets of capacity were identified on sections of the WCML however no continuous paths could be found to link capacity along the entire route to create an end-to-end journey. A timetable recast would be required to investigate whether the capacity for longer continuous paths exists.

D.01.02 From the 3 paths per hour in each direction identified in the 2013 report there were no remaining slots offering a consistent service pattern in all hours analysed within the May 2020 timetable.

D.01.03 The following TPR compliant paths into and out of London Euston were identified:

- A departure slot out of London Euston at XX:57 was found to still exist in all 6 of the scope hours, offering a TPR compliant path to Ledburn Junction. However, by Ledburn Junction these paths are minimum headway with the trains to either side, leaving little buffer time in the timetable to aid recovery in the event of delay. This would therefore pose a significant risk to performance and cause a reduction in timetable resilience.

- An arrival slot into London Euston at XX:43 was found to offer TPR compliant paths from Milton Keynes Central in 4 of the 6 scope hours. These potential paths are between services with a minimum headway gap of 8 minutes at any point along the route. This provides a 2 minute performance buffer to assist recovery in the event of delay. However, utilisation of this path would still be considered a performance risk as it would reduce the ability of the timetable to recover from delay.

D.01.04 The inclusion of any additional services will 'push the limits of timetable robustness'. Successive trains would be running at or near to minimum headway, vastly reducing the performance buffer time and therefore producing a less resilient timetable with increased performance issues.

D.01.05 Using any portion of slot that has been identified on the WCML would reduce the firebreaks currently available for recovery of service during operation of the timetable.

D.01.06 With reference to the punctuality levels that are currently being observed; coupled with a desire to have a robust and reliable timetable, which can recover and mitigate

lateness, whilst also managing capacity in the best way possible - it is advisable from a performance point of view to develop a timetable from scratch rather than adding further services to the existing timetable structure.

D.01.07 Of the 3 departure slots out of London Euston identified in the 2013 report, only the XX:57 was found to still exist in all 6 of the scope hours. The XX:33 and XX:36 departure slots are no longer available due to the inclusion of the GC Blackpool services which use both paths due to them comprising 110mph capable rolling stock.

D.01.08 Table 1 under C.01 provides a summary of the capacity identified in the Down direction.

D.01.09 Of the 3 arrival slots into London Euston identified in the 2013 report, only the XX:43 was found to offer TPR compliant paths from Milton Keynes Central in 4 of the 6 scope hours. The majority of the XX:02 and XX:30 slots have been utilised by additional WMT operated services from Liverpool Lime Street or have been 'eroded' by successive timetable changes.

D.01.10 Table 2 under C.01 provides a summary of the capacity identified in the Up direction.

D.01.11 Differences between the 4 types of rolling stock analysed (those listed under E.04) were not considered significant in terms of the TPR compliance of the paths that were identified, however a 110mph path requires the capacity of two 125mph paths for the journey from London Euston to Milton Keynes Central. Running additional paths at 110mph within a timetable structure predominantly constructed with 125mph trains is not an efficient use of capacity.

D.01.12 The theoretical maximum capacity of the Fast Lines south of Rugby is reduced by running 110mph services within a timetable structure predominantly constructed with 125mph trains, by calling services on the Fast Lines at Watford Junction and by undertaking crossing moves between fast and slow lines, at Ledburn Junction in particular.

D.02 Path Availability between Rugby and Carnforth North Junction

D.02.01 Due to the WCML running at a very high capacity, alongside the increasing complexity of the infrastructure and mixed speed traffic on the WCML further north than Rugby, few additional TPR compliant paths further north than Rugby were found to exist without including a complex stopping pattern to work between existing services.

D.02.02 **Rugby to Preston:**

D.02.03 No opportunities were found for a continuous path from Rugby through to Preston.

D.02.04 Some limited opportunities were found for services to run from Rugby to Crewe and separately Crewe to Preston, however in the majority of cases significant pathing would be required to make the paths TPR compliant.

D.02.05 Most of the capacity identified between Rugby and Preston existed only for significant shorter paths, passing only 1 or 2 stations before terminating.

D.02.06 **Preston to Carnforth North Junction:**

D.02.07 Some TPR compliant paths between Preston and Carnforth North Junction were identified, however this portion of the WCML is predominantly two-track which limits the opportunity for services to overtake one another and therefore limiting the available capacity.

D.02.08 Other significant limits to capacity in this section are:

- Services to and from Morecambe turning around at Lancaster.
- Additional volume of traffic from adjoining lines at Carnforth.

D.02.09 For all paths identified north of Rugby:

- Paths were deemed equally suitable for either 125mph or 110mph capable rolling stock.
- No consideration was given to potential calling patterns

D.03 Freight Uplift

D.03.01 An uplift in freight of one class 4 path per hour across each two-track section of the WCML between Brinklow and Preston was found to be TPR compliant in the majority of hours between 10:00 and 16:00.

D.03.02 The uplift was considered with an eventual view of increasing the number of freight paths to 5 per hour in each direction along the WCML. Therefore, all of the scope hours in which 5 or more freight services in a given direction already exist were not included in this uplift.

D.03.03 The main areas in which additional freight capacity was not identified were:

- Between Crewe and Preston, between the hours of 13:00 and 16:00 in the Down direction.

- Between Crewe and Preston, between the hours of 13:00 and 16:00 in the Up direction and in particular between Wigan North Junction and Preston from 13:00 to 15:00.

D.03.04 The more limited capacity for additional class 4 freight paths north of Crewe appears to be due to the existence of multiple two-track sections on which both freight and passenger services run. These sections of track limit the opportunity for faster trains to overtake which limits the capacity of the WCML north of Crewe.

D.03.05 In all other scope hours, one additional TPR compliant class 4 path was identified for those hours with fewer than 5 freight services currently existing.

D.04 Next Steps

D.04.01 Through discussions with the ORR at the remit stage we indicated the potential need for a further, more detailed piece of work following this short piece of analysis (dependant on outcome). Suggested areas were outlined as below:

- Stage 1 - Extension of the geographical scope to include the following *(each geographical extension to take c. 4-6 weeks dependent on specifics of remit; work could be done in parallel)*
    - Euston platforming
    - Weaver Junction to Liverpool (including Liverpool platforming)
    - Carnforth to Stirling

- Stage 2 – the potential convening of an ESG or IPG in order to undertake further timetable development including the development of a timetable from scratch (if appropriate) rather than adding further services to the existing timetable structure. This may also need to include:
    - More detailed pathing of freight services required above the level in the May 2020 timetable
    - Consideration of freight growth to 2033
    - Calculation of Sectional Running Times (SRTs) for rolling stock not included in this study

D.04.02 Given the absence of a viable and consistent path on the WCML from Euston to the geographic boundaries of this analysis extending the scope, to Liverpool or Scotland, wouldn't add value at this stage.

D.04.03 A next steps approach to stage 2 needs more consideration at an industry level. Therefore, we will be looking to convene an Industry Planning Group. A plan for this approach is currently being worked through and will be developed with industry input.

Part E: Appendix A – Assumptions

E.01 Geographic Scope

E.01.01 The geographic scope for this piece of analysis was the West Coast Main Line from London Euston to Carnforth North Junction. The analysis did not include platforming at London Euston or platform working at any intermediate stations along the route.

E.02 Timetable Scope

E.02.01 The timetable scope was the off-peak between the hours of 10:00 and 16:00.

E.03 Timetable Planning Rules

E.03.01 The TPRs used were those for North West and Central May 2020 V4.0.

E.04 Timing Load Assumptions

E.04.01 The rolling stock analysed included four types of rolling stock currently in operation on the WCML, namely;

- Two types of 125 mph capable stock: classes 390 and tilt enabled 221 (221T)
- Two types of 110mph capable stock: class 91 locomotive with Mark 4 vehicles and class 350

E.05 Source Timetable

E.05.01 The source timetable for the analysis was the December 2016 timetable (Principal Change Timetable 2016) as used in the 2013 report. This was compared to the May 2020 timetable (Subsidiary Change Timetable 2020).

E.06 SRT Assumptions

E.06.01 Some SRTs were missing across sections of the route for some of the rolling stock analysed.

E.06.02 In order to assess the TPR compliance of the paths using these sets of rolling stock, the missing SRTs were assumed to match those of rolling stock with similar characteristics such as maximum speed and were extracted from BPlan for the May 2020 timetable.

E.06.03 Table 15 provides the assumed values of the SRTs covering sections for which there were no current SRTs in BPlan; these assumed values are all pass/pass SRTs for the non-stop services.

Rolling Stock	Direction	From	To	Assumed SRT (minutes)
350-110	Down	Attleborough	Nuneaton	1
		Nuneaton	Amington Junction	7
		Amington Junction	Lichfield North Junction	4.5
		Lichfield North Junction	Rugeley North Junction	4
		Colwich	Stafford	4.5
		Stafford	Norton Bridge	3
		Basford Hall Junction	Crewe	1.5
		Crewe	Crewe Coal Yard	0.5
		Weaver Junction	Acton Grange Junction	3
		Acton Grange Junction	Warrington Bank Quay	1
		Warrington Bank Quay	Dallam Junction	0.5
		Dallam Junction	Winwick Junction	2
		Preston Ribble Junction	Preston	1
91E-7	Down	Attleborough	Nuneaton	1
		Nuneaton	Amington Junction	7
		Preston Fylde Junction	Garstang and Caterral	6
		Garstang and Caterral	Lancaster	6.5
		Lancaster	Morecambe South Junction	1
		Morecambe South Junction	Carnforth North Junction	2.5
350-110	Up	Winwick Junction	Dallam Junction	2
		Dallam Junction	Warrington Bank Quay	0.5
		Warrington Bank Quay	Acton Grange Junction	1
		Acton Grange Junction	Weaver Junction	3

Rolling Stock	Direction	From	To	Assumed SRT (minutes)
		Crewe Coal Yard	Crewe	0.5
		Crewe	Basford Hall Junction	1.5
		Colwich	Rugeley North Junction	1.5
		Rugeley North Junction	Lichfield North Junction	4
		Lichfield North Junction	Amington Junction	4
		Amington Junction	Nuneaton	7
91E-7	Up	Carnforth North Junction	Morecambe South Junction	2.5
		Morecambe South Junction	Lancaster	1.5
		Lancaster	Garstang and Catteral	7
		Garstang and Catteral	Preston Fylde Junction	5.5
		Amington Junction	Nuneaton	7
		Nuneaton	Rugby Trent Valley Junction	9

Table 15: Assumed values of the pass/pass SRTs covering sections for which there are no current SRTs in BPlan

E.07 Freight Services

E.07.01 The baseline for freight services was the volume of train paths in the May 2020 timetable.

E.07.02 There are a number of HS2 MBR services that were considered as part of this analysis which were already included in the May 2020 timetable.

E.07.03 Freight growth, in line with that forecast for the end of CP6 for 'Wembley – Crewe' and 'Crewe – Mossend', was included on the areas of study where freight and FL passenger trains interact. These are as follows:

- Wembley – Crewe growth:
    - Brinklow Junction – Attleborough South Junction
    - Colwich – Stafford

- North of Crewe growth:
    - Winsford South Junction – Warrington
    - Wigan – Balshaw Lane
    - Preston – Carnforth North Junction

E.08 Future Considerations

E.08.01 Table 16 provides a list of future considerations that were identified in the 2013 report and comments on whether these considerations could still be relevant to the May 2020 or future timetables.

Future Consideration	Still valid from May 2020?
An increase in the number of strategic slots for freight.	Yes
Postal Services.	Yes
Extension of Marston Vale service to/from Milton Keynes.	Yes – subsumed by East West Rail aspirations.
Cross Country services to/from the South Coast routed via Coventry.	Valid – unlikely to occur until post-HS2
Extension of Birmingham – Rugeley services to/from Stafford.	No longer valid
Improved journey times for Cross Country services between Birmingham New Street – Manchester Piccadilly.	No longer an issue – delivered post Norton Bridge
Extension of London Euston – Crewe 110mph services to/from Preston.	No Were aspirations to go to Manchester Airport
Accelerated Anglo-Scottish services.	Valid, but uncertain level of acceleration
Potential for issues with WMT units needing to go to Northampton to have their tanks emptied. Unknown start date.	Yes
Potential impact of revised WMT resource plan from May 20 Timetable.	Yes

Table 16: A list of the future considerations that were identified in the 2013 report, stating whether these are still valid and relevant in the May 2020 and future timetables

E.09 Flighting

E.09.01 Flighting is a method of maximising capacity along a route. Trains travelling at the same speeds with the same calling patterns are grouped together to reduce the amount of capacity that is wasted.

E.09.02 Typically, the faster trains with fewer stops run first followed by slower trains with more stops. The fastest service that runs on the route is the "Standard Path".

E.09.03 Figure 2 and Figure 3 demonstrate the use of flighting to increase capacity. The solid black lines between Station A and Station F represent a Standard Path. Each of the bold coloured lines represents a train with the following characteristics:

- The red lines represent the fastest trains, running in a Standard Path.
- The blue line represents a slower train than the red trains, with one stop at Station D.
- The green line represents a slower train than the red trains, with a stop at each of Stations B, C and D.

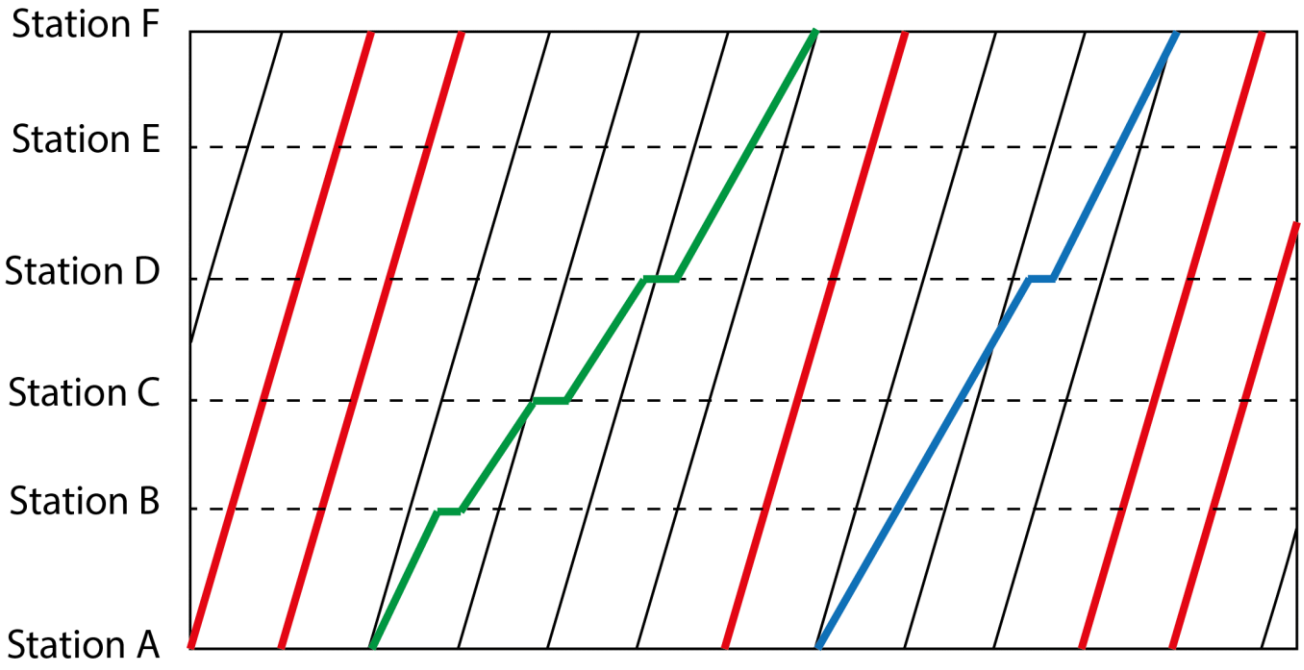


Figure 2: A graph representing the paths of 7 trains travelling between Station A and Station F, occupying 12 Standard Paths

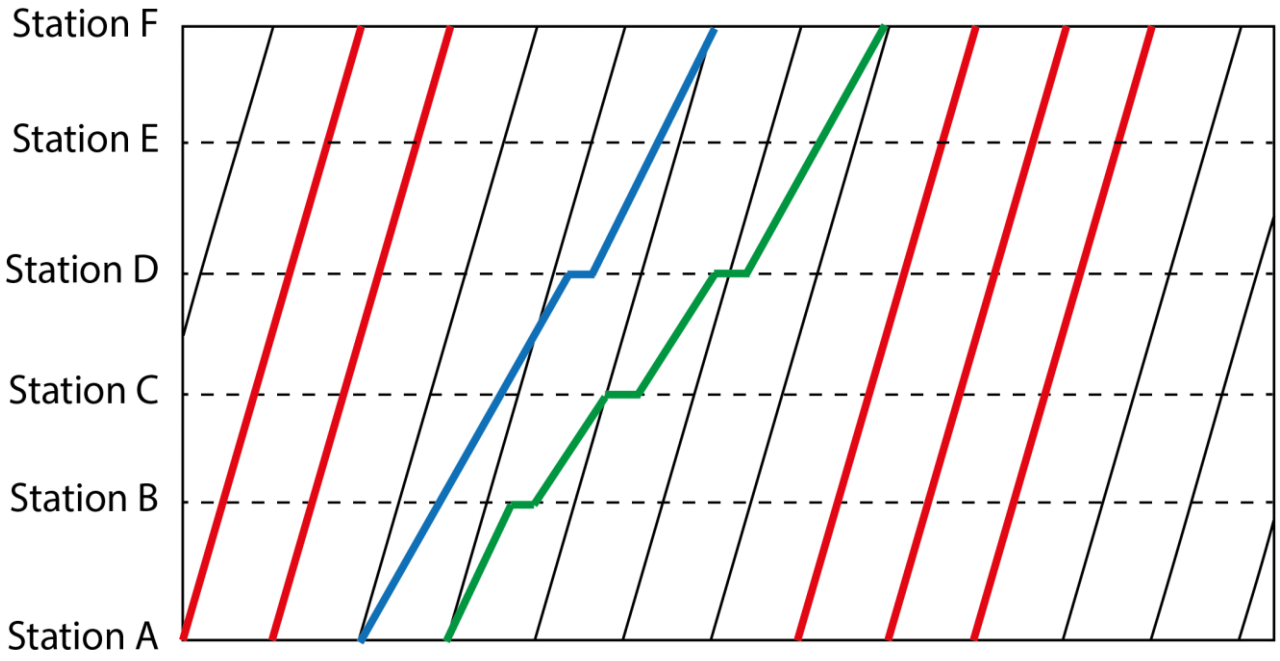


Figure 3: A graph representing the paths of 7 trains travelling between Station A and Station F, occupying 10 Standard Paths

E.09.04 It can be seen that flighting the services, grouping together those with the same or similar path characteristics can reduce the number of Standard Paths used, therefore increasing the capacity along the route.

E.10 Fast Line Arrivals and Departures from London Euston in the May 2020 Timetable

Off Peak standard hour FL departures from London Euston in May 2020 between the hours of 10:00 and 16:00:

Departure Time	Destination	Operator	Rolling Stock	Maximum Speed (mph)
xx:00	Manchester	Avanti West Coast	390	125
xx:03	Birmingham	Avanti West Coast	390/221	125
xx:07	Liverpool	Avanti West Coast	390	125
xx:10	Chester/North Wales	Avanti West Coast	221	125
xx:15	Liverpool	West Midlands Trains	350	110
xx:20	Manchester	Avanti West Coast	390	125
xx:23	Wolverhampton/ Birmingham	Avanti West Coast	390/221	125
xx:30	Glasgow	Avanti West Coast	390	125
xx:33 xx:36	Blackpool North Blackpool North	Grand Central Avanti West Coast	91 390	110 125
xx:40	Manchester	Avanti West Coast	390	125
xx:43	Edinburgh/Glasgow via Birmingham	Avanti West Coast	390	125
xx:46	Crewe	West Midlands Trains	350	110
xx:49	Birmingham	West Midlands Train	350	110

Off Peak standard hour FL arrivals into London Euston in May 2020 between the hours of 10:00 and 16:00:

Arrival Time	Origin	Operator	Rolling Stock	Maximum Speed (mph)
xx:02	Blackpool North/ Liverpool	Grand Central/ West Midlands Trains	91	110
xx:05	Manchester	Avanti West Coast	390	125
xx:10	Glasgow	Avanti West Coast	390	125
xx:14	Birmingham	Avanti West Coast	390/221	125
xx:21	Manchester	Avanti West Coast	390	125
xx:27	Birmingham	West Midlands Trains	350	110
xx:30	Liverpool	West Midlands Trains	350	110
xx:33	Scotland (via Birmingham)	Avanti West Coast	390/221	125
xx:37	Chester	Avanti West Coast	221	125
xx:40	Manchester	Avanti West Coast	390	125
xx:50	Crewe	West Midlands Trains	350	110
xx:55	Birmingham	Avanti West Coast	390/221	125
xx:59	Liverpool	Avanti West Coast	390	125