HS2 Phase Two

Assumptions report PLANET Framework Model version 5.2

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Department for Transport

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PFMv5.2 Assumptions Report Contents

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1 Introduction

1.1.1 The PLANET Framework Model, or PFM, has been developed by HS2 Ltd as a tool to forecast the demand and benefits of HS2. The current version of PFM is known as version 5.2 or PFMv5.2 and its methodology is separately described in the report: *PLANET Framework Model (PFMv5.2) – Model Description*.

1.1.2 This document provides a summary of the input and forecasting assumptions used by PFMv5.2 to generate what is known as the HS2 standard case, as presented in the separate report, *Economic Case for HS2 Phase 2A*.

2 Forecasting assumptions

2.1 Forecasting approach

2.1.1 Separate forecasts of 'Do Minimum' (without scheme) passenger demand are produced by mode and purpose. These make use of the recommended DfT modal forecasting procedures for air, car and rail.

- Rail forecasts are generated in line with WebTAG using DfT's EDGE[1] model.
- Car forecasts are generated using the National Trip End Model in TEMPro[2].
- Domestic air forecasts are generated using the DfT Aviation Model[3].

2.1.2 The following sections in this chapter outline the input assumptions used by these models to produce 'Do Minimum' forecasts for each of these modes.

2.2 Rail demand growth

Elasticities

2.2.1 Rail demand growth is generated by DfT's EDGE model, which is based on current WebTAG[4] guidance for forecasting rail demand. This uses PDFH5.1 growth elasticities for all variables except fares that are based on PDFH4 elasticities. In addition, the ticket type to journey purpose conversion is based on parameters from PDFH5.0

Demand drivers

2.2.2 HS2 Ltd's use of the EDGE model and PDFH utilises up to 14 different demand drivers, which feed into the future year forecasts of rail demand. The base year of PFM is financial year 2010/11; the drivers are provided as a change from this base to the forecast years 2026/27 and the cap year, which is 2037/38 in PFMv5.2. The demand drivers for the modelling were provided by the Department for Transport. The following sections detail the source data and assumptions used for each of these drivers in PFMv5.2 and, for ease of comparison, we also present the assumptions used in PFMv4.3, the model used for the Economic Case for HS2, October 2013.

Population growth

2.2.3 The growth in population used in PFMv5.2 has been sourced from Office of National Statistics (ONS) population projections, November 2013 (low migration variant which is also used by the GDP forecast used in PFMv5.2)[5], with regional and national shares-based data provided by the Centre for Economics and Business Research (CEBR), August 2014. Table 2-1 below presents the projected growth of the population for the forecast years from the base used in PFM.

[1] Exogenous Demand Growth Estimation (EDGE). Details are given in WebTAG TAG Unit M4, November 2014, Forecasting and Uncertainty.
[2] Details of the Trip End Model Presentation Programme (TEMPro) can be found at .https://www.gov.uk/government/collections/tempro. Accessed 20 August 2015.
[3] The model is described in 'UK Aviation Forecasts, DfT, January 2013.
[4] TAG Unit M4: November 2014, Table 1.
[5] http://www.ons.gov.uk/ons/publications/re-reference-tables.html?newquery=*&newoffset=150&pageSize=25&edition=tcm%3A77-318453 Table G1-1 Low Migration Variant. Accessed 8 September 2015.

Table 2-1: Regional and national population growth used in rail demand forecasts

Region/nation	Growth in Population from 2010/11, PFMv5.2		Growth in Population from 2010/11, PFMv4.3	
	2026/27	2037/38 (cap year)	2026/27	2036/37 (cap year)
North East	3.2%	5.0%	3.6%	5.7%
North West	4.4%	5.6%	7.8%	9.5%
Yorkshire & Humberside	6.8%	12.4%	8.1%	13.9%
East Midlands	8.9%	14.5%	13.9%	20.0%
West Midlands	7.5%	10.6%	10.3%	13.8%
East of England	12.4%	19.5%	14.0%	21.2%
London	18.9%	26.0%	18.6%	25.7%
South East	11.1%	16.0%	9.3%	14.3%
South West	9.9%	16.0%	8.1%	14.2%
Wales	4.7%	6.7%	6.8%	9.3%
Scotland	4.7%	4.4%	5.6%	5.9%
Great Britain	9.3%	13.6%	10.3%	14.9%

Employment growth

2.2.4 The growth in employment used in PFMv5.2 has been sourced from the Office for Budget Responsibility[6] (OBR) March 2014 (for short term forecasts) and July 2014 (for long-term forecasts), using the ONS low migration variant numbers for population. Regional/national shares are based on CEBR, August 2014. Table 2-2 below presents the predicted growth in employment as used in PFMv5.2 for the forecast years from 2010/11.

[6] http://budgetresponsibility.org.uk/. Accessed 20 August 2015

Table 2-2: Regional and national employment growth used in rail demand forecasts

Region/nation	% Growth in Employment from 2010/11, PFMv5.2		% Growth in Employment from 2010/11, PFMv4.3	
	2026/27	2037/38 (cap year)	2026/27	2036/37 (cap year)
North East	5.4%	5.6%	4.2%	6.0%
North West	3.4%	3.3%	4.8%	6.4%
Yorkshire & Humberside	9.5%	13.7%	7.6%	13.0%
East Midlands	10.7%	10.8%	10.6%	12.2%
West Midlands	9.2%	12.8%	8.3%	13.1%
East of England	14.3%	16.4%	12.9%	16.4%
London	17.1%	19.6%	14.0%	18.0%
South East	8.1%	8.8%	8.9%	11.2%
South West	4.7%	5.3%	6.6%	8.7%
Wales	4.8%	13.5%	6.8%	16.5%
Scotland	5.5%	9.6%	6.9%	12.4%
Great Britain	9.0%	11.2%	8.8%	12.4%

Growth in Gross Domestic Product per person

2.2.5 As with employment growth, the economic growth (measured by GDP per person) in PFMv5.2 has been sourced from the Office for Budget Responsibility (OBR) March 2014 (for short term forecasts) and July 2014 (for long-term forecasts)[7], using the ONS low migration variant numbers for population. Regional and national shares are based on CEBR August 2014.

2.2.6 In 2011 ONS changed its method of calculation for the GDP deflator from an arithmetic to a geometric mean. This means the GDP deflator now corresponds more closely to a Consumer Price Index (CPI) measure of inflation than Retail Price Index (RPI), although it is not quite the same as either. ONS back calculated historic GDP using this new approach as well as using it in its GDP forecasts.

2.2.7 The PDFH5.1 GDP to rail demand elasticity parameter was estimated using GDP forecasts defined with the previous definition of the GDP deflator (similar to RPI), rather the new deflator (similar to CPI). Consequently, to maintain consistency with the original calibration of the PDFH5.1 the GDP forecasts have to be rebased to the old GDP deflator.

2.2.8 The OBR has estimated that the new deflator increases real GDP growth by approximately 0.2 percentage points per annum; the real GDP growth forecasts have therefore been reduced by 0.2 percentage points every year to ensure the growth

[7] http://budgetresponsibility.org.uk/. Accessed 20 August 2015

rates are consistent with the elasticities that are applied to them[8]. The resulting growth is shown in Table 2-3. The Great Britain figures are a population weighted average of the regional figures.

2.2.9 For this reason, the GDP forecasts used for forecasting rail growth are different to the ones used to forecast future Value of Time (VoT). The GDP series used for VoT is discussed in Chapter 3.

Table 2-3: Regional and national GDP growth used in rail demand forecasts

Region/nation	Growth in GDP per capita from 2010/11, PFMv5.2		Growth in GDP per capita from 2010/11, PFMv4.3	
	2026/27	2037/38 (cap year)	2026/27	2036/38 (cap year)
North East	23.2%	50.5%	22.9%	47.1%
North West	20.4%	47.0%	20.4%	44.2%
Yorkshire & Humber	18.0%	44.1%	21.7%	45.7%
East Midlands	20.2%	46.8%	23.5%	47.8%
West Midlands	20.6%	47.2%	22.9%	47.1%
East of England	22.5%	49.6%	26.7%	51.6%
London	28.1%	56.4%	24.9%	49.5%
South East	28.5%	56.9%	34.8%	61.4%
South West	17.9%	44.0%	28.0%	53.2%
Wales	21.6%	48.5%	22.1%	46.2%
Scotland	23.1%	50.3%	28.5%	53.9%
Great Britain	22.8%	50.0%	25.8%	50.5%

National Rail and London Underground fares

2.2.10 All National Rail fares in PFMv5.2 are assumed to grow at a rate of RPI+1 per calendar year. This assumption applies during the forecast period except 2014-2020, when RPI+0 applies. The same assumptions have been used for London Underground[9] fares in PFMv5.2. Table 2-4 shows the cumulative growth used in the model from 2010/11 to 2026/27 and the cap year.

[8] This was described in paragraph 1.1.5 of WebTAG unit 3.5.6, January 2014, http://webarchive.nationalarchives.gov.uk/20140304105410/http://www.dft.gov.uk/webtag/documents/expert/pdf/U3_5_6-Jan-2014.pdf accessed 20 August 2015

[9] London Underground fares maybe be subject to policy change from 2017 given future mayoral elections.

Table 2-4: Rail fare growth used in rail demand forecasts

	Growth in Rail Fares from 2010/11, PFMv5.2		Growth in Rail Fares from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
National Rail	9.4%	22.0%	17.8%	29.7%

Car ownership

2.2.11 The change in car ownership in PFMv5.2 has been sourced from the National Trip End Model (NTEM) in TEMPro version 6.2[10]. This provides forecasts for the number of car-owning households. Table 2-5 shows the growth in car-owning households for key RIFF[11] zones within the HS2 corridor.

Table 2-5: Car ownership growth used in rail demand forecasts

RIFF zone	**Growth in Car Owning Households from 2010/11, PFMv5.2**		**Growth in Car Owning Households from 2010/11, PFMv4.3**	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
Central London	10.5%	16.4%	10.5%	15.8%
Central Manchester	5.7%	8.0%	5.7%	7.8%
Rest of Manchester	4.9%	6.9%	4.9%	6.7%
Central Birmingham	8.5%	12.3%	8.5%	11.9%
Rest of West Midlands	4.0%	5.5%	4.0%	5.3%
Leeds	6.8%	9.5%	6.8%	9.2%
Rest of West Yorkshire	4.9%	6.8%	4.9%	6.6%
Great Britain	3.8%	5.3%	3.8%	5.1%

Car journey times

2.2.12 The change in average car journey times used in the EDGE model for PFMv5.2 has been sourced from the DfT's National Transport Model[12]. The assumptions for travel times to London from the rest of Great Britain are shown in Table 2-6.

Table 2-6: Car journey time growth used in rail demand forecasts

	Growth in Car Journey Times from 2010/11, PFMv5.2		Growth in Car Journey Times from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**

[10] Refer to https://www.gov.uk/government/publications/tempro-introduction. Accessed 20 August 2015.
[11] RIFF zones are groups of areas defined within the EDGE model.
[12] Refer to https://www.gov.uk/government/collections/transport-appraisal-and-modelling-tools. Accessed 20 August 2015.

Rest of Great Britain to London	5.7%	9.7%	5.7%	10.1%

Car cost

2.2.13 This parameter represents the forecast costs of car use taking account of growth in car fuel prices and projected changes in the fuel efficiency of the vehicle fleet. This method is consistent with a change in WebTAG since February2014 to include vehicle efficiency; previously WebTAG had recommended using only car fuel price as a proxy for car cost.

2.2.14 Car costs in PFMv5.2 have been sourced from WebTAG Databook, May 2014[13] and are shown in Table 2-7.

Table 2-7: Car cost growth used in rail demand forecasts

	Growth in Car Cost from 2010/11, PFMv5.2		Growth in Car Cost from 2010/11, PFMv4.3	
	2026/37	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
Great Britain	-24.0%	-21.7%	22.5%	24.4%

Bus and coach fares

2.2.15 Bus and coach fares in PFMv5.2 are based on an examination by DfT of the past trend, reference to actual fares growth from 2010/11 and an assumption of a future annual average growth rate of RPI+2 from 2014 to 2034 after which RPI+0 is assumed. Forecast growth from 2010/11 is shown in Table 2-8.

Table 2-8: Bus and coach fare growth used in rail demand forecasts

	Growth in bus costs from 2010/11, PFMv5.2		Growth in bus costs from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
Great Britain	40.5%	68.1%	45.3%	77.0%

Bus and coach journey times

2.2.16 The forecast change in average bus and coach journey times in PFMv5.2 has been sourced from the WebTAG Databook, May 2014. The change from 2010/11 for travel times to London from the rest of Great Britain is shown in Table 2-9.

Table 2-9: Bus and coach journey time growth used in rail demand forecasts

	Growth in Bus Journey Times from 2010/11, PFMv5.2		Growth in Bus Journey Times from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/38 (cap year)**
Rest of GB to London	9.1%	15.0%	9.1%	15.0%

[13] Data based on TAG data-book – see tab M4.2.2 in "webtag-data-book-autumn-2014-forthcoming-change.xls" at https://www.gov.uk/government/publications/webtag-tag-data-book-may-2014 Accessed 20 August 2015.

Bus and coach frequency

2.2.17 The forecast change in average bus and coach frequency[14] used in PFMv5.2 has been sourced from DfT and based on the recent reductions in bus subsidies. The change from 2010/11 is shown in Table 2-10.

Table 2-10: Bus and coach frequency growth used in rail demand forecasts

	Growth in Bus Frequency from 2010/11, PFMv5.2		Growth in Bus Frequency from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
Great Britain	-6.0%	-4.2%	+6.7%	+12.0%

Air fares

2.2.18 The forecast change in domestic air fares used in PFMv5.2 has been sourced from 2013 outputs of DfT's aviation model[15] as shown in Table 2-11. The air fares that are used in the network element of the PLANET Long Distance (PLD) model are separately sourced as outlined in section 4.3.

Table 2-11: Air fares growth used in rail demand forecasts

	Growth in Air Fares from 2010/11, PFMv5.2		Growth in Air Fares from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/38 (cap year)**
Great Britain	-4.1%	-4.4%	-4.1%	-4.4%

Air frequency

2.2.19 The forecast change in domestic air frequency used in PFMv5.2 has been sourced from 2013 outputs of DfT's aviation model[16] as shown in Table 2-12.

Table 2-12: Air frequency growth used in rail demand forecasts

	Growth in Air Frequency from 2010/11, PFMv5.2		Growth in Air Frequency from 2010/11, PFMv4.3	
	2026/27	**2037/38 (cap year)**	**2026/27**	**2036/37 (cap year)**
Rest of GB to London	-1.2%	-3.7%	-1.2%	-3.2%

[14] In WebTAG frequency is referred to as 'headway'.
[15] The Model is described in UK Aviation Forecasts, DfT, January 2013.
[16] The Model is described in UK Aviation Forecasts, DfT, January 2013.

Air passengers

2.2.20 The forecast change in domestic air passengers used in PFMv5.2 has been sourced from 2013 outputs of DfT's aviation model[17]. Table 2-13 shows forecasts growth from 2010/11 of air passengers by airport.

Table 2-13: Air passenger growth used in rail demand forecasts

Airport	Growth in air passengers from 2010/11, PFMv5.2		Growth in air passengers from 2010/11, PFMv4.3	
	2026/27	2037/38 (cap year)	2026/27	2036/37 (cap year)
Gatwick Airport	26%	31%	18%	22%
Heathrow Airport	18%	26%	23%	33%
Stansted Airport	73%	99%	72%	88%
Birmingham Airport	65%	197%	154%	197%
Manchester Airport	41%	90%	55%	122%
Southampton Airport	61%	316%	153%	348%
Cardiff Airport	-20%	16%	10%	53%

2.3 Rail demand forecasts

Cap year

2.3.1 The forecast years with PFMv5.2 are taken as:

- an opening year – assumed to be 2026/27; and
- a cap year – currently assumed to be 2037/38.

2.3.2 The cap year represents the year at which long distance rail demand is forecast to reach a certain level beyond which no further demand growth (on any mode) occurs. The cap year is defined as the year in which long distance rail trips over 100 miles (within the PLD matrix) are forecast to equal 290,146 trips[18]. This represents an increase in rail trips over 100 miles of 79% from a 2010/11 base. With current growth assumptions this results with the cap year in PFMv5.2 occurring for all modes in 2037/38.

2.3.3 This cap definition is based on the number of trips originally predicted in the economic case, published in February 2011. This ensures a consistent capping assumption is applied for the standard case across different generations of the economic case.

[17] The model is described in UK Aviation Forecasts, DfT, January 2013

18 PFM uses the year which is the closest to this target. In PFMv5.2, the number of PLD trips greater than 100 miles in 2037/38 is 289,293.

2.3.4 Using the above rail demand drivers, the EDGE model produces rail growth forecasts for the opening year 2026/27 and the cap year 2037/38. The growth is summarised in Table 2-14 for PLD and in Table 2-15 for the regional PLANET models.

Table 2-14: Input forecast PLD matrices – growth in rail demand by journey purpose – PFMv5.2

Journey Purpose	**Growth in Rail Demand from 2010/11** (growth in PLD matrices only)	
	2026/27	**2037/38**
Commuting NCA	-6.1%	0.1%
Commuting CA from	15.7%	41.0%
Commuting CA to	15.7%	41.0%
Business CA from	29.5%	77.7%
Business CA to	30.7%	80.2%
Leisure NCA	3.4%	23.1%
Leisure CA from	25.6%	68.5%
Leisure CA to	27.7%	72.5%
Total	18.9%	52.3%

Note: The car available/non-car available split does not apply for rail business trips.

Table 2-15: Forecast regional PLANET matrices – growth in rail demand PFMv5.2

Regional Model	Journey Purpose	**Growth in Rail Demand from 2010/11** (note this is the growth in regional matrices only)	
		2026/27	**2037/38**
PLANET South (PS)	Business PA	53.1%	106.4%
	Business AP	50.1%	98.1%
	Leisure PA	52.0%	98.7%
	Leisure AP	43.8%	82.8%
	Commuting PA	26.4%	37.4%
	Commuting AP	27.0%	40.5%
	Total	**30.8%**	**48.6%**
PLANET Midlands (PM)	Business CA	23.8%	52.2%
	Business NCA	5.3%	21.0%
	Leisure CA	24.0%	53.4%
	Leisure NCA	4.8%	20.8%
	Commuting CA	19.8%	41.8%
	Commuting NCA	-1.5%	6.6%
	Total	**17.7%**	**39.5%**
PLANET North (PN)	Business CA	26.5%	63.5%
	Business NCA	3.5%	21.9%
	Leisure CA	27.1%	64.2%
	Leisure NCA	4.3%	22.8%
	Commuting CA	17.1%	38.2%
	Commuting NCA	-4.1%	4.0%
	Total	**16.4%**	**40.3%**

PA = Production Attraction. AP= Attraction production CA= Car Available NCA = No Car available

2.4 Highway demand forecasts

Economic growth

2.4.1 The highway demand forecasts were developed using factors derived from TEMPro v6.2. To ensure consistency between these TEMPRO based forecasts and the rail forecasts, which used a more recent OBR GDP growth forecast, a GDP elasticity was applied to the matrices to correct for the discrepancy.

2.4.2 Use was made of the DfT Long Distance Model forecasts using a high and low GDP estimate to derive implied arc elasticities of highway demand to GDP. The elasticities that were derived are shown in Table 2-16.

Table 2-16: Implied elasticity of highway demand with respect to GDP

Attribute	Purpose		
	Commuting	Business	Other
Implied Elasticity	0.087	0.151	0.147

2.4.3 The elasticities shown above were applied to the relative growth in GDP and global factors were calculated with these values, which are shown in Table 2-17. These values were applied to the forecast matrices to correct for the change in GDP forecast. The 2037/38 highway demand forecasts have been derived by assuming linear growth between the highway demand forecasts for 2026/27 and 2040/41.

Table 2-17: Growth applied highway demand to correct for change in GDP forecasts

Year	Growth applied to TEMProv6.2 outputs		
	Commuting	Business	Other
2026/27	-0.7%	-1.2%	-1.2%
2040/41	-0.8%	-1.4%	-1.4%

Highway forecasts for long distance trips by purpose

2.4.4 Including the adjustment described above, Table 2-18 shows the highway forecasts applied to the base matrices by the three trip purposes.

Table 2-18: Highway forecasts for long distance trips used in PFM5.2

	Growth in Highway Trips from 2010/11	
Journey Purpose	2026/27	2037/38
Commuting	8.3%	12.6%
Business	9.7%	15.5%
Leisure	13.4%	21.3%
Total	11.9%	18.8%

Highway forecasts for short distance trips

2.4.5 Short-distance trips and goods vehicles trips are represented as pre-loaded flows on the network. For the base year these are calculated by assigning the base year PLD matrices onto the highway network and taking the difference between the assigned flows and observed traffic flows. The traffic flow data was primarily derived from the Highways England traffic flow data system (TRADS).

2.4.6 The method to calculate the preloads for the forecast years used the NTM traffic forecast component of the Road Transport Forecasts 2011 (RTF11)[19]. The key input assumptions to RTF11 are the following:

- population and employment data – based on NTEM 5.4;
- GDP forecasts – 2011-2015 from OBR projections (Budget 2011), and post 2015 growth from OBR's July 2011 Fiscal Sustainability Report; and
- fuel prices – based on DECC's October 2011 fossil fuel price projections.

2.4.7 It is noted that the above assumptions are not consistent with those used for forecasting other modes; however, these are the latest DfT assumptions and so are the most appropriate source of data.

2.4.8 NTM forecasts traffic levels by region and road type using the DfT's Fitting On of Regional Growth and Elasticities (FORGE) mechanism. FORGE is not a traditional assignment model as it uses observed data on the level of traffic using each link of the road network from its 2003 base year and then applies elasticities derived from the demand model to forecast future levels of traffic.

2.4.9 The flows for the years required for the study (2010/11, 2026/27 and the cap year 2037/38) were derived from Road Transport Forecasts 2011[20], Table 4.3 which shows forecast traffic in calendar years 2010 and 2035. The growth implied by extrapolation of the average annual growth rates to 2037 is shown below in Table 2-19. The link preloads were uplifted using the following assumptions:

- As the projections from the National Transport Model have a broad order of magnitude they possess a significant range of uncertainty. As this uncertainty is likely to be greater for more disaggregate results, a single factor was calculated to be applied globally to all regions;
- The values calculated apply to England only; it is assumed that Wales and Scotland have the same growth factors;
- As the assignment matrices are car only, the only vehicle type to be included in the calculation of the growth factor is car; and
- As the nature of the network modelled is predominantly major roads, the

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4243/road-transport-forecasts-2011-results.pdf. Accessed 20 August 2015

[20] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4243/road-transport-forecasts-2011-results.pdf. Accessed 20 August 2015.

only road types to be considered in the calculation of the growth factors are Motorway, Trunk and Principal.

Table 2-19: Highway Forecasts by Vehicle Type and Road Type, England

Growth from 2010 to 2037	Motorway	Trunk	Principal	Other Roads	All Roads
Cars	47%	44%	38%	38%	41%
LGV	98%	98%	97%	98%	97%
HGV	49%	47%	44%	43%	47%
Bus & Coach	0%	-53%	-12%	-8%	-12%
Total	53%	50%	46%	46%	48%

Source: Extrapolation of NTF 2011 forecast to 2035

2.5 Air demand forecasts

2.5.1 The PLANET Framework Model (PFM v5.2) – Model Description report provides a detailed description of the DfT Aviation Model and its components. PFMv5.2 uses outputs from the most recently published DfT aviation forecasts[21], at the time of model development.

2.5.2 The 2037/38 air demand forecasts have been derived by using a linear interpolation method to calculate the level of air demand in 2037/38 based on the level of demand in 2026/27 and 2040/41. The resulting matrix growth used is shown Table 2-20.

Table 2-20: DfT Aviation Matrices – Growth in Domestic Air Passengers in PFMv5.2 (annual domestic trips)

	Growth in Domestic Air Passengers from 2010/11	
Journey Purpose	2026/27	2037/38
Business	30%	66%
Leisure	24%	67%
Total	27%	62%

Note: There is no Air Passenger Commuting Matrix in PFM

[21] UK Aviation Forecasts, DfT, January 2013, https://www.gov.uk/government/publications/uk-aviation-forecasts-2013 Accessed 20th August 2015.

3 Appraisal

3.1 Background

3.1.1 The appraisal of HS2 requires a range of assumptions to compare costs and benefits in accordance with WebTAG guidance. This section outlines the assumptions that have been adopted and their sources.

3.1.2 The economic appraisal uses outputs from the 'Do Minimum' with HS2 scenarios run in PLD and the regional PLANET models to produce an appraisal of the economic performance of Phase One and the full network over the construction period and 60 years of operation.

3.1.3 The section breaks the assumptions down into different elements used in the appraisal.

3.2 Price base

3.2.1 The costs and benefits presented in the appraisal of HS2 are based on 2011 prices using the HM Treasury GDP deflator as a measure of inflation. The definition of this deflator has been changed from being more consistent with an RPI metric to being more consistent with a CPI metric.

3.3 Appraisal period

3.3.1 In line with WebTAG guidance the appraisal period is based on 60 years of operation.

3.3.2 The key assumptions used in the modelling and appraisal by PFMv5.2 are:

- Phase One – Opening Year 2026;
- Phase 2A – Opening Year 2027;
- Full network – Opening Year 2033;
- First Forecast Modelled Year – 2026/27;
- Second Forecast Modelled Year – 2037/38.

3.4 Parameters

3.4.1 Within the PFMv5.2 appraisal process there are a series of weights that are applied to each element by purpose. These are shown in Table 3-1. The comparable weights used in the PFMv5.2 model are given in Chapter 8.

Table 3-1: Generalised cost element weights for rail – PFMv5.2

Rail Element	Business	Commute	Other
In Vehicle Time	1.0	1.0	1.0
Wait Time	1.0	2.5	2.5
Access/Egress Costs PLD	1.0	1.0	1.0
Access/Egress Costs regional PLANETs	1.0	2.0	2.0
Board Time Penalty (mins)	30.0	30.0	30.0

Values of time

3.4.2 The values of time in the appraisal are assumed to increase with income. The measure of income used is GDP per person (as recommended by TAG Unit A1.3[22]).

3.4.3 The appraisal is based on the same GDP and population sources that feed into the PFM demand (choice) model's forecasts as outlined in chapter 2.

3.4.4 The precise inputs to the appraisal are OBR's GDP growth forecasts published July 2014 and the ONS low migration population growth projection for the UK. GDP growth is measured in real terms using the GDP deflator which is based on CPI (see Table 3-2, WebTAG Databook, November 2014).

3.4.5 These inputs to the appraisal differ slightly from their use in the demand model which is based on mainland Great Britain transport networks that exclude Scottish islands and with income growth adjusted for inflation using the retail prices index.

Table 3-2: Growth in GDP used to derive values of time in the appraisal - PFMv5.2

Attribute	Growth from 2010	
	2026	2037
GDP, UK	43%	85%
Population, UK (low migration variant)	10%	14%
GDP per person, UK	30%	62%

3.4.6 The values of time used in PFMv5.2 are based on WebTAG guidance[23] and are given in Table 3-3.

[22] TAG unit A1.3 User and Provider Impact, November 2014

[23] WebTAG Databook, November 2014

Table 3-3: Values of time – PFMv5.2

Mode	Values of Time by Purpose (£/hr) PFMv5.2 (2010/11 prices)		
	Business	**Commute**	**Other**
Rail	£31.96 per hour	£6.81 per hour	£6.04 per hour
Car	£27.06 per hour (driver)* £20.52 per hour (passenger)*	£6.81 per hour	£6.04 per hour

*Per person value is calculated using car occupancy per vehicle kilometre travelled for the work journey purpose, all week average, 2010, from WebTAG Databook, November 2014, Table A1.3.3.

3.4.7 In line with guidance (WebTAG Databook, November 2014), the values of working and non-working time are assumed to increase with income with an elasticity of 1.0.

Annualisation factors

3.4.8 PFMv5.2 provides outputs for an average weekday. In order to undertake an appraisal of HS2, these weekday values are annualised to represent a calendar year. Table 3-4 shows the annualisation factors that have been derived for each mode and journey purpose for use in PLD.

3.4.9 The factors for rail and air are consistent with the method adopted to de-annualise weekday demands from annual matrices. In the case of highway there is no de-annualisation in the matrix development process and the factors have been sourced from an analysis of NTS.

Table 3-4: Annualisation factors – PFMv5.2 PLD

Purpose	Rail	Air	Highway
Business	256	313	275
Commuting	254	n/a	282
Other	416	313	361
Average	309	313	306

3.4.10 In addition there a set of factors used to annualise information from the regional PLANET models which are given in Table 3-5. The regional PLANET models represent the morning peak period and so higher annualisation factors are used.

Table 3-5: Regional PLANET annualisation factors – PFMv5.2

Purpose	7AM to 10 AM	10AM to 4PM	4PM to 7PM	7PM to 7AM	Total (incl. Weekend)
Business User	304	539	365	169	1,376
Commuting User	278	86	260	73	697
Leisure User	303	1,181	602	476	2,562
Business Crowding	253	0	304	0	557
Commuting Crowding	253	0	237	0	490
Leisure Crowding	253	0	503	0	756

Fares

3.4.11 In accordance with WebTAG, benefits and costs in the appraisal are presented in real terms using the GDP deflator. As such the definition of inflation used in the calculation of revenue (RPI) and the definition of inflation used in the rest of the appraisal (GDP deflator) are inconsistent.

3.4.12 In order to define fares growth on the basis of the GDP deflator, revenues are uplifted by the difference in the RPI and GDP deflator indices over time. The difference between these indices is around 0.9% per annum; in effect, this means real fares growth defined on the basis of RPI+1 per annum is equivalent to growth of the GDP deflator +1.9% per annum.

3.4.13 For the purpose of our modelling, all National Rail and London Underground fares are assumed to grow at a rate of RPI+1 per year between 2010 and the second modelled year except between 2014 and 2020, when RPI+0 applies. Within the appraisal there is no further real growth in fares for the remainder of the appraisal period beyond that point.

3.4.14 The regional uni-modal models do not contain a fares matrix, and revenue is therefore calculated on the basis of average fares per kilometre as shown in Table 3-6.

Table 3-6: Fares yield – PFMv5.2

Purpose	Fares £/passenger kilometre (2010 prices)		
	PLANET South	PLANET Midlands	PLANET North
Business	£0.138	£0.155	£0.148
Commuting	£0.129	£0.139	£0.157
Other	£0.125	£0.142	£0.138

Ramp-up effects

3.4.15 In order to reflect the demand and revenue assumptions in the early years of the HS2 scheme, a series of ramp up assumptions for demand benefits are applied within the appraisal as shown by Table 3-7.

Table 3-7: Assumptions related to ramp-up effects, PFMv5.2

Year After Opening	Year Phase One	Year Full Network	**Growth adjustment applied to Demand and Benefits**
0	2026	2033	-20%
1	2027	2034	-10%
2	2028	2035	-5%
3 and beyond	2029	2036	0%

Discount rates

3.4.16 In line with TAG Unit A1.1 and WebTAG Databook, November 2014[24] a series of discount rates are applied from 2011. The annual discount rates assumed are:

- until 2045: annual discount rate = 3.5%;
- between 2045 and 2089: annual discount rate = 3.0%; and
- beyond 2090: annual discount rate = 2.5%.

Highway factors used in the appraisal

3.4.17 Vehicle operating costs are derived using the approach outlined in TAG Unit A1.3[25]. Fuel consumption is estimated using the function:

$$L = a / v + b + c * v + d * v^2$$

where: L= fuel consumption, expressed in litres per kilometre;

v = average speed in kilometres per hour; and

a, b, c, d are parameters defined for each vehicle category.

3.4.18 The input for speed of highway traffic, v, is taken from PLD's highway model, which estimates average traffic speed using DfT link type specific volume delay functions and traffic estimates. The vehicle operating cost parameters adopted within the HS2 appraisal are based on the parameters used by TAG Unit A1.3[26].

3.4.19 The impacts of road decongestion are assessed in line with TAG A5.4, January 2014[27]. In the absence of more specific evidence TAG suggests the use of a diversion factor based on results from the DfT's National Transport Model which suggest 26% of a change in rail passenger kilometres would be diverted from car kilometres.

[24] WebTAG Databook, November 2014
[25] TAG unit A1.3 User and Provider Impacts, November 2014
[26] TAG unit A1.3 User and Provider Impacts, November 2014
[27] TAG unit A5.4 Marginal External Costs, January 2014

3.4.20 The TAG Unit A5.4 values used to derive Highway External Costs for 2026 and 2037 are presented in Table 3-8. These have been derived by interpolation and extrapolation of the values quoted in WebTAG Databook, November 2014.

Table 3-8: Highway external costs (pence / car km)

Element	Pence/ car km (2010)			Pence/ car km (2026)			Pence/ car km (2037)		
	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads
Congestion (London)	0.1	67.1	46.4	1.2	146.9	78.9	3.2	226.7	111.3
Congestion (Conurbations)	2.8	34.2	23.8	5.9	59.1	44.4	11.8	90.3	66.1
Congestion (Other Urban)	n/a	13.2	10.8	n/a	24.0	16.5	n/a	35.8	22.1
Congestion (Rural)	1.1	2.2	2.7	4.1	4.2	6.0	10.8	6.6	8.8
Infrastructure (London)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Infrastructure (Conurbation)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Infrastructure (Other Urban)	n/a	0.1	0.1	n/a	0.1	0.1	n/a	0.2	0.2
Infrastructure (Rural)	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.2	0.2
Accident (London)	0.0	3.0	3.0	0.0	3.9	3.9	0.0	4.8	4.8
Accident (Conurbations)	0.0	3.0	3.0	0.0	3.9	3.9	0.0	4.8	4.8
Accident (Other Urban)	n/a	3.0	3.0	n/a	3.9	3.9	n/a	4.8	4.8
Accident (Rural)	0.0	0.7	0.7	0.0	0.9	0.9	0.0	1.1	1.1
Local Air Quality (London)	0.3	0.3	0.3	0.0	0.0	0.0	0.1	0.0	0.0
Local Air Quality (Conurbations)	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Local Air Quality (Other Urban)	n/a	0.1	0.1	n/a	0.0	0.0	n/a	0.0	0.0
Local Air Quality (Rural)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Noise (London)	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Noise (Conurbations)	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Noise (Other Urban)	n/a	0.2	0.2	n/a	0.3	0.3	n/a	0.3	0.3
Noise (Rural)	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.2
Greenhouse Gases (London)	0.9	1.0	1.2	0.7	0.8	1.0	1.1	1.4	1.6
Greenhouse Gases (Conurbations)	0.9	0.9	1.0	0.7	0.7	0.8	1.1	1.1	1.2
Greenhouse Gases (Other Urban)	n/a	0.8	0.9	n/a	0.7	0.8	n/a	1.0	1.2
Greenhouse Gases (Rural)	0.9	1.0	1.2	0.7	0.7	0.7	1.1	1.0	1.0
Indirect Taxation (London)	-5.3	-5.6	-7.1	-3.9	-4.4	-5.4	-3.6	-4.2	-5.1
Indirect Taxation (Conurbations)	-5.2	-5.2	-5.7	-3.7	-3.9	-4.3	-3.5	-3.7	-4.0

Element	Pence/ car km (2010)			Pence/ car km (2026)			Pence/ car km (2037)		
	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads
Indirect Taxation (Other Urban)	n/a	-4.8	-5.4	n/a	-3.6	-4.0	n/a	-3.4	-3.8
Indirect Taxation (Rural)	-5.3	-4.8	-4.7	-3.8	-3.5	-3.5	-3.5	-3.3	-3.3

Wider impacts

3.4.21 The wider impacts of HS2 that are additional to transport user benefits have been estimated in line with TAG Unit A2.1, January 2014. The impacts are estimated by using DfT's wider impacts in transport appraisal software. In the case of the output change in imperfectly competitive markets WebTAG recommends these are estimated as being equivalent in value to 10% of the business user transport benefits.

Carbon impacts

3.4.22 The impacts of HS2 on emissions of carbon from highway and diesel train use have been appraised using a bespoke model. It uses PFMv5.2 assumptions. These are:

- Assumptions for car fuel consumption, car emissions and the value of a non-traded tonne of carbon from WebTAG;
- Train kms and highway kms from PFM;
- Car speeds for long distance and local from the DfT's National Transport Model; and
- Diesel train energy consumption is sourced from DfT's Rail Emissions Model.

4 Highway and air networks

4.1 Background

4.1.1 Within PLD and the regional PLANET models are a series of networks for the 'Do Minimum' and 'Do Something' scenarios. Chapter 4 outlines the assumptions made for the air and highway networks. Chapters 5 and 6 outline the assumptions related to the rail networks.

4.2 Do Minimum and Do Something highway networks

4.2.1 For PFMv5.2 no additional highway schemes were added between 2026/27 and 2040/41, hence the 2026/27 and 2037/38 (cap year) networks are identical. In addition, they are also identical in the 'Do Minimum' and 'Do Something' scenarios.

4.2.2 The schemes that were included in the PFMv5.2 model are listed in Table 4-1. Note the same network was used in PFMv4.3.

Table 4-1: Highway Schemes in PFMv5.2- 2026/27 and 2037/38

Scheme Assumed	
A1 Bramham – Wetherby	A11 Fiveways to Thetford Improvement
A3 Hindhead Improvement	A160 / A180 Improvements, Immingham
A421 Bedford to M1 Junction 13	A465 Dualling Scheme between Abergavenny and Hirwaun
M1 Junctions 25-28 Widening Scheme	A556 Knutsford to Bowdon Environmental Improvement
M25 Junctions 16-23 Widening	M1 Junctions 28-31 Managed Motorways
M25 Junctions 27-30 Widening	M1 Junctions 32-35a Managed Motorway
M27 J3-4 Widening	M1 Junctions 39-42 Managed Motorway
M42 J7-9 Hard Shoulder Running	M25 Junctions 23-27 Managed Motorways
M6 J4-5 Hard Shoulder Running	M25 Junctions 5-7 Managed Motorways
M6 Junctions 8-10A Managed Motorways (Birmingham Box Phase 2)	M60 Junctions 15-12 Lane Gain
M74 Completion	M60 Junctions 8-12 Managed Motorways
M80 Stepps to Haggs	M62 Junctions 18-20 Managed Motorway
A1 Dishforth to Leeming Improvement Scheme (A1 Dishforth to Barton)	M8 M73 M74 Motorway Improvements
A23 Handcross to Warninglid	A453 Widening (M1 Junction 24 to A52 Nottingham)
A46 Newark to Widmerpool Improvement	A494 Drome Ewloe Improvement
M1 Junction 10-13 Improvements	A5-M1 Link (A505 Dunstable Northern Bypass)
M4 Junction 19-20 and M5 Junction 15-17 Managed Motorways	A9 Dualling

Scheme Assumed	
M4 Junction 3-2 Bus Lane Suspension Scheme	M3 Junctions 2-4a Managed Motorway
M6 Junctions 5-8 Managed Motorways (Birmingham Box Phase 3)	M4 Junctions 3-12 Managed Motorway
M62 Junctions 25 to 30 Managed Motorway	M54 to M6 / M6 (Toll) Link Road
M6 Junction 10A - 13 Managed Motorway	

4.3 Do Minimum and Do Something air networks

4.3.1 The air passenger supply in PFM represents domestic air services wholly within mainland of Great Britain, thus excludes services to Northern Ireland, the Channel Islands, Isle of Man and Scottish islands. Within PFMv5.2 the networks were taken directly from the DfT Aviation Model[28].

4.3.2 Table 4-2 shows the changes in routes between the various forecast years used in PFMv5.1.

Table 4-2: Air Network Changes in PFMv5.1

2026/27 Routes added relative to 2010/11	2026/27 Routes removed relative to 2010/11
Exeter – Stansted	Aberdeen – Luton
Inverness – Bristol	Aberdeen – Durham
Inverness – Edinburgh	Edinburgh – Gatwick
Inverness - London City	Edinburgh – Manchester
London City – Inverness	Edinburgh – Stansted
Newquay - Leeds Bradford	Exeter – Edinburgh
Stansted – Exeter	Glasgow – Luton
	Glasgow – Southampton
	Gatwick – Edinburgh
	Luton – Aberdeen
	Luton – Glasgow
	Luton – Inverness
	Manchester – Bristol
	Manchester – Edinburgh
	Manchester – Norwich
	Durham – Aberdeen
	Prestwick - Stansted

[2828] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013

	Stansted – Edinburgh
	Stansted - Prestwick
2037/38[29] Routes added relative to 2026/27	**2037/38 Routes removed relative to 2026/27**
Aberdeen – Exeter	Glasgow – Gatwick
Edinburgh – Gatwick	Inverness – Bristol
Edinburgh – Inverness	Inverness – Luton
Exeter – Aberdeen	Gatwick – Glasgow
Gatwick – Edinburgh	Gatwick – Manchester
Inverness – Stansted	Manchester – Gatwick
Manchester – Bristol	Stansted – Glasgow
Manchester – Norwich	
Newquay – Manchester	
Norwich – Exeter	
Stansted – Inverness	

Air fares

4.3.3 The networks in PFMv5.2 take the base year domestic air fare matrix unadjusted from the DfT Aviation Model which provides air fares between all modelled airports in constant 2008 prices and values. These are adjusted to the 2010/11 base year and the forecast years using the index of changes in real domestic business and leisure fares supplied by the DfT.

4.3.4 The index of changes in real air fares is shown in Table 4-3.

Table 4-3: Real Fare Index Factors – Air Fares, PFMv5.2

Purpose	Growth in air fares from 2008		
	2010/11	2026/27	2037/38
Business	-3.8%	-1.1%	0.7%
Leisure	-2.5%	16.0%	22.9%

[29] 2040/41 air networks have been adopted for 2037/38 in PFMv5.2

5 Rail network: Do Minimum

5.1 Background

5.1.1 The rail networks within PFMv5.2 include a representation of a timetable and its associated capacity. The 'Do Minimum' provides a reference against which the 'Do Something' HS2 option is compared.

5.1.2 With a few exceptions, the 'Do Minimum' timetable assumptions are based on future committed schemes only. The 'Do Minimum' makes use of information provided by the DfT for Network Rail services (September 2015 timetable) and Transport for London (TfL) for London Underground Limited (LUL) services. The rail and LUL 'Do Minimum' networks are assumed to be identical in the 2026/27 (first forecast year model) and 2037/38 (cap year model).

5.1.3 **These assumptions are designed only for the purpose of providing an indicative reference case for the appraisal of HS2. No decisions have yet been taken about train service requirements – or which stock will operate them – in any of the relevant franchises, and therefore these service patterns should be considered to be indicative.**

5.1.4 In the PLD model these assumptions relate to the average service pattern on weekdays. Information used within the regional PLANET models relates to services during the morning peak period. Within these assumptions, no work has been undertaken to review the local commuter services.

5.1.5 A summary of the key assumptions used within the PLD sub-model of PFMv5.2 for the Train Operating Companies affected by HS2 are given in this chapter.

5.2 Chiltern Railways

5.2.1 The 'Do Minimum' service and rolling stock assumptions for Chiltern Railways in PFMv5.2 have been fully updated compared to PFMv4.3.

5.2.2 The assumed future year 'Do Minimum' timetable includes Evergreen 3, which allows for new London Marylebone - Oxford services via Bicester Town to be introduced, as well as a small amount of train lengthening on some peak services between Aylesbury and High Wycombe.

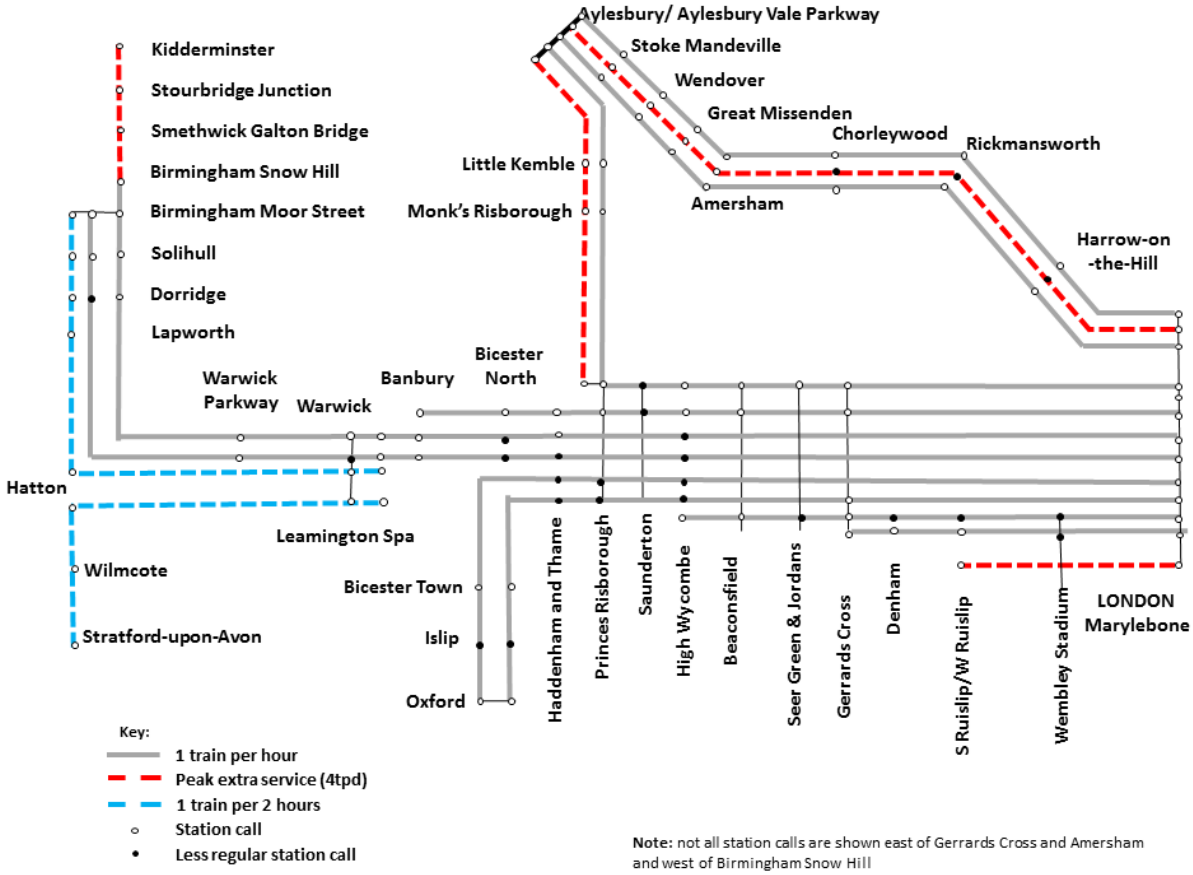
5.2.3 The main characteristics of the service specification are:

- 2 trains per hour (tph) + peak extras between London Marylebone and Aylesbury Vale Parkway/Aylesbury via Amersham
- 2tph London Marylebone – Birmingham Snow Hill/Birmingham Moor Street
- 2tph London Marylebone – Oxford
- 1tph London Marylebone – Gerrards Cross
- 1tph London Marylebone – Banbury

- 1tph London Marylebone – High Wycombe
- 1tph London Marylebone - Aylesbury Vale Parkway/Aylesbury via Princes Risborough
- 0.5tph Leamington Spa – Birmingham Moor Street
- 0.5tph Stratford-Upon-Avon – Leamington Spa
- 5 trains per day (tpd) Princes Risborough – Aylesbury
- 4tpd peak only London Marylebone – West Ruislip

5.2.4 Figure 5-1 shows a summary of the service and service pattern assumed in the 'Do Minimum'.

Figure 5-1: Chiltern - Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.3 Cross Country

5.3.1 The 'Do Minimum' assumptions for Cross Country PFMv5.2 are the same as used in PFMv4.3 except some errors (listed at paragraph 5.3.4) were found in the implementation of this specification.

5.3.2 The future year 'Do Minimum' timetable includes electrification, with an all-electric fleet, but with locomotive hauled service on non-electrified routes or sections of routes. The timetable assumes no significant changes in journey times except where services are diverted via East-West Rail (e.g. Bournemouth to Manchester Piccadilly).

5.3.3 There are small changes in the future year 'Do Minimum' timetable from the modelled base year, with the exception of the addition of an hourly service between Manchester and Birmingham International. This was added due to extra train paths becoming available as a result of some Cross Country services being re-routed via East-West Rail and to maintain Stockport/Macclesfield/Stoke-on-Trent frequencies to Birmingham New Street and Birmingham International.

5.3.4 PFMv5.2 contains the following corrections to the PFMv4.3 assumptions:

- Capacities on a number of routes were amended as they were incorrectly coded as 4 car Class 380 trains and they should have been 5-car intercity express programme (IEP) rolling stock (Seats: 328, Capacity: 763). These routes are:

  a) Manchester Piccadilly to Birmingham New Street;

  b) Birmingham New Street to Newcastle

  c) Derby to Newcastle;

  d) Sheffield to Reading; and

  e) Manchester Piccadilly to Bournemouth.

- Southampton to Manchester Piccadilly service frequency was incorrectly coded with headway of 480 minutes whereas it should have been 320 minutes.

- Birmingham New Street to Bournemouth service (1 train per day) had been omitted from PLD this was re-added in with a travel time of 3hr 11mins. This is assumed to be an IEP.

- York to Plymouth service (1 train per day) had been omitted from PLD this was re-added in with a travel time of 6hr 7mins. This is assumed to be an IEP.

- Birmingham New Street to Glasgow (1 train per day) had been omitted from PLD this was re-added in with a travel time of 6hrs 14mins. This is assumed to be an IEP.

5.3.5 Figure 5-2 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for Cross Country services.

Figure 5-2: Cross Country- Average Service Pattern used in PFMv5.2 – 'Do Minimum'

5.4 East Coast Main Line

5.4.1 The 'Do Minimum' assumptions for East Coast in PFMv5.2 are fully updated compared to those used in PFMv4.3.

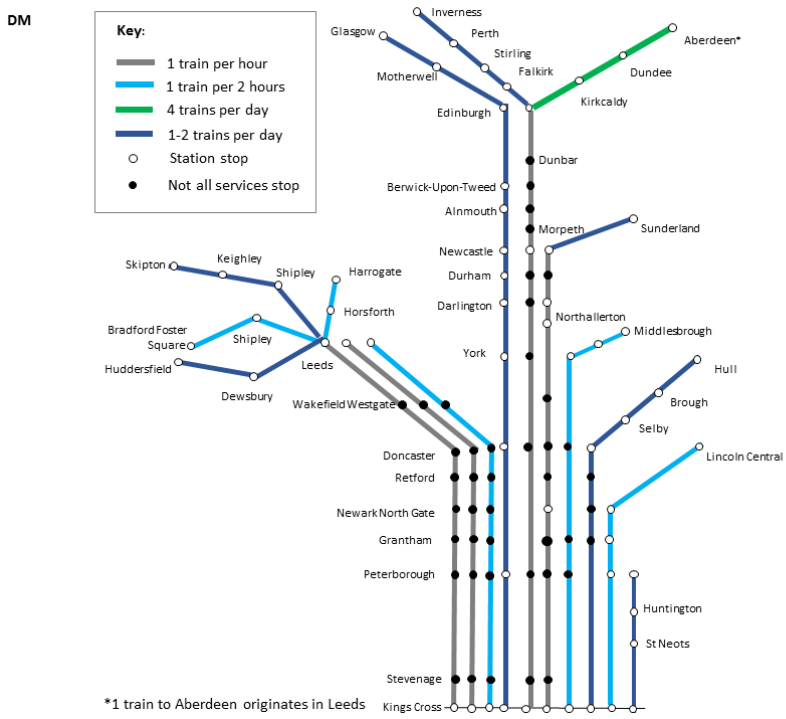
5.4.2 The future year 'Do Minimum' timetable uses the Intercity East Coast (ICEC) May 2020 weekday timetable developed by the new Virgin Trains East Coast franchisee. This timetable incorporates 5 and 9 car electric and bi-mode trains IEPs and reduced formation class 91/Mk IV (2+7), replacing class 91/Mk IV (2+9) and high speed train formations. The key features of this timetable are:

- 26tpd between Edinburgh and London King's Cross with the fastest journey time of four hours; three trains extend to Aberdeen, and one each to Glasgow, Stirling and Inverness;
- 1tph between Newcastle and London King's Cross, with two services extending to Sunderland;
- an additional train every two-hours between Middlesbrough and London King's Cross (six down and seven up);
- 35tpd serving Leeds, averaging 2tph with a journey time of two hours. Of these trains, 6tpd travel onwards to each of Harrogate and Bradford, and 1tpd travels onwards to each of Huddersfield and Skipton;
- 3tpd from London King's Cross to Doncaster, 1tpd from Doncaster to London King's Cross, along with 1tpd from each of Newark and Peterborough to London King's Cross; and
- One train every two hours between Lincoln and London King's Cross.

5.4.3 There are small reductions in journey times for key East Coast Mainline (ECML) destinations – due to introduction of the IEP fleet – such as Edinburgh (3%), Newcastle (2%), Skipton (5%), Harrogate (3%) and Bradford (5%).

5.4.4 Figure 5-3 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for East Coast Main Line services.

Figure 5-3: East Coast Main Line – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.5 Great Western

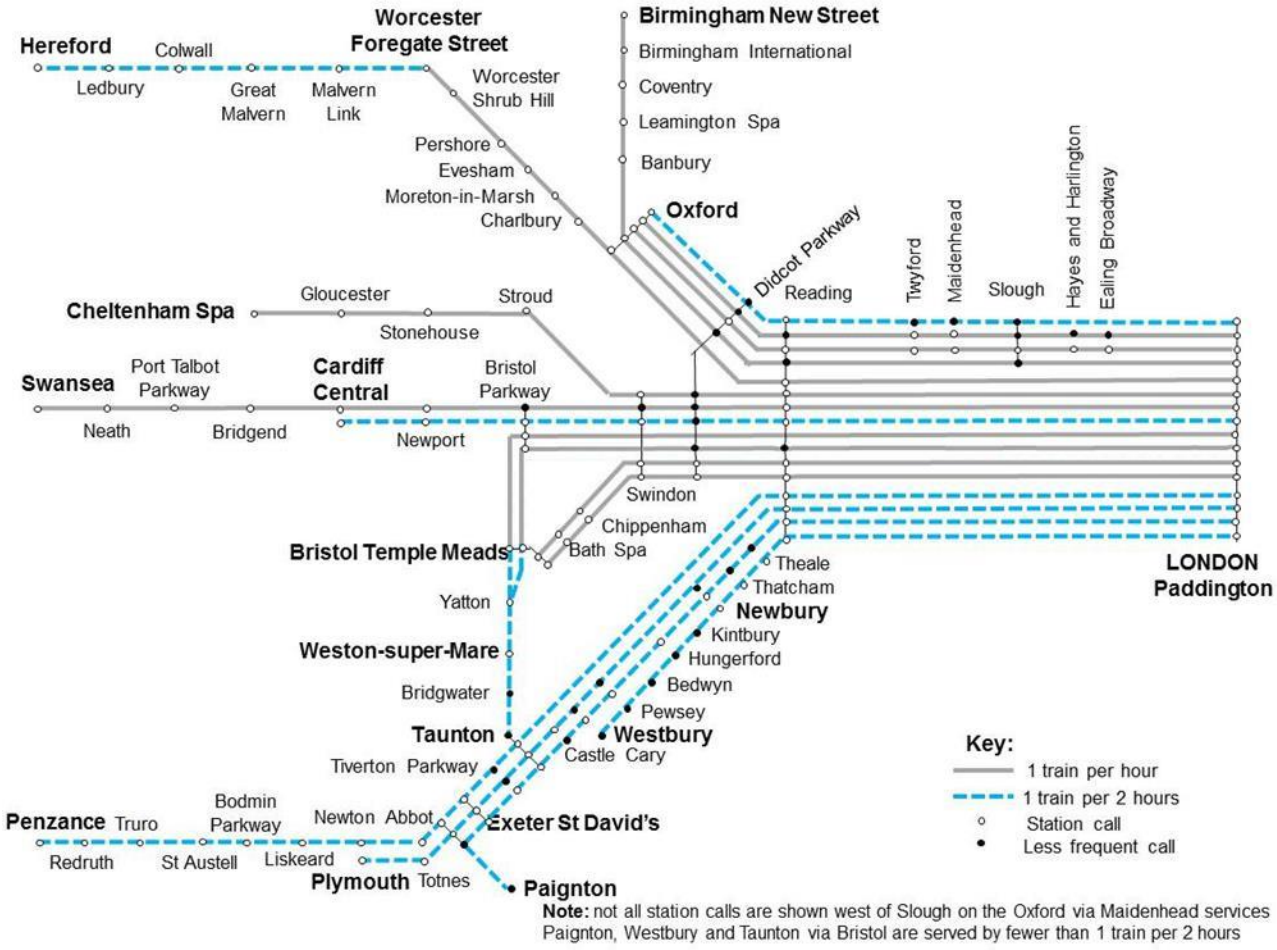
5.5.1 The 'Do Minimum' assumptions for Great Western in PFMv5.2 are the same as used in PFMv4.3.

5.5.2 The key points of the specification assumed are:

- The introduction of an hourly service operating between Birmingham New Street and London Paddington to back fill for the diversion of Cross Country services via East West rail;
- Doubling the service frequency between Bristol Temple Meads and London Paddington;
- Increased service frequency operating between Cheltenham and London Paddington;
- Increased service frequency operating between Hereford and London Paddington;
- Removal of services to/from London Paddington starting/finishing at Didcot Parkway;
- A reduction in services operating between Oxford and London Paddington with new services introduced between Oxford and London Marylebone as part of Chiltern Line service pattern; and
- Replacement of local services operated by Great Western between Reading and London Paddington by service operated by extending Heathrow Express services to Reading.

5.5.3 Figure 5-4 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for Great Western services.

Figure 5-4: Great Western – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.6 London Midland

5.6.1 The 'Do Minimum' assumptions for London Midland have been fully updated compared to PFMv4.3.

5.6.2 The London Midland future year 'Do Minimum' timetable allows for 110mph running on the fast lines and some train lengthening. Three trains per hour are scheduled to run at 110mph between London Euston and Ledburn Junction (south of Leighton Buzzard) which means that all Crewe services, most Northampton services, and some of the through Birmingham services benefit from accelerated journey times.

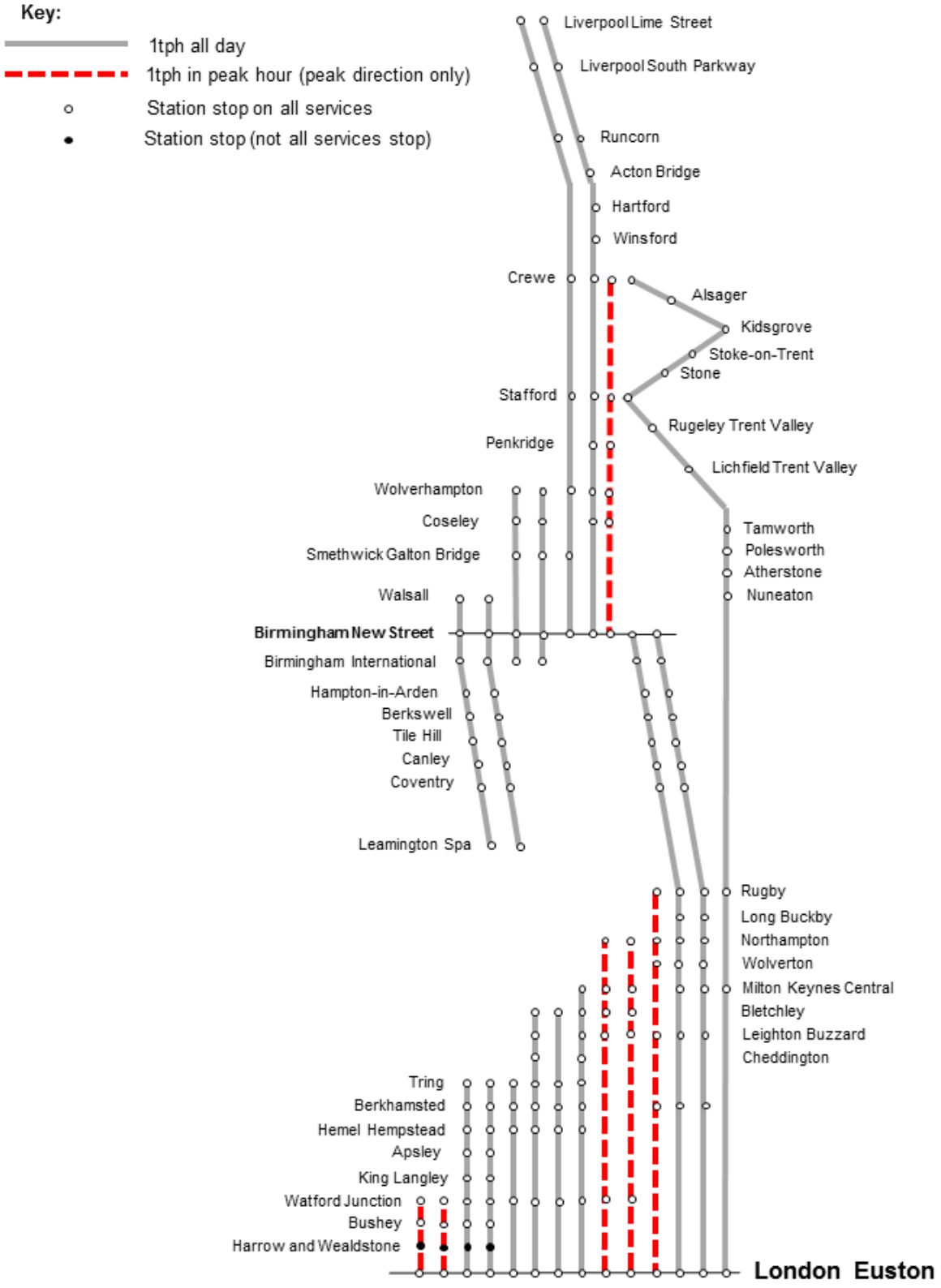
5.6.3 Key points of the LM specification are:

- 2tph between Birmingham New Street and London Euston;
- 1tph (peak period service only) between Coventry and Birmingham New Street;
- 1tph between London Euston and Crewe (via Trent Valley)
- 1tph between Birmingham International and Birmingham New Street;
- 1tph peak services between London Euston and Northampton;

- 2tph between Birmingham New Street and Liverpool Lime Street; and
- Services starting at Northampton, Milton Keynes Central and Tring to London Euston

5.6.4 Figure 5-5 shows a summary of the service and stopping pattern assumed in the PFMv5.2 'Do Minimum' for London Midland services.

Figure 5-5: London Midland – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.7 East Midland

5.7.1 The 'Do Minimum' assumptions for East Midland PFMv5.2 are fully updated compared to those used in PFMv4.3

5.7.2 The future year 'Do Minimum' PFMv5.2 timetable is based on the latest East Midlands (EM) Trains timetable which assumes electrification of the midland main line and some line speed improvements. It includes the following:

- 1tph between Corby and London St Pancras (where the service is coded between Kettering and London St Pancras, as Corby is not included in PFM);
- 1tph between Leicester and London St Pancras;
- 2tph between Nottingham and London St Pancras; and
- 2tph between Sheffield and London St Pancras.

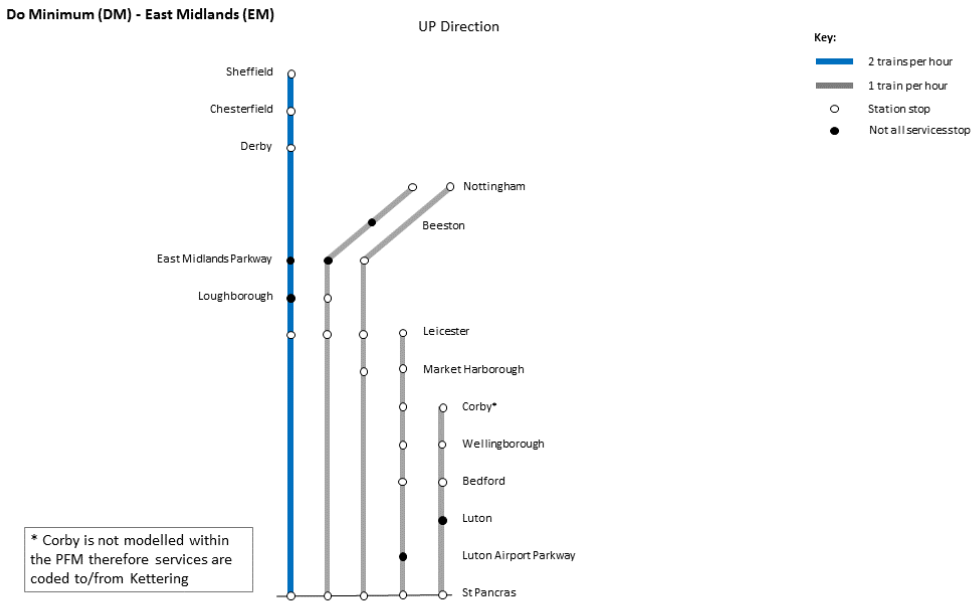
5.7.3 The timetable assumes all services into London St Pancras operate using electric 5-car IEPs, which results in changes in capacity.

5.7.4 Elsewhere on the network the major timetable changes are summarised as follows:

- The EM service between Leicester and Liverpool has been truncated at Manchester, and re-routed to serve Derby rather than Nottingham;
- The Nottingham to Worksop service has a reduced headway of 16 trains per day from 24; and
- Numerous small fluctuations in headway and journey time.

5.7.5 Figure 5-6 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for East Midland services.

Figure 5-6: East Midland – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.8 West Coast Main Line

5.8.1 The 'Do Minimum' service and rolling stock assumptions for West Coast in PFMv5.2 have been fully updated compared to PFMv4.3.

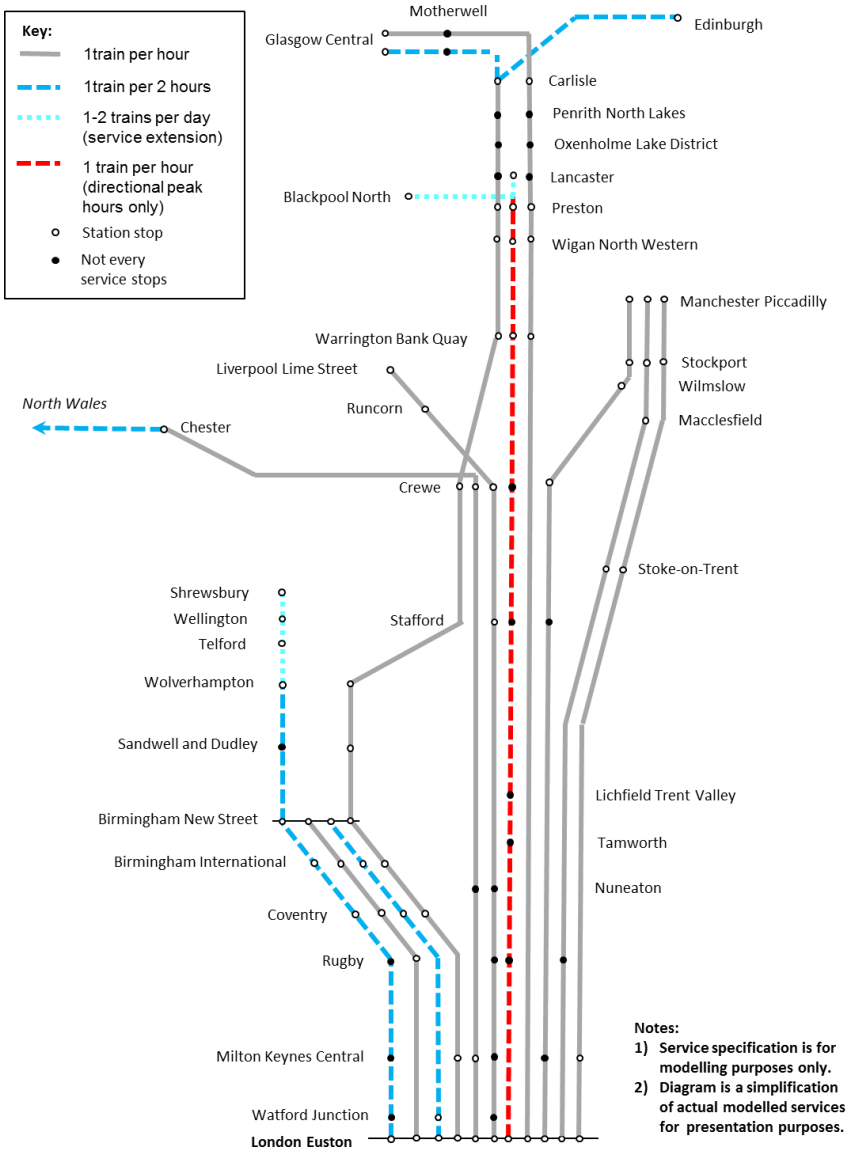
5.8.2 The DM network includes:

- 10-12 extra London – Scotland through services, routed via the West Midlands to either Edinburgh or Glasgow Central at alternating hours of the day in each direction per day as a result of the joining together of the hourly Scotland-Birmingham services to Wolverhampton/Birmingham to London Euston services
- A daily service between Blackpool North and Euston and vice versa
- 2tpd between Shrewsbury and Euston (extended from Wolverhampton)
- Preston to Euston is now modelled as a peak hourly service pattern dependant on direction, with additional single peak services to both Blackpool North and Lancaster.
- The increase in seating capacity of the Class 390 9-car Pendolino
- The increase in total capacity of the Class 390 11-car Pendolino,
- The introduction of a 2 x 5-car Class 222 Super Voyager to model doubled up 5-car 'Super Voyager' trains[30]

[30] The operating cost model treats 10-car Super Voyager units as vehicle type 222 to avoid spurious results.

5.8.3 Figure 5-7 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for West Coast Main Line services.

Figure 5-7: West Coast Main Line – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.9 TransPennine

5.9.1 The 'Do Minimum' assumptions for TransPennine in PFMv5.2 are the same as used in PFMv4.3 with some modifications.

5.9.2 On the North TransPennine route the PFMv5.2 future year timetable assumes the following services through the Manchester – Leeds core:

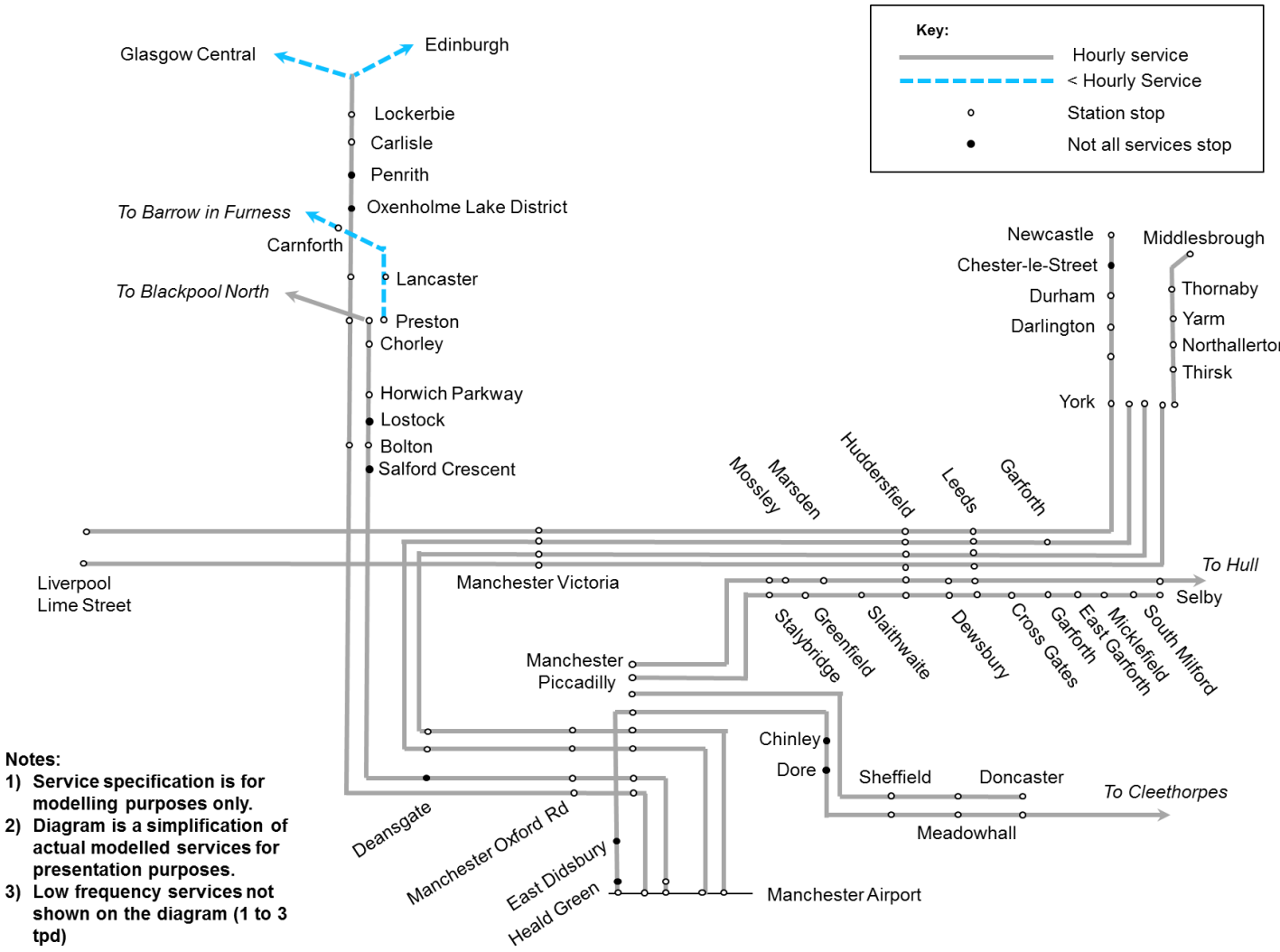
- 1tph between Manchester and Selby via Leeds;
- 1tph between Manchester and Hull via Leeds;
- 1tph between Manchester and Doncaster via Sheffield.
- 1tpd from Preston to Barrow-in-Furness.
- 1tph from York to Middlesbrough.
- 1tph between Liverpool and Newcastle via Manchester and Leeds; and
- 1tph between Liverpool and York via Manchester and Leeds.
- To / from Manchester Airport:
  - 2tph to York;
  - 1tph to Scotland alternating between Edinburgh and Glasgow;
  - 1tph to Blackpool; and
  - 1tph to Cleethorpes via Sheffield.

5.9.3 The TransPennine services pattern in PFMv4.3 has the following modifications in PFMv5.2 :

- services using the West Coast Mainline corridor between Manchester Airport and Scotland have been updated to reflect the National Rail Timetable 2014, with 2tpd extra towards Manchester Airport (one from Edinburgh and one from Glasgow) routed via Bolton. The service remains at generally an hourly frequency;
- correction of minor discrepancies in stopping patterns to better reflect the overall service allocation; and
- the addition of an hourly service between Middlesbrough and York, previously missing from the diagrams. Such a shuttle service is required due to route electrification.

5.9.4 Figure 5-8 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for TransPennine services.

Figure 5-8: TransPennine – Average Service Pattern used in PFMv5.2 – 'Do Minimum'

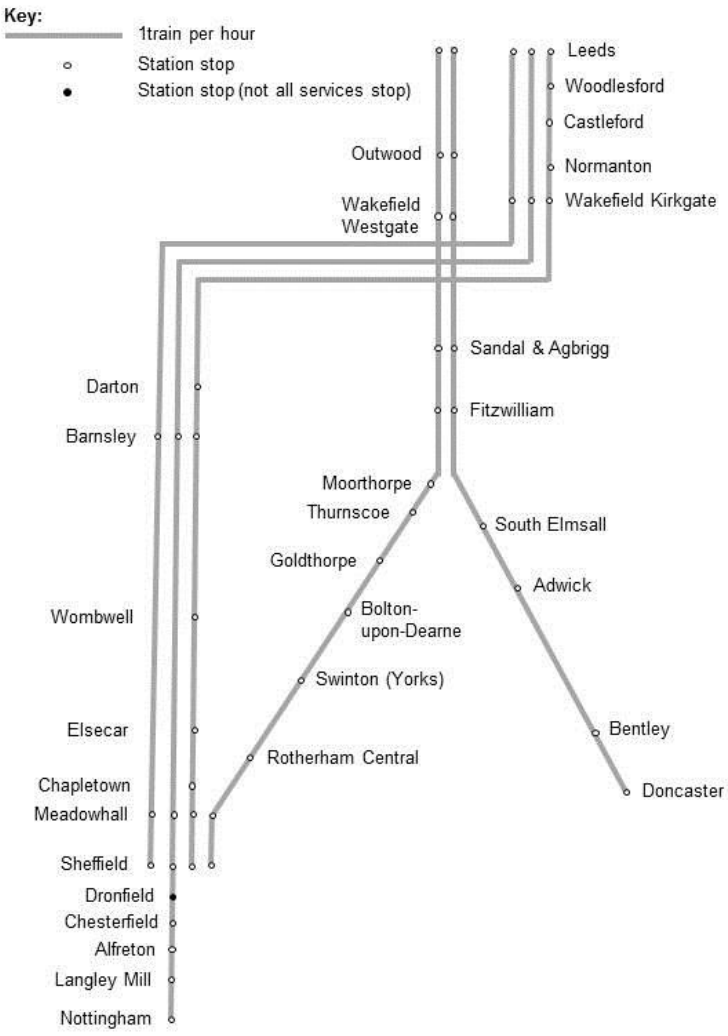


5.10 Northern Trains

5.10.1 The 'Do Minimum' assumptions for Northern Trains in PFMv5.2 are the same as used in PFMv4.3.

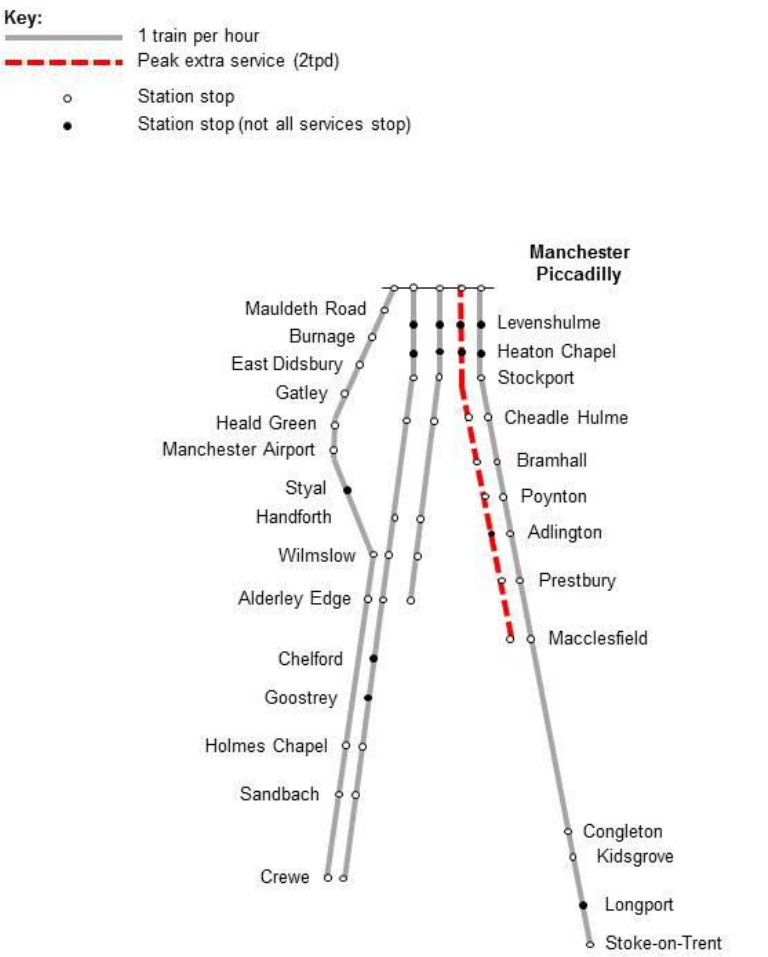
5.10.2 The indicative Northern Trains timetable was prepared by DfT for PFMv4.3 modelling purposes only and is based on using the capacity provided by the Northern Hub. Figure 5-9 shows a summary of the service and stopping pattern assumed in the 'Do Minimum' for Northern Trains services on the South Manchester and Leeds to Doncaster corridors.

Figure 5-9: Northern Trains – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

Figure 5-9 (continuation from previous page)



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

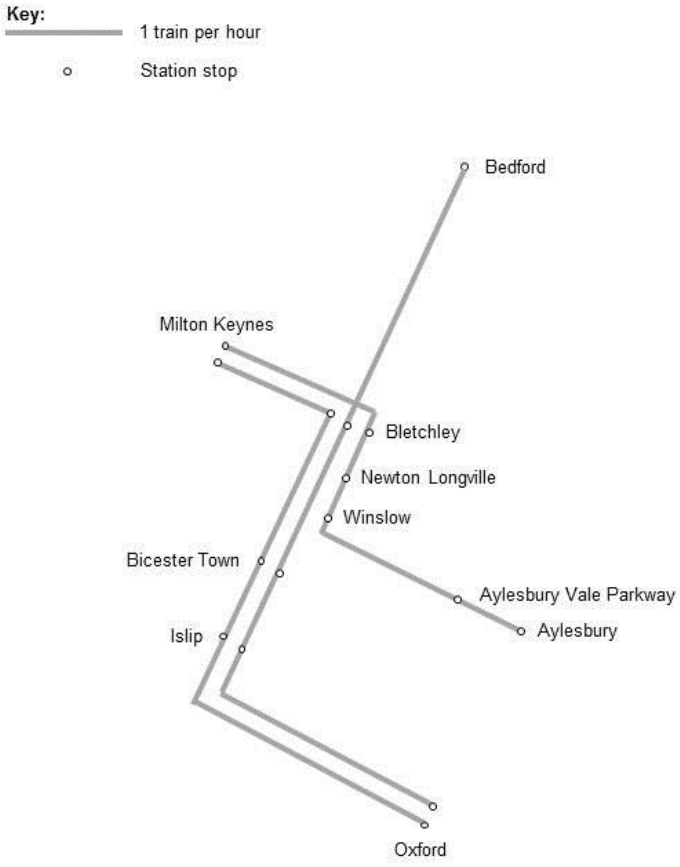
5.11 East-West Rail

5.11.1 The 'Do Minimum' assumptions for the East West Rail Link in PFMv5.2 are the same as used in PFMv4.3 and are assessed to remain valid.

5.11.2 The East-West Rail western section (between Oxford and Bletchley) is assumed within PFMv4.3 based on the DfT view of the likely service patterns as late 2012. Figure 5.10 shows a summary of the service pattern assumed in the 'Do Minimum' for East-West Rail services. This assumes hourly services as follows:

- Oxford and Bedford;
- Oxford and Milton Keynes; and
- Aylesbury and Milton Keynes.

Figure 5-10: East- West Rail – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



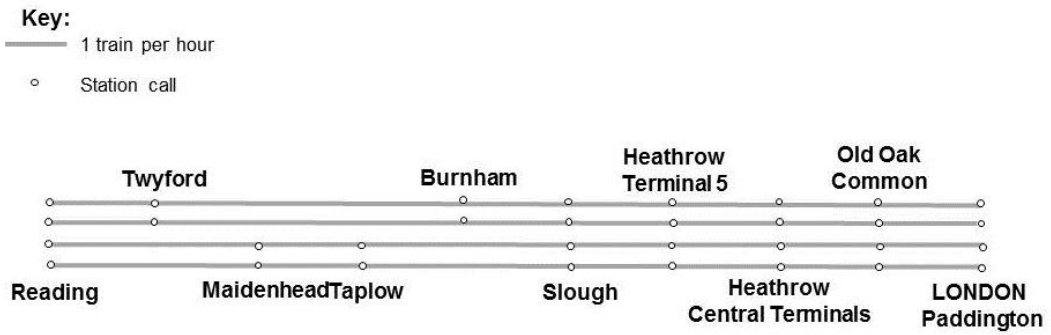
Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

5.12 Other services

5.12.1 The 'Do Minimum' assumptions for Crossrail in PFMv5.2 include the extension to Reading of services between Abbey Wood and Maidenhead via Twyford. A frequency of two services per hour has been publicised for this service, however, it was not possible to code this in PLD without a full update to the Crossrail coding. Therefore a frequency of six trains per day is retained on these services, which offers a representation of the route.

5.12.2 A western access to London Heathrow has been included within PFM v5.2. Heathrow Express is assumed to utilise this link. Figure 5-11 shows a summary of the service pattern assumed in the 'Do Minimum' for Heathrow Express services.

Figure 5-11: Heathrow Express – Average Service Pattern used in PFMv5.2 – 'Do Minimum'



5.13 London Underground

5.13.1 The 'Do Minimum' assumptions for London Underground in PFMv5.2 are the same as used in PFMv4.3 and are assessed to remain valid.

5.13.2 TfL supplied London Underground network and vehicle type data extracted from TfL's Railplan model.

5.14 National Rail – rolling stock

5.14.1 PFM holds a selection of rolling stock types as defined vehicles within the model. The assumptions used or combinations thereof, for example Class 165 and Class 172 on Chiltern, are shown in Table 5-1 and have been sourced from DfT.

Table 5-1: Rolling Stock Capacity Assumed in PFMv5.2

Rolling stock type	Seated capacity	Total capacity
Class 67 with 5 Mk iii coaches incl. first class	360	435
Class 67 with 6 Mk iii coaches	432	488
Class 67 with 6 Mk iii coaches incl. first class	390	480
Class 91 9-car	477	747
Class 156 2-car	152	239
Class 158 2-car	138	217
Class 158 4-car	276	433
Class 165 2-car	184	244
Class 165 3-car	276	366
Class 165 2 x 2car	368	488
Class 165 2car & Class 165 3car	460	610
Class 165 2car & Class 172 2car	328	462
Class 165 2 x 2car & Class 165 3car	644	854
Class 165 3 x 2car	552	732
Class 168 3-car	204	348
Class 168 3car & Class 168 4car	476	812
Class 168 2 x 3car & Class 172 2car	552	914
Class 168 3car & Class 172 2car	348	566
Class 168 4-car	272	464
Class 168 4car & Class 165 2car	456	708
Class 170 2-car	117	205
Class 170 3-car	191	326
Class 170 4-car	234	409
Class 170 5-car	308	531
Class 172 2-car	144	218
Class 172 2car & Class 165 3car	420	584
Class 180 5-car	284	434

Class 185 3-car	169	301
Class 185 6-car	338	602
Class 220 4-car	190	310
Class 221 5-car	252	410
Class 221 2 x 5-car	504	820
Class 222 4-car	190	310
Class 222 5-car	242	386
Class 222 7-car	343	520
Class 222 10-car	484	772
Class 225 7-car	409	644
Class 319 3-car	217	294
Class 319 4-car	289	392
Class 323 3-car	284	498
Class 350 4-car	226	396
Class 350/1 4-car	224	392
Class 350/1 8-car	448	785
Class 350/1 12-car	672	1177
Class 350/2 4-car	267	468
Class 350/2 8-car	534	936
Class 350/2 12-car	801	1404
Class 365 4-car	269	391
Class 365 8-car	538	782
Class 365 12-car	807	1173
Class 377 3-car	185	294
Class 377 4-car	247	392
Class 377 5-car	309	490
Class 377 8-car	494	784
Class 377 12-car	741	1176
Class 380 4-car	275	399
Class 380 8-car	550	798
Class 390 9-car	468	798
Class 390 11-car	597	982
HST 5-car	271	436

HST 6-car	325	523
HST 8-car	446	658
IEP 5-car (Cross Country and Great Western)	328	763
IEP 5-car (East Coast)	303	477
IEP 5-car (East Midlands)	318	753
IEP 9-car (East Coast)	611	963
IEP 9-car (Great Western)	651	1491

6 Rail network: Do Something

6.1 Introduction

6.1.1 To understand the costs and benefits of the scheme, our modelling requires assumptions on a service specification for HS2 and a service specification for released capacity on the classic network. These assumptions are set out in the following sections. **The assumptions set out here have been derived for transport modelling purposes only. They are not a future proposed service specification**.

There are many potential options for future service specifications across the network. DfT's strategic case sets out the high level principles that will be followed in making best use of released capacity, including:

- To ensure that all places with a direct London service today retain a broadly comparable or better service after HS2 opens;
- To provide additional commuter capacity where it is most needed;
- To spread the benefits of long-distance and inter-regional services to the many towns and cities that can be served by the capacity created on the existing rail network;
- To integrate HS2 services fully into the wider national rail network;
- To provide capacity for the growing rail freight sector; and
- To improve performance by making timetables more robust.

6.1.2 Decisions on future services will be taken much nearer the time. What is set out here are a set of assumptions for modelling purposes.

6.1.3 In the following sections the HS2 service assumptions and assumptions on the classic network are set out separately. Within the PFMv5.2 model the impacts of these are combined.

6.2 HS2 service patterns

Phase One

6.2.1 There are four stations assumed on the Phase One route: Birmingham Curzon Street, Birmingham Interchange, Old Oak Common and London Euston.

6.2.2 The Phase One service pattern is the same as used in PFMv4.3. It is shown in Figure 6-1 and comprises:

- London Euston to Birmingham Curzon Street; and
- A series of services that are 'classic compatible', i.e. they use the HS2 link between London and its connection with the West Coast Main Line and then switch to the classic network;

- London Euston to Manchester Piccadilly (three trains per hour);
- London Euston to Liverpool Lime Street (two trains per hour);
- London Euston to Preston (one train per hour); and
- London Euston to Glasgow Central (one train per hour)

Phase 2A

6.2.3 Phase 2A is assumed to have the same service pattern as Phase One. This means that we assume the same number of services, and stopping pattern, as presented in the 2013 Economic Case, but some services gain the benefit of a reduced journey time by using the new high-speed section of track. The following HS2 services take advantage of that journey time saving:

- London Euston to Glasgow Central service;
- London Euston to Preston service;
- London Euston to Liverpool Lime Street stopping at Crewe, Runcorn and Liverpool;
- Two of the three London Euston to Manchester Piccadilly services. (Additional infrastructure may be required to have the third London to Manchester service take advantage of the HS2 route).

6.2.4 Phase 2A would become operational in 2027. It is shown in Figure 6-2.

Figure 6-1: HS2 Service Pattern used in PFMv5.2 – Phase One

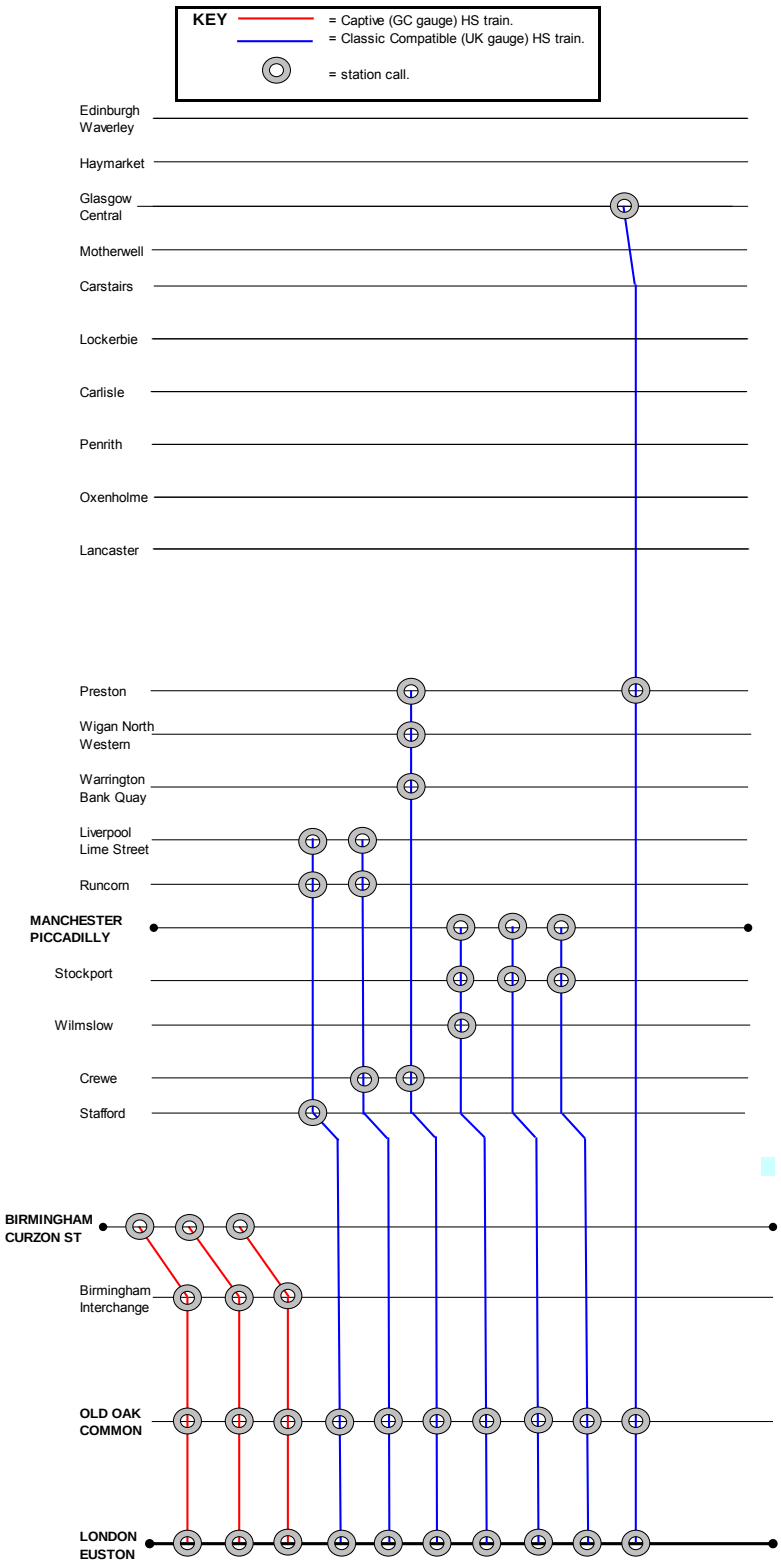
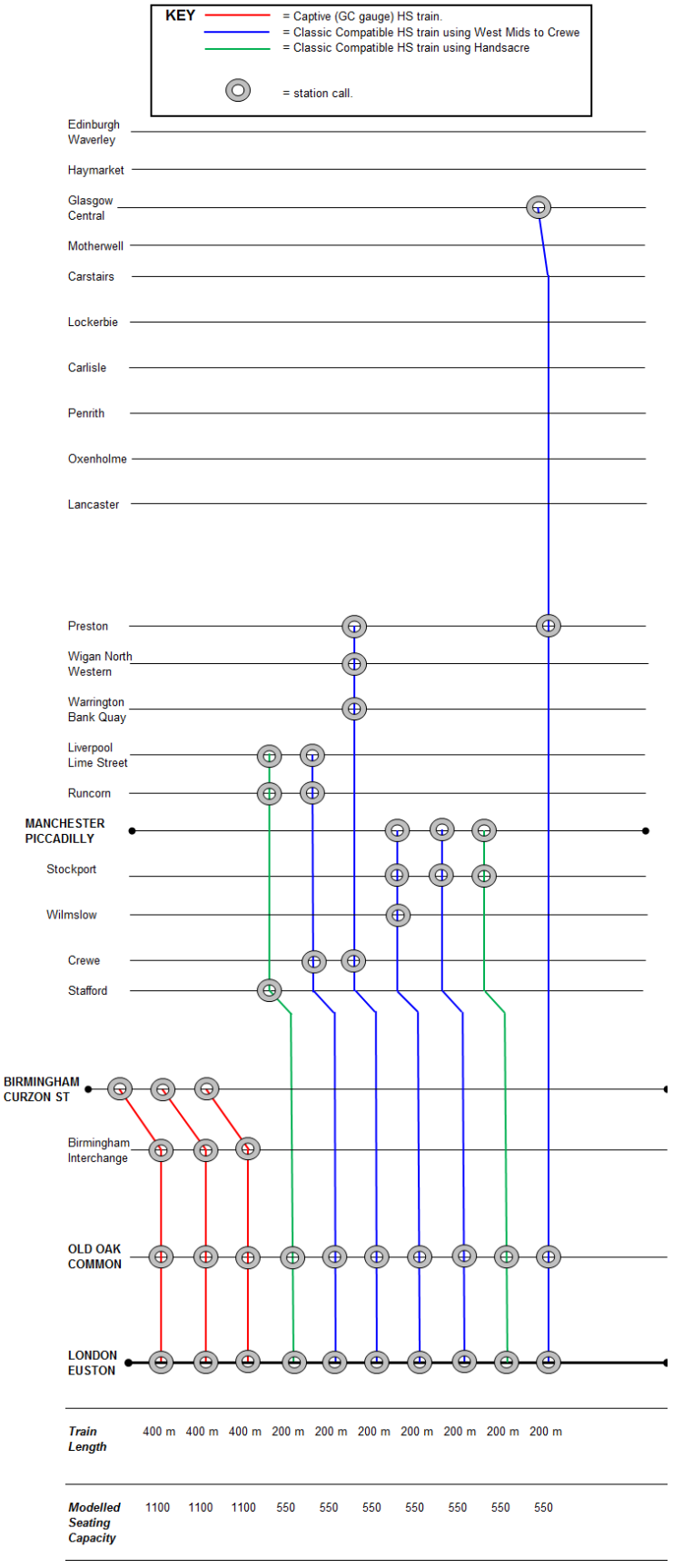


Figure 6-2: HS2 Service Pattern used in PFMv5.2 – Phase 2A



Full network

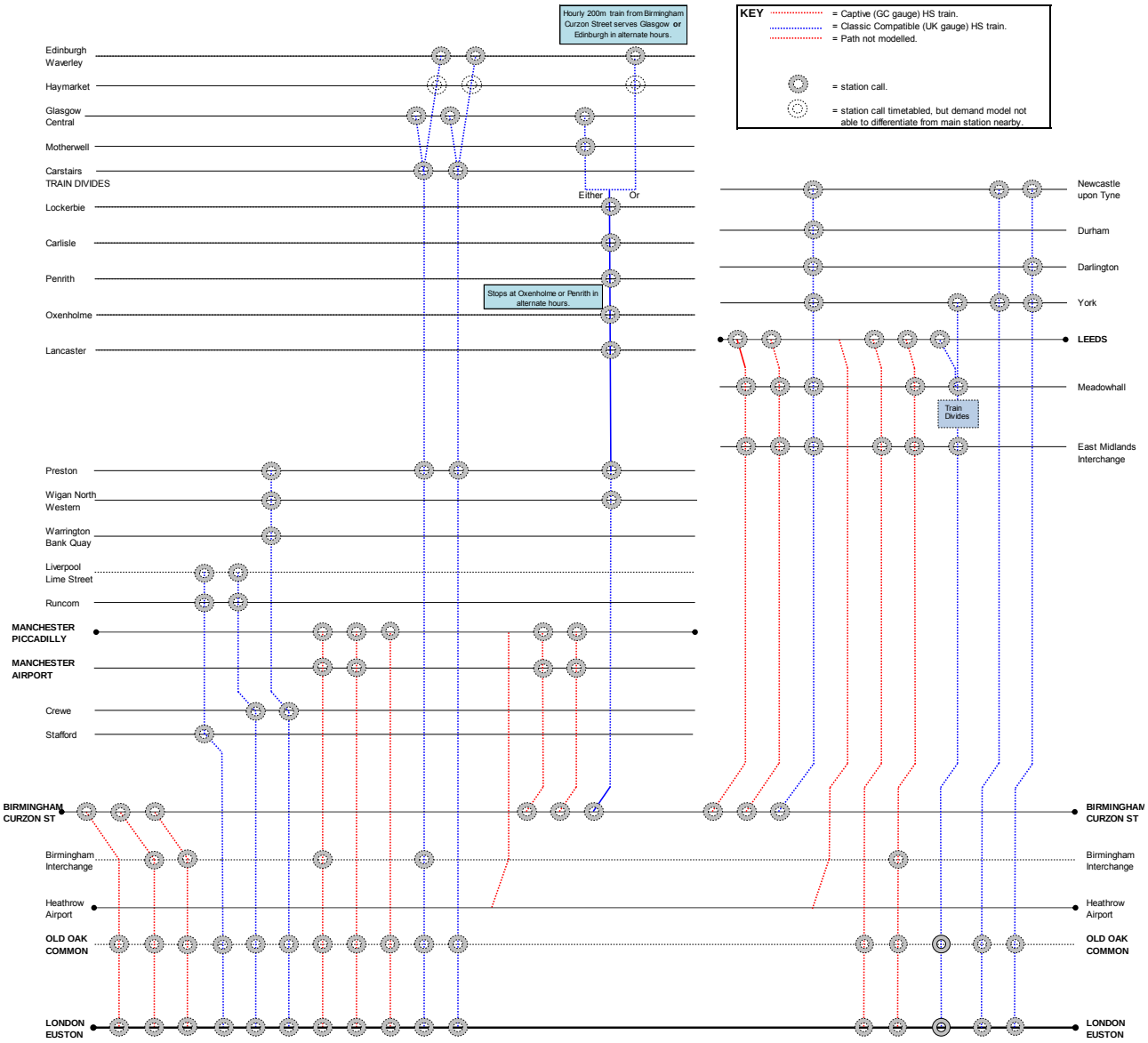
6.2.6 The full network service pattern is based on the preferred route set out in the Phase Two consultation published on 17th July 2013. It is shown in Figure 6-3 and comprises:

- HS2 services:
  - London Euston to Birmingham Curzon Street (3tph);
  - London Euston to Manchester Piccadilly (3tph);
  - London Euston to Leeds (3tph[31]);
  - Birmingham Curzon Street to Manchester Piccadilly (2tph); and
  - Birmingham Curzon Street to Leeds (2tph);
- And a series of services that are classic compatible, i.e. they use the HS2 link from London Euston and switch to the classic network at the appropriate location:
  - London Euston to Liverpool Lime Street (2tph);
  - London Euston to Preston (1tph);
  - London Euston to Glasgow Central/ Edinburgh Waverley (2tph);
  - Birmingham Curzon Street to Glasgow Central/ Edinburgh Waverley (1tph);
  - Birmingham Curzon Street to Newcastle (1tph);
  - London Euston to Leeds/ York (1tph[32]); and
  - London Euston to Newcastle (2tph).

[31] Two trains operate entirely to Leeds, the third combines/splits at Meadowhall to serve Leeds and York (the next footnote also refers to this service).

[32] A Leeds train combines/splits with a classic compatible York service at Meadowhall

Figure 6-3: HS2 Service Pattern used in PFMv5.2 – Full Network



6.3 Released capacity

6.3.1 With the introduction of HS2 the specification of some classic rail services has been amended:

- to remove any duplication between classic and HS2 services;
- to ensure that HS2 and classic rail services are fully integrated; and
- to make use of the capacity freed up by the introduction of HS2 to improve the rail services to certain locations.

6.3.2 These changes to the classic rail services are referred to as the released capacity specification.

6.3.3 Assumptions about released capacity have been included within the PFMv5.2 modelling. There are many other potential combinations of released capacity. The assumptions in PFMv5.2 represent one possible set of assumptions for business case modelling purposes. **They have been developed for demand modelling purposes and they do not infer that this will be the specification implemented**.

6.3.4 The released capacity specification varies between Phase One and Full Network of HS2. The train operating companies (TOCs) where services are modified as a result of the introduction of HS2 in Phases One and Full Network are summarised in Table 6-1. Note that the Phase 2A released capacity specification is the same as that for Phase One.

Table 6-1: TOCs Impacted by Released Capacity Specification

Train Operating Company	Phase One and Phase 2A	Full Network
West Coast Main Line	✓	✓
East Coast Main Line		✓
London Midland	✓	✓
East Midland Trains		✓
Trans Pennine Trains	✓	✓
Cross Country	✓	✓
Southern Trains	✓	✓
Great Northern Trains		✓
Thameslink Trains		✓
Northern Trains		✓
East West Rail		✓
Crossrail	✓	✓
Great Western	✓	✓
Heathrow Express	✓	✓

West Coast

6.3.5 A summary of services and stopping patterns for the West Coast is included in figure 6-4 for Phase One.

6.3.6 The service pattern for Phase Two is shown on figure 6-5.

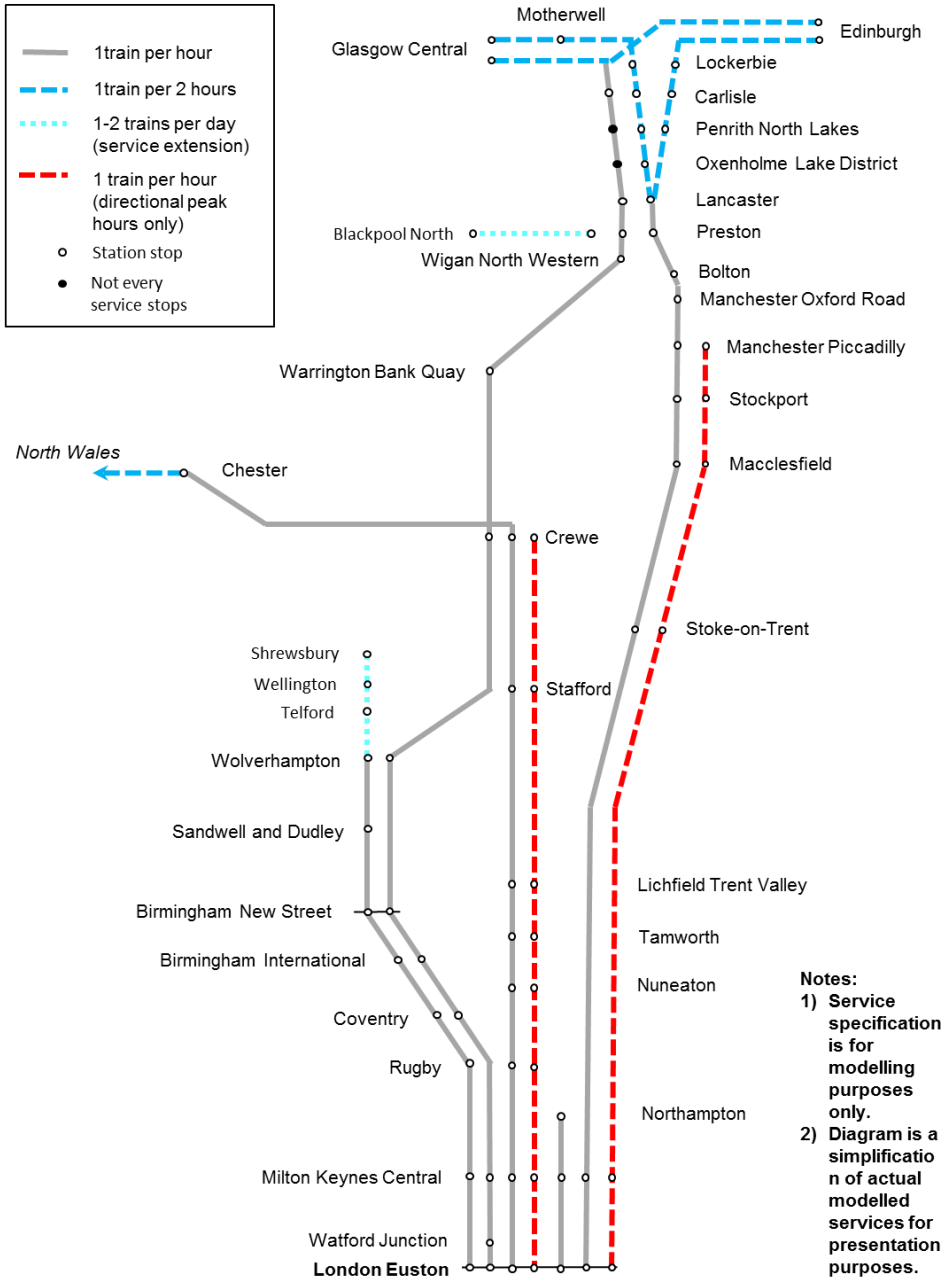
6.3.7 The Phase One timetable assumes the following services to/from London Euston:

- 1tph to Wolverhampton (2 trains per day extension to Shrewsbury);
- 1tph to Scotland via Birmingham (alternating between Glasgow and Edinburgh);
- 1tph peak shuttle service between Preston and Blackpool North;

- 1tph to Chester (7-8 trains per day extension to North Wales) with a regularised stopping pattern compared to the do-minimum along the Trent Valley;
- one train per peak hour in the peak direction from/to Crewe;
- 1tph to Northampton (in addition to LM services);
- 1tph to Scotland via Manchester (alternating between Glasgow and Edinburgh); and
- one train per peak hour in the peak direction to Manchester.

6.3.8 Train types used are similar to those by service in the new 'Do Minimum', but with all Pendolino trains being of 9-car length alone, and the same mix of Voyagers on those services diesel worked.

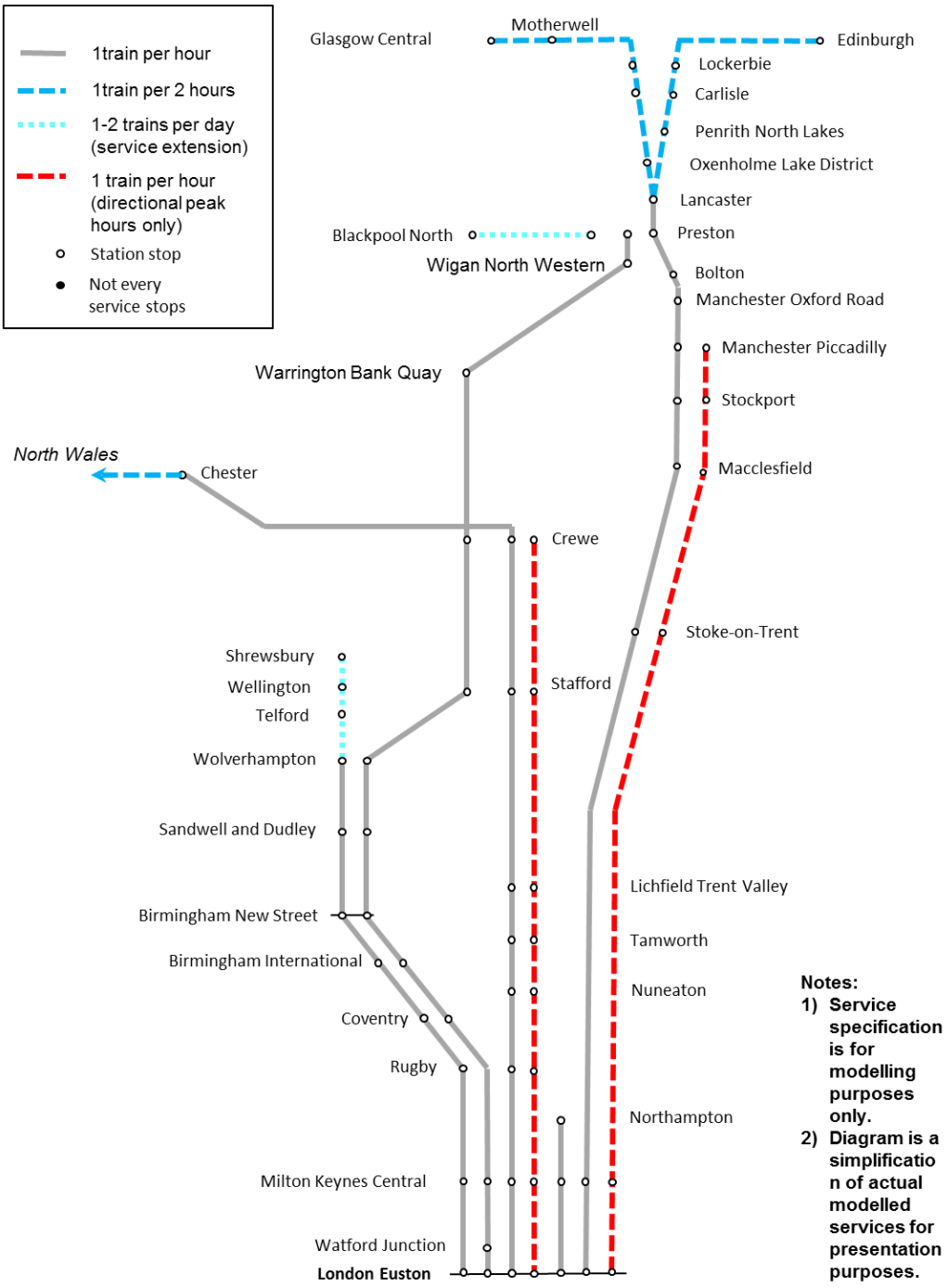
Figure 6-4: West Coast Long Distance Services assumed in PFMv5.2 – Phase One



6.3.10 Phase Two is identical to the Phase One specification, with the exception being that the hourly service from Euston to Scotland via the West Midlands (alternating between Glasgow and Edinburgh) only runs to Preston in the Phase Two specification.

6.3.11 Train types adopted are as used in Phase One.

Figure 6-5: West Coast Long Distance Services assumed in PFMv5.2 – Phase Two



East Coast Main Line

6.3.13 The Phase One timetable is unchanged from the 'Do Minimum'.

6.3.14 The Phase Two timetable assumes the following services to/from London:

- 1tph to Leeds, with same two hourly service frequency as the Do Minimum continuing to Bradford and Harrogate, and the peak Skipton service;
- 1tph to Edinburgh;
- 1tph to Newcastle;
- The additional two-hourly service between Middlesbrough and London King's Cross in the DM is maintained with an extra intermediate stop at Doncaster; and
- 1tph to between Lincoln and London King's Cross;

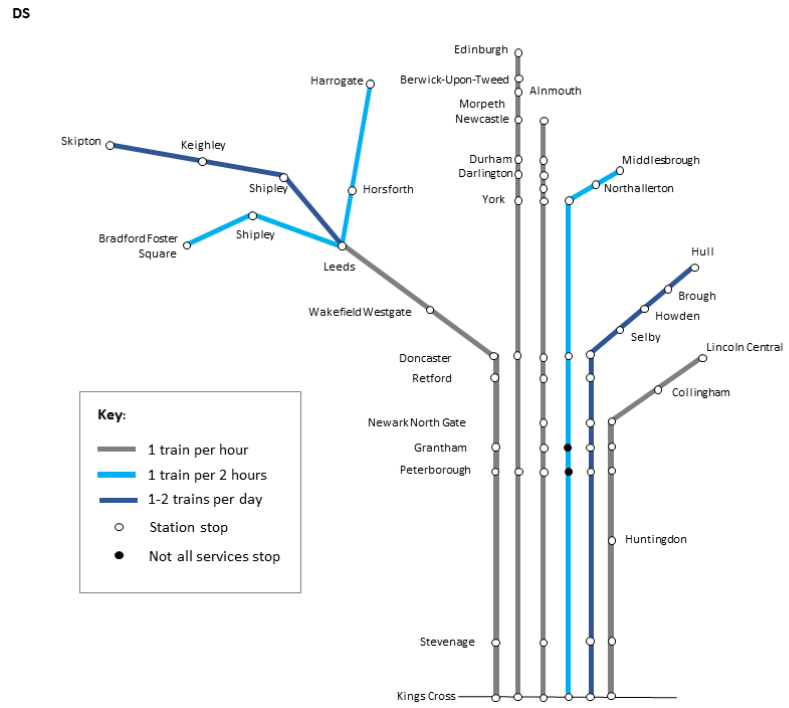
6.3.15 IEP journey time improvements introduced with the 'Do Minimum' timetable are incorporated in the model coding.

6.3.16 ECML Sunderland services from the 'Do Minimum' have been recoded under the Northern TOC. In addition, one train per hour has been coded between Leeds and Doncaster under the Northern TOC to retain the same level of service provision on this section of network as in the 'Do Minimum' scenario.

6.3.17 ECML services north of Edinburgh, have been recoded as ScotRail services.

6.3.18 A summary of services and stopping patterns for East Coast Main Line in Phase Two is included in figure 6-6. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-6: East Coast Service – Average Service Pattern used in PFMv5.2 – Phase Two



London Midland

6.3.19 The do something LM network is consistent with the 'Do Minimum' and the same in both Phase One and Full Network scenarios.

6.3.20 The do something timetable assumes the following services to/from London Euston:

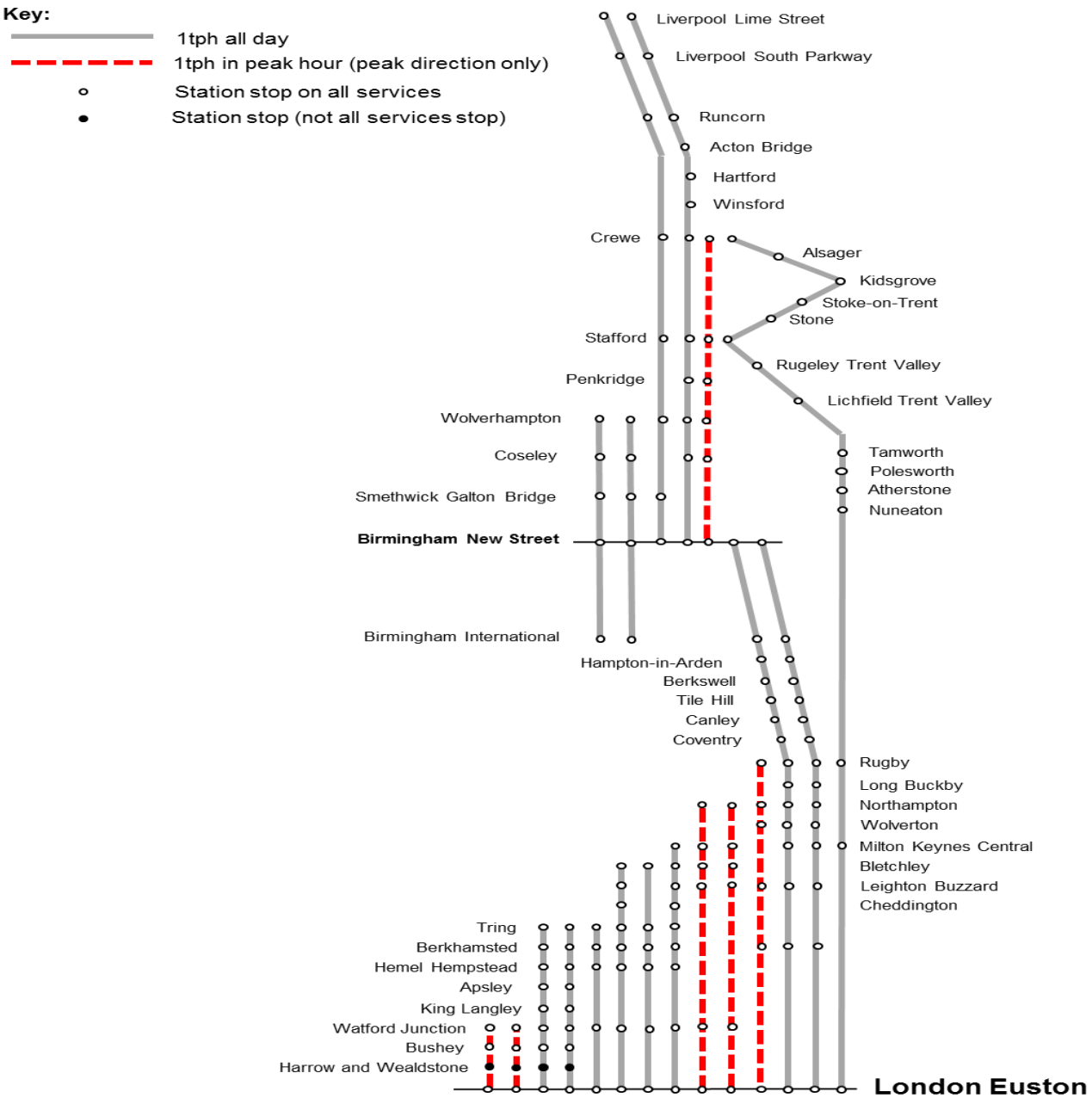
- 2tph peak services between London Euston and Watford Junction,
- 3tph between London Euston and Tring,
- 2tph between London Euston and Bletchley,
- 1tph between London Euston and Milton Keynes,
- 2tph peak services between London Euston and Northampton,
- 2tph peak services between London Euston and Rugby,
- 2tph between London Euston and Birmingham New Street,
- 1tph between London Euston and Crewe (via Litchfield Trent Valley).

6.3.21 The do something timetable also assumes the following services starting at Birmingham New Street:

- 2tph peak services between Birmingham International and Wolverhampton,
- 1tph peak services between Birmingham New Street and Crewe, and
- 2tph between Birmingham New Street and Liverpool Lime Street.

6.3.22 A summary of services and stopping patterns for London Midland services in Phase One and Phase Two is shown in figure 6-7.

Figure 6-7: London Midland Service Pattern used in PFMv5.2 – Phase One & Full network


Key:
1tph all day
1tph in peak hour (peak direction only)
Station stop on all services
Station stop (not all services stop)
Liverpool Lime Street
Liverpool South Parkway
Runcorn
Acton Bridge
Hartford
Winsford
Crewe
Alsager
Kidsgrove
Stoke-on-Trent
Stone
Stafford
Rugeley Trent Valley
Penkridge
Lichfield Trent Valley
Wolverhampton
Tamworth
Coseley
Polesworth
Smethwick Galton Bridge
Atherstone
Nuneaton
Birmingham New Street
Birmingham International
Hampton-in-Arden
Berkswell
Tile Hill
Canley
Coventry
Rugby
Long Buckby
Northampton
Wolverton
Milton Keynes Central
Bletchley
Leighton Buzzard
Cheddington
Tring
Berkhamsted
Hemel Hempstead
Apsley
King Langley
Watford Junction
Bushey
Harrow and Wealdstone
London Euston

East Midlands Trains

6.3.23 The Phase One 'Do Something' timetable for East Midlands Trains has been updated with exactly the same changes as the 'Do Minimum' scenario as there are no HS2 Phase One effects on this service.

6.3.24 The Phase Two timetable assumes the following service pattern for London services on the Midland main line:

- 1tph between Nottingham and London St Pancras[33];
- 1tph between Sheffield and London St Pancras[34];
- 1tph between Derby and London St Pancras, which routes via the East Midlands High Speed station at Toton[35];
- 1tph between Corby (Kettering) and London St Pancras. Note that services to and from Corby are coded to and from Kettering as Corby is not a station that is directly represented in PLD; and
- 1tph between Leicester and London St Pancras.

6.3.25 All London services are assumed to be 5-car IEPs.

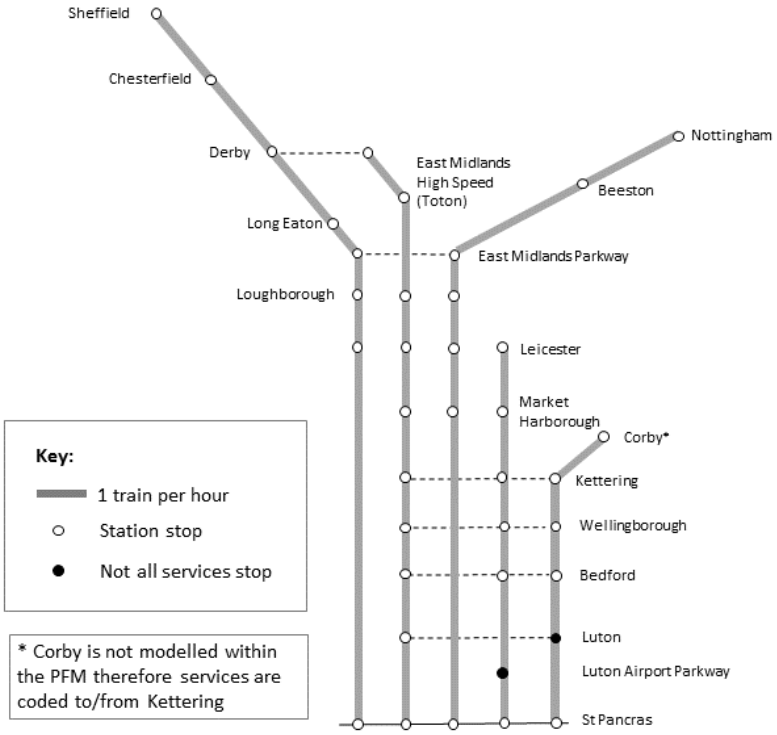
6.3.26 A summary of services and stopping patterns for East Midlands Trains services to/from London in Phase Two is included in figure 6-8. Phase One is not presented as it is unchanged from the 'Do Minimum'.

6.3.27 The Phase 2 timetable is also amended within the East Midlands area to allow for released capacity and connectivity of the East Midlands high speed station[36]:

- The Liverpool to Norwich services group is re-routed in Phase 2 to stop at Toton, this incurs an additional six-minute journey time. The Nottingham to Norwich variant is extended to start/terminate at Toton incurring an additional 14-minute journey time.
- Both the Matlock to Nottingham and Derby to Nottingham service groups are re-routed via Toton in Phase 2, incurring an additional 14-minute journey time.

[33] The East Midlands Nottingham services have been coded with variable stopping patterns, therefore not all services stop at Beeston, East Midlands Parkway and Market Harborough.
[34] The East Midlands Sheffield services have been coded with variable stopping patterns, as a result these services are missing intermediate stops at Loughborough and Long Eaton.
[35] The East Midlands Derby services are missing intermediate stops at Luton, Bedford, Wellingborough, Kettering and Market Harborough
[36] The connections to Toton for the following East Midlands services have not been included in this model release version.

Figure 6-8: East Midlands Service Pattern used in PFMv5.2 – Phase Two



TransPennine Trains

6.3.28 The Phase One timetable for TransPennine Trains assumes:

- 1tph between Manchester and Selby via Leeds;
- 1tph between Manchester and Hull via Leeds;
- 1tph between Manchester and Doncaster via Sheffield;
- 6tpd from Preston to Barrow-in-Furness;
- 1tph from York to Middlesbrough;
- 1tph between Liverpool and Newcastle via Manchester and Leeds; and
- 1tph between Liverpool and York via Manchester and Leeds.
- To / from Manchester Airport:
  - 2tph to York;
  - 1tph to Manchester Piccadilly (the truncation of the do minimum Manchester Airport Scotland service;
  - 1tph to Blackpool;
  - 1tph to Cleethorpes via Sheffield.

6.3.29 The TransPennine Phase One services pattern in PFMv4.3 has the following modifications in PFMv5.2:

- Services between Manchester Airport and Manchester Piccadilly in Phase One were incorrectly extended to Scotland in the PFMv4.3 Phase One model: these are curtailed at Manchester Piccadilly in PFMv5.2. In Phase Two, these services were already correctly curtailed at Manchester Piccadilly in the PFMv4.3 model in contrast to as stated in the PFMv4.3 Assumptions Report;
- Correction of minor discrepancies in stopping patterns to better reflect the overall service allocation; and
- The addition of an hourly service between Middlesbrough and York, previously missing from the diagrams. Such a shuttle service is required due to route electrification.

6.3.30 The Phase Two timetable contains the following differences to Phase One:

- One train per two hours between Liverpool Lime Street and Newcastle is extended to Edinburgh.

6.3.31 A summary of services and stopping patterns for TransPennine Train services is included in figure 6-9 for Phase One and figure 6-10 for Phase Two.

Figure 6-9: Trans Pennine Service Pattern used in PFMv5.2 – Phase One

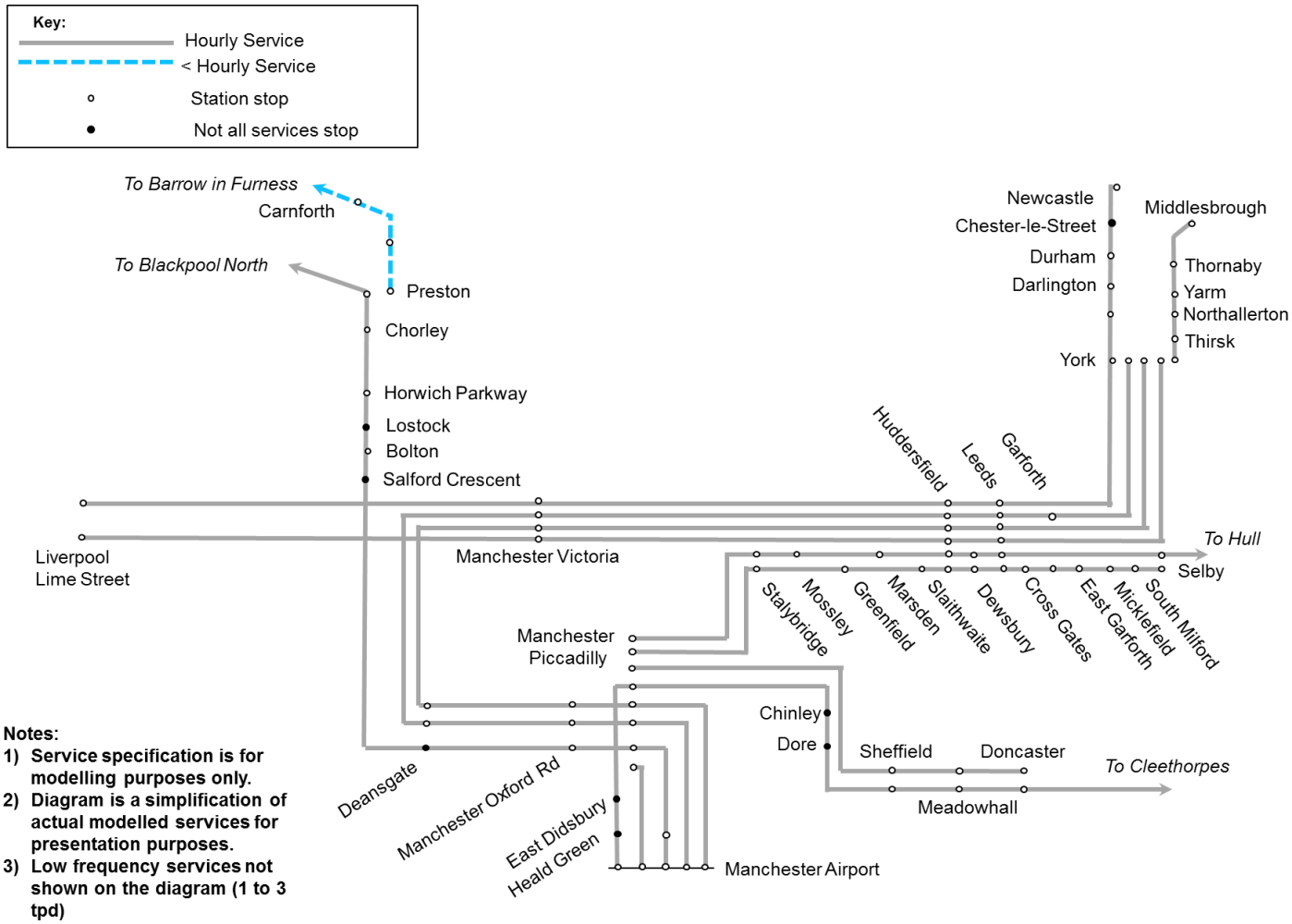
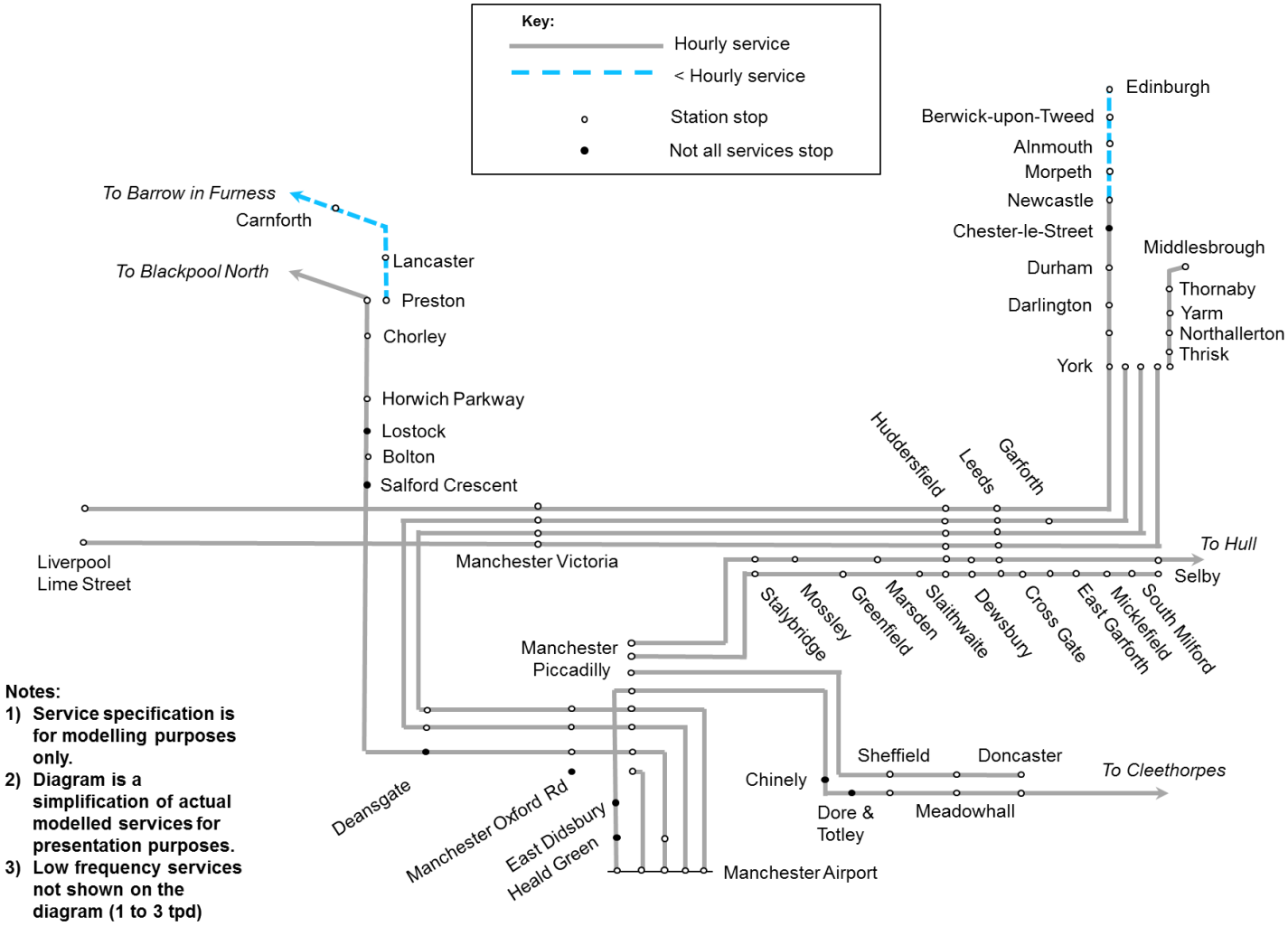


Figure 6-10: Trans Pennine Service Pattern used in PFMv5.2 – Phase Two



Cross Country

6.3.32 The Phase One timetable for Cross Country services is as assumed for the 'Do Minimum' in PFMv5.2.

6.3.33 The Phase Two timetable is broadly the same as that in the 'Do Minimum' in PFMv5.2 except as follows

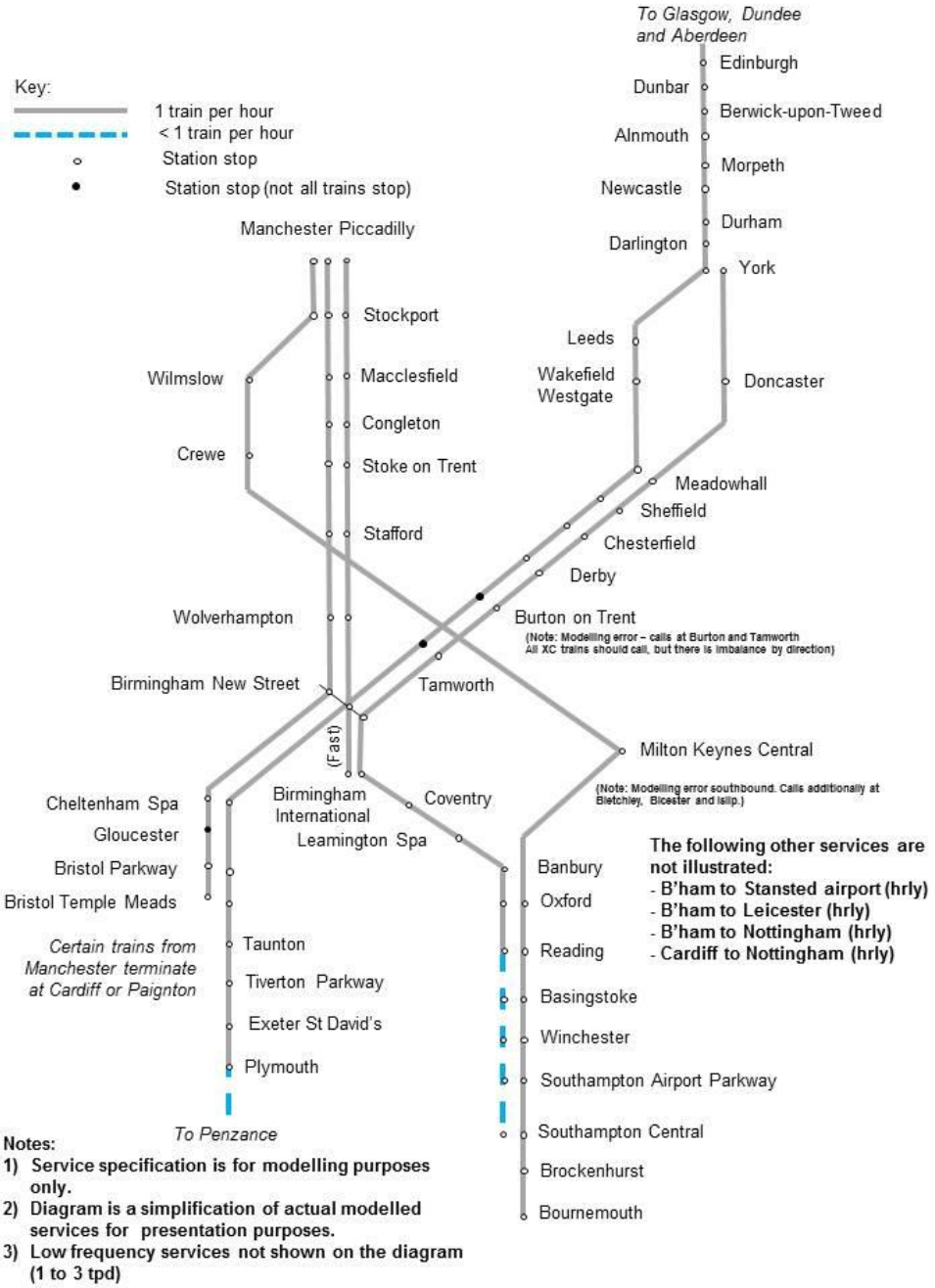
- additional calling points are provided at Meadowhall, Chesterfield, Burton-on-Trent and Tamworth on all services to Edinburgh and York; and Congleton and Macclesfield on services to Manchester.
- Reading to Newcastle services are cut back to terminate at York (and vice versa).

This then provides a service pattern as follows:

- 1tph between Manchester and Bournemouth via Milton Keynes;
- 1tph between Manchester and Bristol via Birmingham (with some services continuing on to Cardiff or Paignton);
- 1tph between Manchester and Birmingham International;
- 1tph between Plymouth and Edinburgh, with some services continuing on to Penzance in the South West or Glasgow, Dundee or Aberdeen in Scotland; and
- 1tph between Reading and Newcastle, with some services continuing on to Southampton or Guildford in the south, or Edinburgh in the north.

6.3.34 A summary of services and stopping patterns for Cross Country services in Phase Two is included in figure 6-11. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-11: Cross Country Service Pattern used in PFMv5.2 – Phase Two



Southern Trains

6.3.35 Within PFM the changed assumptions for Southern Trains relates to the service operating to Milton Keynes. In both Phase One and Phase Two an hourly service is assumed, with a second train per hour in peak times, between East Croydon and Milton Keynes Central.

6.3.36 A summary of services and stopping patterns for Southern Trains in Phases One and Two is included in figure 6-12.

Figure 6-12: Southern Train Service Pattern used in PFMv5.2 – Phase One and Phase Two

Thameslink and Great Northern Trains

6.3.37 The Thameslink specification presented here relates to selected Thameslink services in the corridors impacted by the released capacity specification, that is, the Midland route to Bedford and the Great Northern route to Peterborough.

6.3.38 Phase One is unchanged from the 'Do Minimum' and assumes the following:

- On the Thameslink Midland corridor:
  - 5.5tph between Bedford and Brighton via central London;
- And on the Great Northern Peterborough corridor:
  - 1tph peak only between King's Cross and Peterborough;
  - 2tph between Three Bridges and Peterborough via central London.

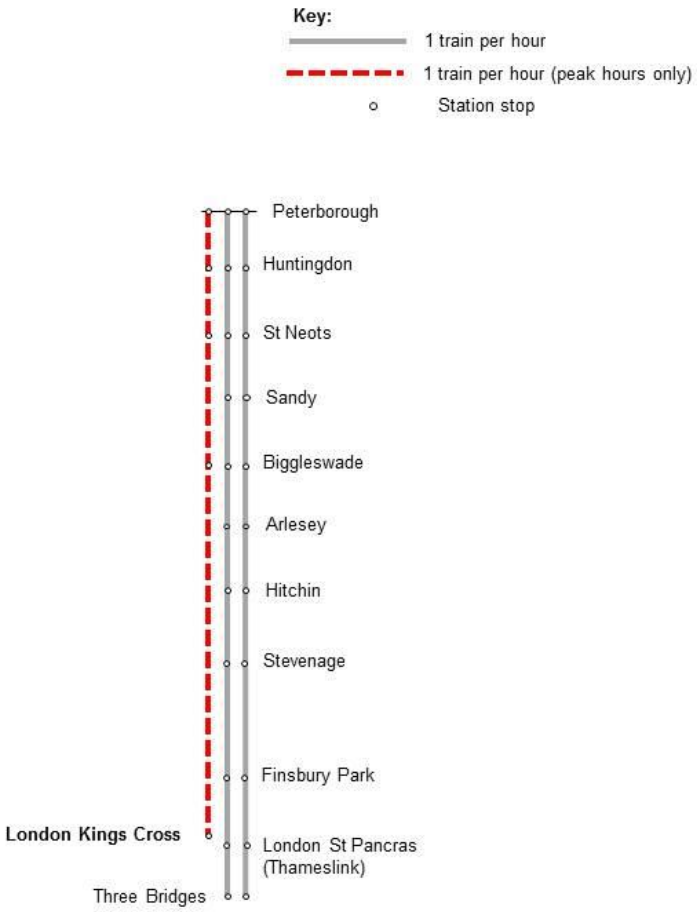
6.3.39 Phase Two assumes the following:

- On the Thameslink Midlands corridor:
  - 5.5tph between Bedford and Brighton via central London;
  - 1tph between Bedford and London St Pancras semi-fast.
- And on the Great Northern Peterborough corridor:
  - 1tph peak only between King's Cross and Peterborough semi fast;
  - 1tph peak only between King's Cross and Peterborough stopping service;
  - 2tph between Three Bridges and Peterborough via central London;
  - 1tph between King's Cross and Peterborough semi-fast.

6.3.40 A summary of services and stopping patterns for Thameslink Midland and Thameslink Great Northern services is presented in figure 6-13 for Phase One and figure 6-14 for Phase Two.

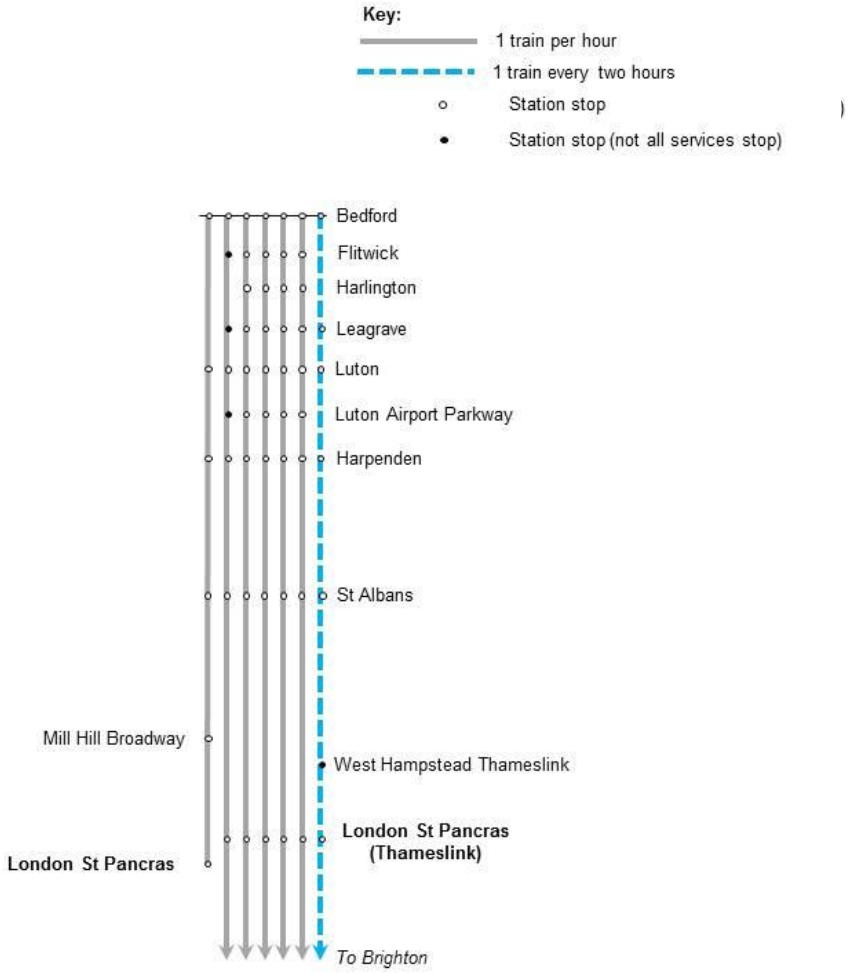
Figure 6-13: Thameslink- Midlands and Great Northern Service Pattern used in PFMv5.2 – Phase One

Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Bedford, plus any released capacity services**



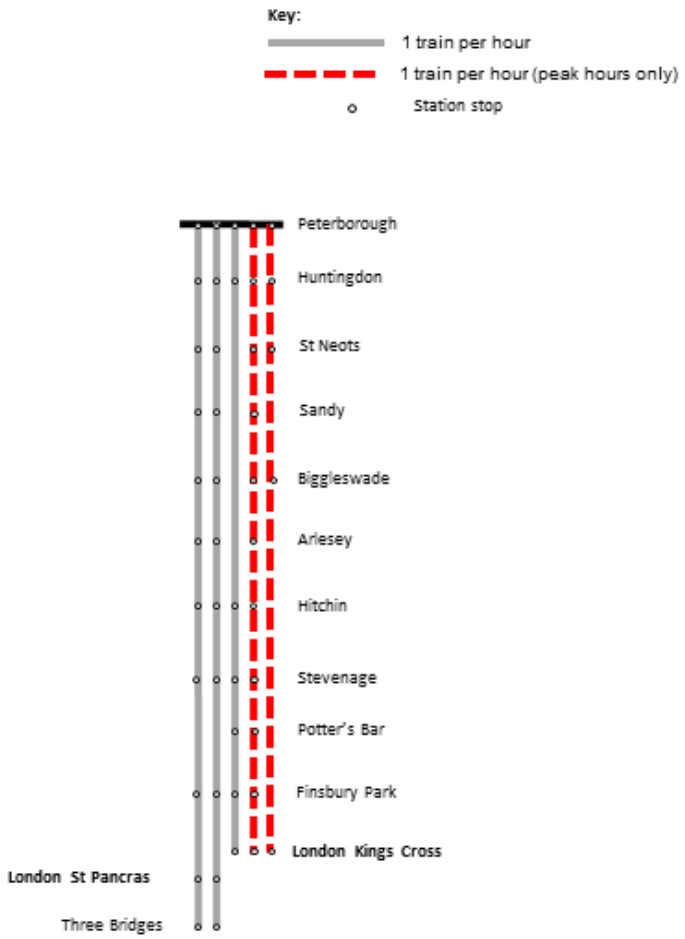
Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Peterborough, plus any released capacity services**

Figure 6-14: Thameslink – Midlands and Great Northern Service Pattern used in PFMv5.2 – Phase Two



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Bedford, plus any released capacity services**

Figure 15 – Great Northern Trains
Average Service Pattern – Phase 2



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

Northern Trains

6.3.41 The Northern Trains specification presented here relates to selected Northern services in the corridors impacted by the released capacity specification, i.e., the Leeds-Doncaster corridor and South Manchester corridors.

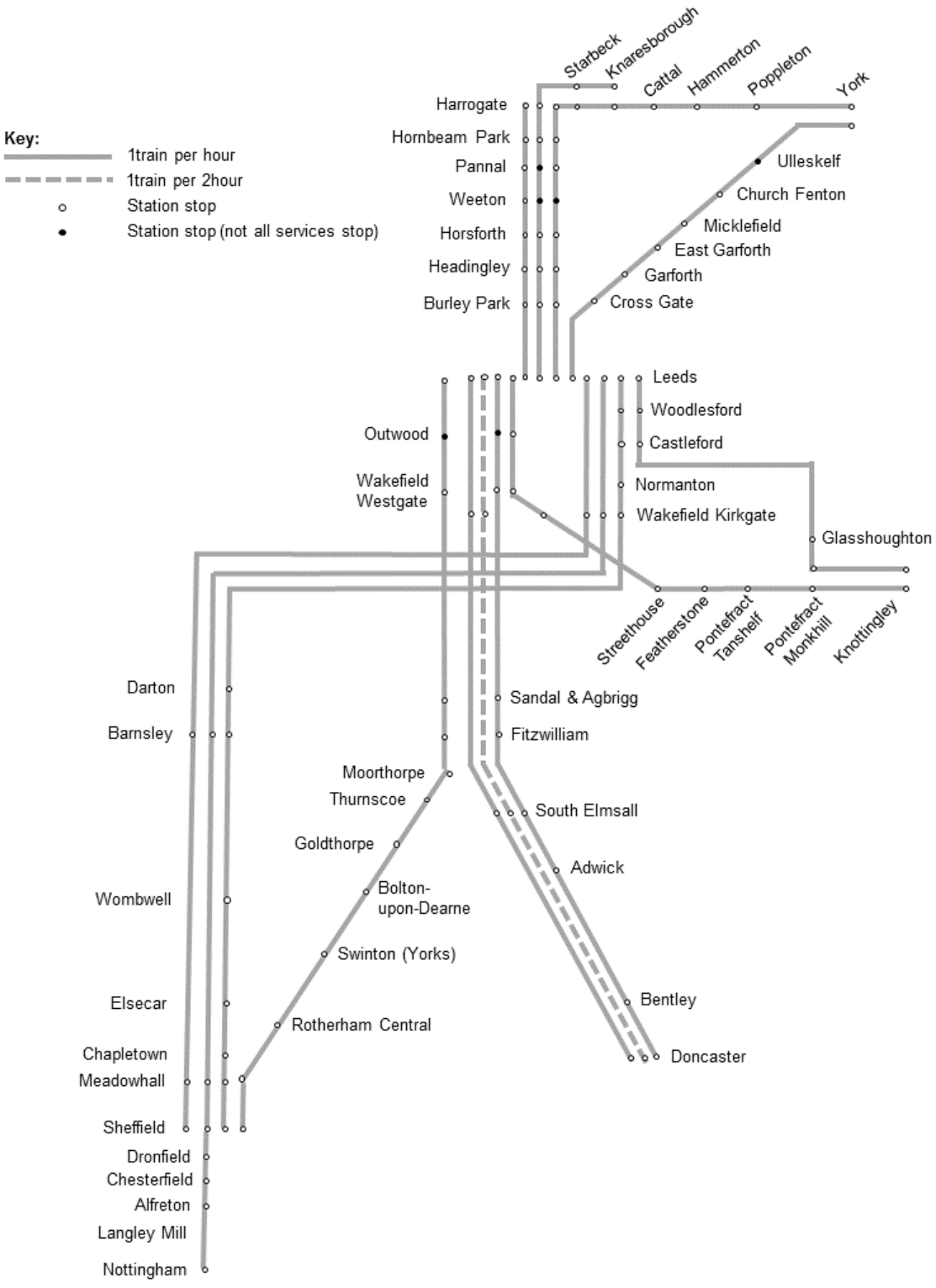
6.3.42 The Phase One timetable is as per the 'Do Minimum'.

6.3.43 The Phase Two timetable assumes the following for each corridor.

- On the Leeds-Doncaster corridor the following services to/from Leeds:
  - 1tph to Nottingham
  - 1tph to Sheffield
  - 1tph to Sheffield via Rotherham stopping service;
  - 1tph to Doncaster calling all stations; and
  - 1.5tph to Doncaster semi-fast (backfilling for removed East Coast capacity).
- On the South Manchester corridor the following services to/from Manchester Piccadilly:
  - 1tph to Crewe via Manchester Airport;
  - 1tph to Crewe via Stockport;
  - 1tph to Alderley Edge via Stockport;
  - 1tph to Stoke on Trent stopping service;
  - peak extra services to Macclesfield;
  - 1tph to Stoke on Trent semi-fast (backfilling for removed West Coast capacity); and
  - 1tph to Crewe semi-fast (again backfilling for removed West Coast capacity).

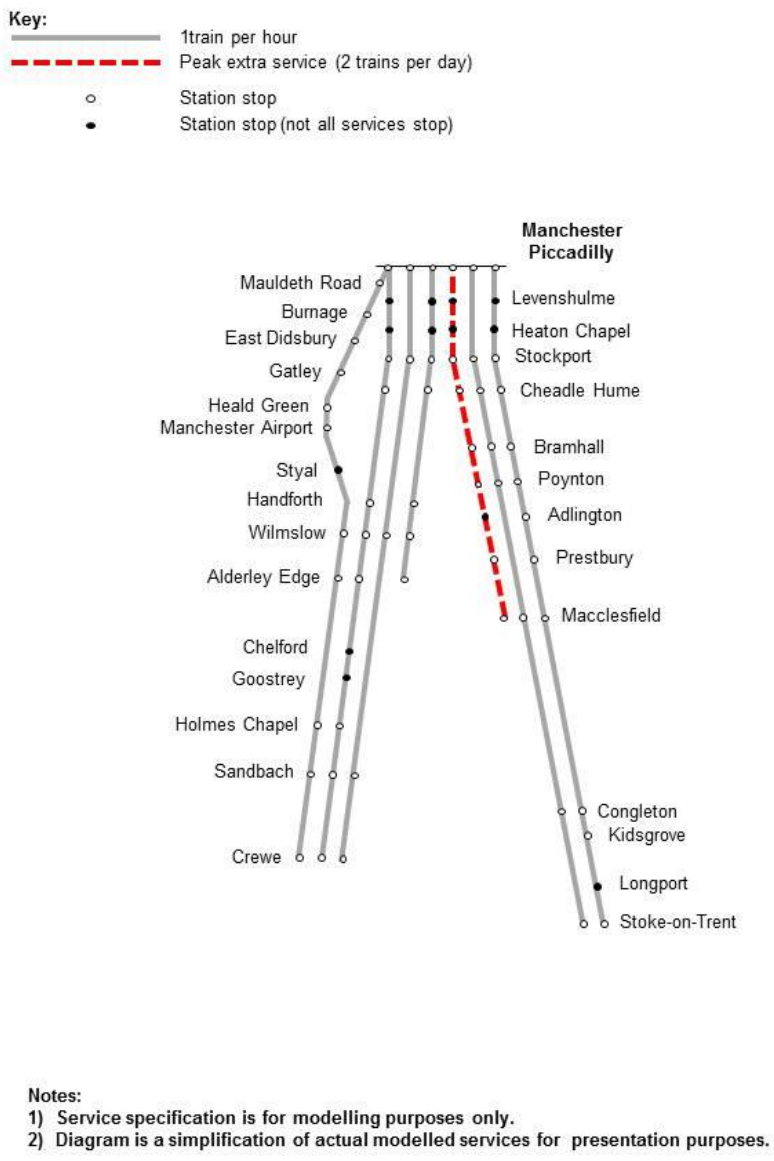
6.3.44 A summary of services and stopping patterns for Northern services on the Leeds Corridor are presented in figure 6-15 for Phase Two. A summary of the service patterns assumed in the South Manchester corridor are shown on Figure 6-16 for Phase Two. Phase One services for Northern Trains are not shown as they are as per the 'Do Minimum'.

Figure 6-15: Northern Train Services- Leeds Corridor Service Pattern used in PFMv5.2 – Phase Two



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

Figure 6-16: Northern Train Services- South Manchester Corridor Service Pattern used in PFMv5.2 – Phase Two



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

East-West Rail

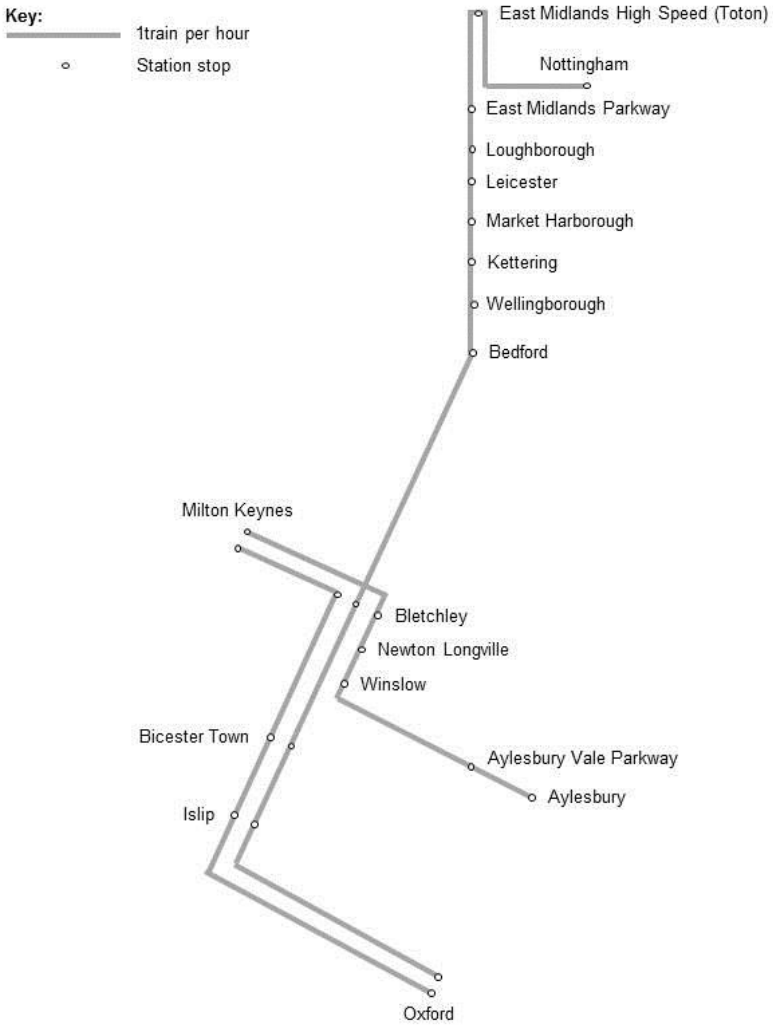
6.3.45 The Phase One timetable is as the 'Do Minimum' specification.

6.3.46 The Phase Two timetable assumes:

- 1tph between Oxford and Nottingham via Bedford (projected on from the Do Minimum Oxford-Bedford service);
- 1tph between Oxford and Milton Keynes; and
- 1tph Aylesbury and Milton Keynes.

6.3.47 A summary of services and stopping patterns for East West Rail is included in Figure 6-17. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-17 East-West Rail Service Pattern used in PFMv5.2 – Phase Two



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.

Old Oak Common

6.3.48 All Crossrail, Great Western and Heathrow Express services between Paddington and the west go via Old Oak Common in both Phase One and Phase Two. The impact of stopping at Old Oak Common is an increase in journey time of between two and four minutes.

7 Rail reliability assumptions, PFMv5.2

7.1.1 The approach to modelling reliability in PFMv5.2 involves making adjustments to the journey times for HS2 and classic services as a proxy for changes in reliability. The approach considers the potential improvement in reliability that HS2 can deliver by examining one measure of reliability – average minutes lateness (AML).

7.1.2 Improvements in AML as a result of HS2 are converted into an equivalent journey time saving based on evidence in PDFH and WebTAG[37]. PFM assumes that all passengers value one AML as equivalent to three minutes of journey time[38]. This perceived reduction in journey time is then input into the model to forecast the change in demand due to reliability improvements.

7.1.3 PFM uses HS2 Ltd's design assumption that on dedicated HS2 track the average delay will be 0.003 minutes/km; this is equivalent to an average delay of 30 seconds delay between Old Oak Common and Birmingham Curzon Street. For DM services running on classic lines an average delay of 0.014 minutes/km delay is assumed (taken from PEARS data 2012).

Table 7-1: Reliability Benefits of HS2 in Phase One, selected services

HS2 Service Group	AML Classic Rail	Forecast AML with HS2	Change in AML	Equivalent Journey Time Reduction (i.e., 3 times AML)
London - Birmingham	2.6	0.5	**2.0**	6
London– Phase One connection to WCML	2.9	0.5	2.3	7

Table 7-2: Reliability Benefits of HS2, Full network, selected services

HS2 Service Group	AML Classic Rail	Forecast AML with HS2	Change in AML	Equivalent Journey Time Reduction (i.e., 3 times AML)
London - Birmingham	2.6	0.5	2.0	6
London – Liverpool via Crewe	3.5	0.7	2.8	9
London - Sheffield	3.8	0.8	3.0	9
London - Manchester	4.1	0.9	3.3	10
London - Leeds	4.7	0.9	3.7	11
Birmingham - Manchester	1.9	0.5	1.4	4
London – Phase 2 connection to WCML	4.4	0.9	3.5	11

[37] WebTAG unit 3.15.4
[38] PDFH5.1 recommends a weighting of 3.0 for London-Inter Urban non-commuting trips.

8 General model assumptions

8.1 Introduction

8.1.1 The Model Development Overview report provides details of the parameters and assumptions that are used within PFMv5.2. This section outlines the weights used within the model.

Generalised cost element weights for rail

8.1.2 Within PFMv5.2 there are a series of weights that are applied to each element into to derive generalised costs of travel. The modelled values are given in Table 8-1.

Table 8-1: Generalised Cost Element Weights for Rail – PFMv5.2

	Model Values (all purposes)		
Rail Element	**PLD**	**PLANET South**	**PLANETs Midlands & North**
IVT	1.0	1.0	1.0
Wait Time	2.0	2.0	2.0
Walk Time (for connections)	2.0	2.0	2.0
Access/Egress Time*	1.0	2.0	1.0
Board Time Penalty (mins)	30.0	3.5	20.0

* values shown are for the assignment model, different values are used in the SCM (PT access IVT=1.0 and highway access IVT=2)

Glossary

AML	Average minutes lateness
AP	Attraction to production
ATOC	Association of Train Operating Companies
CA	Car available
CAA	Civil Aviation Authority
CEBR	Centre for Economics and Business Research
CPI	Consumer Price Index
DECC	Department of Energy & Climate Change
DfT	Department for Transport
DM	Do Minimum
DS	Do Something
EDGE	Endogenous Demand Growth Estimator – forecasting framework for rail demand growth in Great Britain (DfT)
GDP	Gross domestic product
HAM	Heathrow Access Model
HSR	High Speed Rail
HS2	High Speed Two (the project)
HS2 Ltd	HS2 project promoter
ICWC	Inter City West Coast
IEP	Intercity express programme
IVT	In vehicle time
LASAM	London Airports Surface Access Model
LUL	London Underground Limited
MOIRA	Rail forecasting software and database. Maintained on behalf of ATOC members for rail demand and revenue forecasting.
NAPALM	National Air Passenger Allocation Model (DfT)
NAPDM	National Air Passenger Demand Model (DfT)

NCA	Non-car available
NTEM	National Trip End Model (DfT)
NTM	National Transport Model (DfT)
OBR	Office for Budget Responsibility
ONS	Office of National Statistics
ORR	Office of Rail and Road
P/A	Production/Attraction
PDFH	Passenger Demand Forecasting Handbook
PFM	PLANET Framework Model
PLD	PLANET Long Distance
PM	PLANET Midlands
PN	PLANET North
PS	PLANET South
PT	Public transport
RIFF	Rail Industry Forecasting Framework
RPI	Retail Price Index
RTF	Road Traffic Forecasts (DfT)
SCM	Station Choice Model
TEMPro	Trip End Model presentation Program (DfT)
TfL	Transport for London
TOC	Train Operating Company
WebTAG	DfT's web-based Transport Appraisal Guidance