THE ECONOMIC CASE FOR HS2

PFM v4.3: Assumptions report

October 2013

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Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

High Speed Two (HS2) Limited,
2nd Floor, Eland House,
Bressenden Place,
London SW1E 5DU

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

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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 4.3 or PFMv4.3 and its methodology is separately described in the report *Planet Framework Model (PFMv4.3) – Model Description*.

1.1.2 This document provides a summary of the input and forecasting assumptions used by PFMv4.3 to generate what is known as the HS2 standard case, as presented in the separate *Economic Case for HS2* document.

2 Forecasting assumptions

2.1 Forecasting approach

2.1.1 Separate forecasts of 'Do Minimum' (without scheme) 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 growth elasticities for all variables except fares that are based on PDFH4 elasticities.

Demand drivers

2.2.2 HS2 Ltd's use of the EDGE model and PDFH utilises 14 different demand drivers, which feed into the future year forecasts of rail demand. The base year of PFM represents the financial year 2010/11 (described in this report as 2010) so the drivers are provided as a change from this base to the two forecast years as defined above. The demand drivers for the modelling were provided by the Department for Transport, and the following sections detail the source data and assumptions used for each of these drivers.

[1] EDGE= Exogenous Demand Growth Estimation. Details are given in WebTAG TAG Unit 3.15.4 Rail Passenger Demand Forecasting Methodology.
[2] Refer to WebTAG TAG Unit 3.15.2: Use of Tempro Data.
[3] The Model is described in 'UK Aviation Forecasts, DfT, January 2013.
[4] WebTAG TAG unit 3.15.4: Rail Passenger Demand Forecasting Methodology, August 2012.

Population growth

2.2.3 The growth in population has been sourced from October 2011 Office of National Statistics (ONS) National Forecasts (low migration variant)[5], with regional shares based on July 2012 data provided by the Centre for Economics and Business Research (CEBR). Table 2-1 below presents the GB population for 2010 and the predicted growth for 2026 and 2036.

Table 2-1: Regional population growth used in rail demand forecasts – PFMv4.3

Region	Growth in Population from 2010	
	2026	2036
North East	3.3%	5.6%
North West	7.6%	9.3%
Yorkshire & Humberside	7.5%	13.4%
East Midlands	13.2%	19.4%
West Midlands	9.9%	13.5%
East of England	13.1%	20.5%
London	17.8%	25.0%
South East	8.7%	13.9%
South West	7.4%	13.6%
Wales	6.4%	9.1%
Scotland	5.4%	5.9%
Great Britain	9.8%	14.5%

Employment growth

2.2.4 The growth in employment has been sourced from the Office for Budget Responsibility (OBR) March 2012 for short term forecasts and July 2012 for long-term forecasts)[6] using the ONS low migration variant numbers for population. Regional shares are based on CEBR (July 2012). Table 2-2 below presents the GB employment for 2010 and the predicted growth for 2026 and 2036.

[5] http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/stb-2010-based-npp-principal-and-key-variants.html#tab-Variant-population-projections. Accessed 25 October 2013.
[6] http://budgetresponsibility.org.uk/fiscal-sustainability-report-july-2012/. Accessed 25 October 2013.

Table 2-2: Regional employment growth used in rail demand forecasts – PFMv4.3

Region	% Growth in Employment from 2010	
	2026	2036
North East	4.1%	5.8%
North West	4.7%	6.2%
Yorkshire & Humberside	7.0%	12.3%
East Midlands	10.3%	12.0%
West Midlands	7.8%	12.6%
East of England	12.5%	16.0%
London	13.6%	17.5%
South East	8.7%	10.9%
South West	6.4%	8.5%
Wales	5.8%	15.5%
Scotland	6.3%	11.8%
Great Britain	8.5%	12.0%

Growth in GDP per capita

2.2.5 As with employment, the growth in GDP has been sourced from the Office for Budget Responsibility (OBR) March 2012 for short term forecasts and July 2012 for long-term forecasts)[7] using the ONS low migration variant numbers for population. Regional shares are based on CEBR (July 2012).

2.2.6 In 2011 ONS changed the way they calculate the GDP deflator from an arithmetic to a geometric mean. This means the GDP deflator now corresponds more closely to a CPI measure of inflation than 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 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 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% per annum; the real GDP growth forecasts have therefore been

[7] http://budgetresponsibility.org.uk/fiscal-sustainability-report-july-2012/

reduced by 0.2% per annum to ensure the growth rates are consistent with the elasticities that are applied to them[8]. The resulting growth is shown in table 2-3.

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 GDP growth used in rail demand forecasts – PFMv4.3

Region	Growth in GDP per capita from 2010	
	2026	2036
North East	21%	44%
North West	18%	42%
Yorkshire & Humber	20%	43%
East Midlands	21%	45%
West Midlands	21%	44%
East of England	24%	49%
London	23%	47%
South East	32%	58%
South West	26%	50%
Wales	20%	44%
Scotland	26%	51%
Great Britain	23%	47%

National Rail and Underground fares

2.2.10 All National Rail and London Underground fares are assumed to grow at a rate of RPI+1% for all forecast years with adjustments made to convert to financial years. Table 2-4 shows the cumulative growth from 2010 to 2026 and 2036.

Table 2-4: National rail fare growth used in rail demand forecasts – PFMv4.3

Region	Growth in Rail Fares from 2010	
	2026	2036
Great Britain	17%	28%

Car ownership

2.2.11 The change in car availability has been sourced from the National Trip End Model (NTEM) in TEMPRO version 6.2[9]. This provides forecasts for the number of

[8] This is described in paragraph 1.12.5 of WebTAG unit 3.5.6
[9] Refer to https://www.gov.uk/government/publications/tempro-introduction. Accessed 25 October 2013.

households with access to a car. Table 2-5 shows the growth in car owning households for key RIFF[10] zones within the HS2 corridor.

Table 2-5: Car ownership growth used in rail demand forecasts – PFMv4.3

Region	Growth in Car Owning Households from 2010	
	2026	2036
Central London	10%	15%
Central Manchester	6%	8%
Rest of Manchester	5%	7%
Central Birmingham	8%	12%
Rest of West Midlands	4%	5%
Leeds	7%	9%
Rest of West Yorkshire	5%	7%
Great Britain	1%	3%

Car journey times

2.2.12 The change in average car journey times used in the EDGE model has been sourced from the DfT's National Transport Model[11]. 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 – PFMv4.3

Region	Growth in Car Journey Times from 2010	
	2026	2036
Rest of GB to London	5%	10%

[10] RIFF Zones- These are groups of areas defined within the EDGE rail forecasting model used by the DfT.
[11] Refer to https://www.gov.uk/government/collections/transport-appraisal-and-modelling-tools. Accessed 25 October 2013.

Car fuel price

2.2.13 Growth in car fuel prices have been sourced from DfT fuel price forecasts based upon the November 2011 DECC oil price forecasts and March 2011 budget indirect tax assumptions as set out in WebTAG[12] and are shown in table 2-7.

Table 2-7: Car fuel price growth used in rail demand forecasts – PFMv4.3

Region	Growth in Car Fuel Price from 2010	
	2026	2036
Great Britain	22%	24%

Bus and coach fares

2.2.14 Bus and coach fares are assumed to grow at a rate of RPI+2% for all years between 2010 and 2036. This is based on examination by the DfT of past trends using data from the ONS and the DfT. The growth from 2010 is shown in table 2-8.

Table 2-8: Bus and coach fare growth used in rail demand forecasts – PFMv4.3

Region	Growth in Bus Costs from 2010	
	2026	2036
Great Britain	42%	77%

Bus and coach journey times

2.2.15 The forecast change in average bus and coach journey times has been sourced from the DfT's National Transport Model and is therefore consistent with the road journey times. The change from 2010 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 – PFMv4.3

Region	Growth in Bus and Coach Journey Times from 2010	
	2026	2036
Rest of GB to London	8%	16%

[12] These assumptions are described in WebTAG 3.5.6.

Bus and coach frequency

2.2.16 The forecast change in average bus and coach frequency13 has been sourced from DfT and based on an examination of past trends. The change from 2010 is shown in table 2-10.

Table 2-10: Bus and coach frequency growth used in rail demand forecasts – PFMv4.3

Region	Growth in Bus and Coach Frequency from 2010	
	2026	2036
Great Britain	6%	12%

Air fares

2.2.17 The forecast change in domestic air fares has been sourced from 2011 outputs of DfT's aviation model[14] as shown in table 2-11. The air fares that are used in the network element of PLD model are separately sourced as outlined in section 4.3.

Table 2-11: Air fares growth used in rail demand forecasts – PFMv4.3

Region	Growth in Air Fares from 2010	
	2026	2036
Great Britain	-4%	-4%

Air frequency

2.2.18 The forecast change in domestic air frequency has been sourced from 2011 outputs of DfT's aviation model[15] as shown in table 2-12.

Table 2-12: Air frequency growth used in rail demand forecasts – PFMv4.3

Region	Growth in Air Frequency from 2010	
	2026	2036
Rest of GB to London	-1%	-3%

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

Air passengers

2.2.19 The forecast change in domestic air passengers has been sourced from 2011 outputs of DfT's aviation model[16]. Table 2-13 shows forecasts growth from 2010 of air passengers by airport.

Table 2-13: Air passengers growth used in rail demand forecasts – PFMv4.3

Region	Growth in Air Passengers from 2010/11	
	2026	2036
Gatwick Airport	16%	23%
Heathrow Airport	23%	33%
Luton Airport	113%	139%
Stansted Airport	64%	88%
Birmingham Airport	147%	189%
Manchester Airport	52%	110%
Southampton Airport	126%	345%
Cardiff Airport	9%	42%

2.3 Rail demand forecasts

Cap year

2.3.1 The forecast years with PFMv4.3 are taken as:

- An opening year – assumed to be 2026; and
- A cap year – currently assumed to be 2036.

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 trips17. This represents an increase in rail trips over 100 miles of 79% from a 2010 base. With current growth assumptions this results with the cap year in PFMv4.3 occurring for all modes in 2036.

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

2.3.4 Using the above rail demand drivers the EDGE model produces rail growth forecasts for 2026 (taken as the opening year of the scheme) and 2036 the year in which the

[16] The Model is described in 'UK Aviation Forecasts, DfT, January 2013
[17] HS2 Ltd use the year which is the closest to this target. In PFMv4.3, the number of PLD trips greater than 100 miles in 2036 is 288,469.

demand cap is reached. The growth is summarised in Table 2-14: Input forecast PLD matrices – growth in rail demand by journey purpose – PFMv4.3.

Table 2-14: Input forecast PLD matrices – growth in rail demand by journey purpose – PFMv4.3

Journey Purpose	**Growth in Rail Demand from 2010/11** (Note this is the growth in PLD matrices only)	
	2026	**2036**
Commuting NCA	10%	19%
Commuting CA from	34%	61%
Commuting CA to	34%	61%
Business CA from	54%	90%
Business CA to	62%	101%
Leisure NCA	15%	28%
Leisure CA from	38%	68%
Leisure CA to	40%	71%
Total	35%	62%

*Note that 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 PFMv4.3 (2026 and 2036)

Regional Model	Journey Purpose	**Growth in Rail Demand from 2010/11** (Note this is the growth in Regional matrices only)	
		2026	**2036**
PLANET South (PS)	Commuting PA	49%	74%
	Commuting AP	46%	70%
	Business PA	51%	85%
	Business AP	49%	82%
	Leisure PA	54%	88%
	Leisure AP	47%	80%
	Total	**49%**	**76%**
PLANET Midlands (PM)	Commuting CA	37%	63%
	Commuting NCA	15%	29%
	Business CA	37%	62%
	Business NCA	20%	35%
	Leisure CA	38%	64%
	Leisure NCA	16%	31%
	Total	**34%**	**58%**
PLANET North (PN)	Commuting CA	33%	59%
	Commuting NCA	10%	22%
	Business CA	36%	66%
	Business NCA	12%	26%
	Leisure CA	38%	70%
	Leisure NCA	14%	29%
	Total	**30%**	**55%**

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

2.4 Highway demand forecasts

GDP

2.4.1 The highway demand forecasts were developed using factors derived from TEMPROv6.2. 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 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.

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	-0.5%	-0.9%	-0.8%
2036	-0.6%	-1%	-1%

Highway forecasts for long distance trips by purpose

2.4.4 Including the adjustment described above, Table 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 PFM4.3

	Growth in Highway Trips from 2010	
Journey Purpose	2026	2036
Commuting	9%	12%
Business	10%	15%
Leisure	14%	21%
Total	12%	18%

Highway forecasts for short distance trips

2.4.5 Short-distance trips and good vehicles 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 Agency TRADS database.

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)[18]. 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, 2026 and 2036) were derived using interpolation and extrapolation from Table 4.3 from Road Transport Forecasts[19] 2011 which is also shown below in Table. 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 only road types to be considered in the calculation of the growth factors are Motorway, Trunk and Principal.

[18] http://assets.dft.gov.uk/publications/road-transport-forecasts-2011/road-transport-forecasts-2011-results.pdf. Accessed 25 October 2013.
[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4243/road-transport-forecasts-2011-results.pdf. Accessed 25 October 2013.

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

Growth from 2010 to 2036	Motorway	Trunk	Principal	Other Roads	All Roads
Cars	43%	40%	35%	35%	37%
LGV	88%	88%	87%	88%	87%
HGV	45%	43%	40%	39%	43%
Bus & Coach	0%	-50%	-11%	-7%	-11%
Total	49%	46%	42%	42%	44%

Source: NTM 2011

2.5 Air demand forecasts

2.5.1 The *PLANET Framework Model (PFM v4.3) – Model Description* report provides a detailed description of the DfT Aviation Model and its components. The demand drivers such as GDP are consistent with those adopted for the rail forecasts. The resulting matrix growth used is shown Table 2-20.

Table 2-20: DfT Aviation Matrices – Growth in Domestic Air Passengers in PFMv4.3 (annual domestic trips)

	Growth in Domestic Air Passengers from 2010	
Journey Purpose	2026	2036
Business	39%	74%
Leisure	32%	63%
Total	36%	69%

Note: There is no Air Passenger Commuting Matrix in PFMv4.3.

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 source.

3.1.2 The economic appraisal uses outputs from the 'Do Minimum' and with HS2 scenarios run in PLD and the regional Planet models to produce a 60-year appraisal of the economic performance of the Phase One and Phase Two schemes.

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 Office of National Statistics (ONS) GDP deflator as a measure of inflation. The definition of this deflator has been changed from being more consistent with a Retail Price Index (RPI) to being more consistent with a Consumer Price Index (CPI) metric.

3.3 Appraisal period

3.3.1 In line with WebTAG guidance the appraisal period is 60 years.

3.3.2 The key assumptions used in the modelling and appraisal by PFMv4.3 are

- Phase One – Opening Year 2026
- Phase Two – Opening Year 2033
- First Forecast Modelled Year – 2026
- Second Forecast Modelled Year – 2036

3.4 Parameters

Within the PFMv4.3 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 PFMv4.3 model are given in Chapter 8.

Table 3-1: Generalised cost element weights for rail – PFMv4.3

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

3.4.1 The values of time in the appraisal are assumed to increase with income. The measure of income used is GDP per capita (as recommended by WebTAG Unit 3.5.6)[20].

3.4.2 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.

3.4.3 The precise inputs to the appraisal are OBR's UK GDP growth forecasts published in June 2012 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).

3.4.4 These inputs to the appraisal differ slightly from their use in the demand model which are based on mainland Great Britain, that is, excluding the Scottish Islands and Northern Ireland, 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 – PFMv4.3

Attribute	Growth from 2010	
	2026	2036
GDP, UK, GDP deflator	44%	83%
Population, UK (low migration variant)	10%	15%
GDP per person, UK	31%	60%

3.4.5 The values of time used in PFMv4.3 are based on forthcoming WEBTAG guidance[21] and are given in table 3-3.

[20] WebTAG TAG unit 3.5.6 Values of Time and Operating Costs
[21] WebTAG TAG unit 3.5.6 Values of Time and Operating Costs

Table 3-3: Values of time – PFMv4.3

Mode	Values of Time by Purpose (£/hr) PFMv4.3 Model (2010 prices)		
	Business	**Commute**	**Other**
Rail	£31.90 per hour	£6.81 per hour	£6.04 per hour
Car	£25.28 per hour	£6.81 per hour	£6.04 per hour

3.4.6 In line with forthcoming guidance (TAG 3.5.6) the values of working and non-working time are assumed to increase with income with an elasticity of 1.0.

Annualisation factors

3.4.7 PFMv4.3 provides outputs for an average weekday. In order to undertake an appraisal of the HS2 scheme 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.

3.4.8 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 – PFMv4.3 PLD

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

3.4.9 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 – PFMv4.3

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

3.4.10 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.

3.4.11 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, and 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. By 2036 this difference is 28%.

3.4.12 For the purpose of our modelling, all National and London Underground fares are assumed to grow at a rate of RPI+1% for all years between 2010 and the second modelled year. Within the appraisal there is no further real growth in fares for the remainder of the appraisal period beyond that point.

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

Table 3-6: Fares yield – PFMv4.3

Purpose	Fares £/pass km (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

3.4.14 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

Year After Opening	Year Phase One	Year Phase Two	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

3.4.15 In line with WebTAG Unit3.5.4 (August 2012)[22] a series of discount rates are applied from 2011. The annual discount rates assumed are:

- Until 2043: annual discount rate = 3.5%
- Between 2044 and 2088: annual discount rate = 3.0%
- Beyond 2089: annual discount rate = 2.5%

Highway factors used in the appraisal

3.4.16 Vehicle operating costs are derived using the approach outlined in WebTAG (Unit 3.5.6) [23]. Fuel consumption is estimated using the function:

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

Where

L= fuel consumption, expressed in litres per kilometres;

v= average speed in kilometres per hour; and

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

3.4.17 The vehicle operating cost parameters adopted within the HS2 appraisal are based on the parameters used by WebTAG (Unit 3.5.6)[24]. The appraisal uses an average speed of 50mph in all appraisal years.

3.4.18 In line with WebTAG3.9.5 (August 2012)[25] the benefits of road decongestion are assessed. The assumptions used to derive Highway External Costs have been sourced from WebTAG3.9.5 (August 2012). The values for 2026 and 2036 are presented in table 3-8. These have been derived by interpolation of the values quoted in TAG3.9.5.

[22] WebTAG TAG unit 3.5.4 Cost Benefit Analysis August 2012.
[23] WebTAG TAG unit 3.5.6 Values of Time and Operating Costs.
[24] WebTAG TAG unit 3.5.6 Values of Time and Operating Costs.
[25] WebTAG TAG unit 3.9.5 MSA-Decongestion Benefits August 2012.

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

Element	Pence/ car km (2010)			Pence/ car km (2026)			Pence/ car km (2036)		
	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads	Motorways	A roads	Other Roads
Congestion (London)	0.1	69.2	48.4	1.2	149.9	80.4	3.2	221.1	108.5
Congestion (Conurbations)	2.9	35.2	24.5	6.0	60.2	45.3	11.4	88.0	64.5
Congestion (Other Urban)	n/a	13.6	11.2	n/a	24.4	16.9	n/a	34.8	21.6
Congestion (Rural)	1.1	2.3	2.8	4.1	4.3	6.1	10.6	6.4	8.6
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	4.7	4.7
Accident (Conurbations)	0.0	3.0	3.0	0.0	3.9	3.9	0.0	4.7	4.7
Accident (Other Urban)	n/a	3.0	3.0	n/a	3.9	3.9	n/a	4.7	4.7
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	0.1	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	1.3	1.5
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	0.8	0.8	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	-3.5	-4.1	-5.0
Indirect Taxation (Conurbations)	-5.2	-5.2	-5.7	-3.7	-3.9	-4.4	-3.4	-3.6	-3.9
Indirect Taxation (Other Urban)	n/a	-4.8	-5.4	n/a	-3.6	-4.0	n/a	-3.3	-3.7
Indirect Taxation (Rural)	-5.3	-4.8	-4.7	-3.8	-3.5	-3.5	-3.4	-3.2	-3.2

4 Network changes – air and highway

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. This chapter outlines the assumptions made for the forecast air and highway networks. Chapters 5 and 6 outline the assumptions related to the rail networks.

4.2 DM and DS highway network

4.2.1 For PFMv4.3 no additional highway schemes were added between 2026 and 2036, hence the 2026 and 2036 (cap year) networks were 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 PFMv4.3 model are listed in table 4-1.

Table 4-1: Highway Schemes in PFMv4.3- 2026 and 2036

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 HSR	M25 Junctions 23-27 Managed Motorways
M6 J4-5 HSR	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
M4 Junction 3-2 Bus Lane Suspension Scheme	M3 Junctions 2-4a Managed Motorway

Scheme Assumed	
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 DM and DS air networks

4.3.1 The air passenger supply in PFM represents domestic air services wholly within mainland Britain, thus excludes services to Northern Ireland, the Channel Islands, Isle of Man and Scottish Islands. Within PFMv4.3 the networks for all years were taken directly from the DfT Aviation Model.

4.3.2 Table 4-2 shows the changes in routes between the various forecast years used in PFMv4.3.

Table 4-2: Air Network Changes in PFMv4.3

2026 Routes added relative to 2010	**2026 Routes removed relative to 2010**
Aberdeen – London City	Aberdeen – Gatwick
Luton – Manchester	Aberdeen – Luton
Newquay – Leeds Bradford*	Edinburgh – Gatwick*
Newquay – Manchester*	Gatwick – Manchester
	Glasgow – Luton
	Glasgow – Stansted
	London City – Edinburgh*
	Prestwick – Stansted
2036 Routes added relative to 2026	**2036 Routes removed relative to 2026**
Edinburgh – Gatwick*	Edinburgh – Stansted*
Edinburgh – Inverness	Gatwick – Glasgow
Exeter – Aberdeen*	Glasgow – Leeds Bradford
Glasgow – Stansted*	Inverness – Luton
Inverness – London City	Newquay – Manchester*
Leeds Bradford – Prestwick	Southampton – Glasgow*
Norwich – Exeter*	
Norwich – Newquay*	

Note: * = route operates one way

Air fares

4.3.3 The networks in PFMv4.3 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 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 fares is shown in table 4-3.

Table 4-3: Real Fare Index Factors – Air Fares

Purpose	Growth in Rail Fares from 2008		
	2010	2026	2036
Business	2%	0%	0%
Leisure	6%	0%	0%

5 'Do Minimum' rail network

5.1 Background

5.1.1 The rail networks within PFMv4.3 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 committed schemes only. The 'Do Minimum' makes use of information provided by the DfT for Network Rail services 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 and 2036 (cap year models).

5.1.3 **These assumptions are designed only for the purpose of providing an indicative reference case for the appraisal of HS2. It should be noted that 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 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 PLD for the strategic Train Operating Companies are given in this chapter.

Chiltern Railway

5.1.6 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.

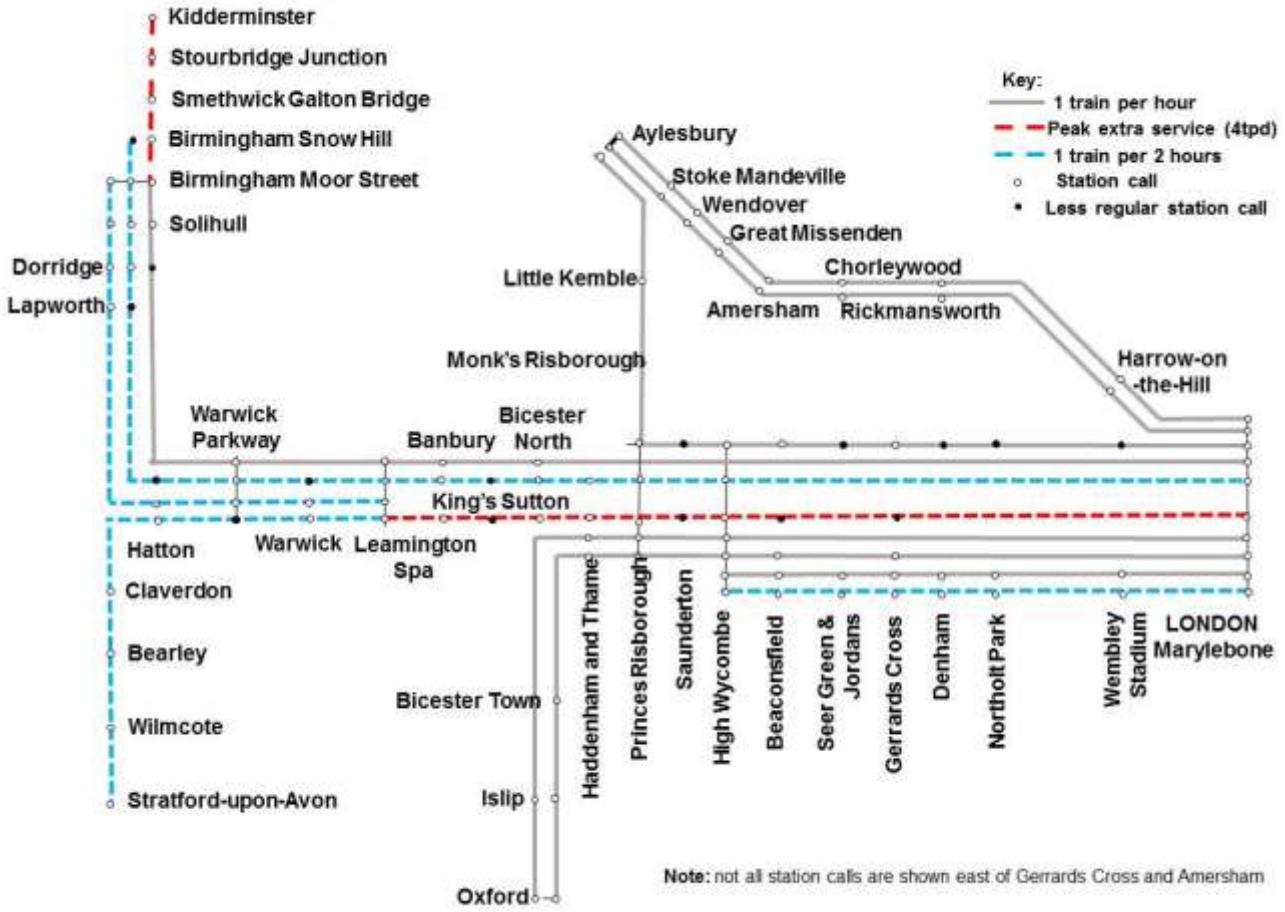
5.1.7 The key changes arising in the service specification between 2010 and 2026 are:

- An additional two trains per day each way operating from London Marylebone to Aylesbury (via Denham);
- Diversion of services between Banbury and London Marylebone to instead start from Oxford due to Evergreen 3 (Banbury continues to be served by Birmingham services to London Marylebone and a Birmingham to London Paddington service);
- Revision of services between Bicester North and London Marylebone (Bicester North continues to be served by Birmingham services and the introduction of Oxford services provides trains stopping at Bicester Town);
- The introduction of services between Birmingham Moor Street and Leamington Spa; and

- The introduction of services between London Marylebone and Oxford (Evergreen 3).

5.1.8 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 PFMv4.3 – 'Do Minimum'



Cross Country

5.1.9 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).

5.1.10 There are small changes in the future year 'Do Minimum' timetable from the modelled base year with the notable exception being the addition of an hourly service between Manchester and Birmingham International which 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.

5.1.11 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 PFMv4.3 – 'Do Minimum'

East Coast Main Line

5.1.12 The future year 'Do Minimum' timetable uses the Phase 2 timetable assumed in the DfT's Intercity Express Programme (IEP) business case modelling. This timetable, which is illustrative of what could be feasible under IEP Phase 2, includes IEP electric and bi-mode trains (5 and 9 car formations) displacing and supplementing the existing class 91/MK IV and HST fleet and assumes a three trains per hour service all day to Newcastle and Leeds from London Kings Cross. The key features of the specification assumed in PFMv4.3 are:

- Additional trains operating between London Kings Cross and Edinburgh

Waverley (an additional 13 services southbound and 15 services northbound per day);

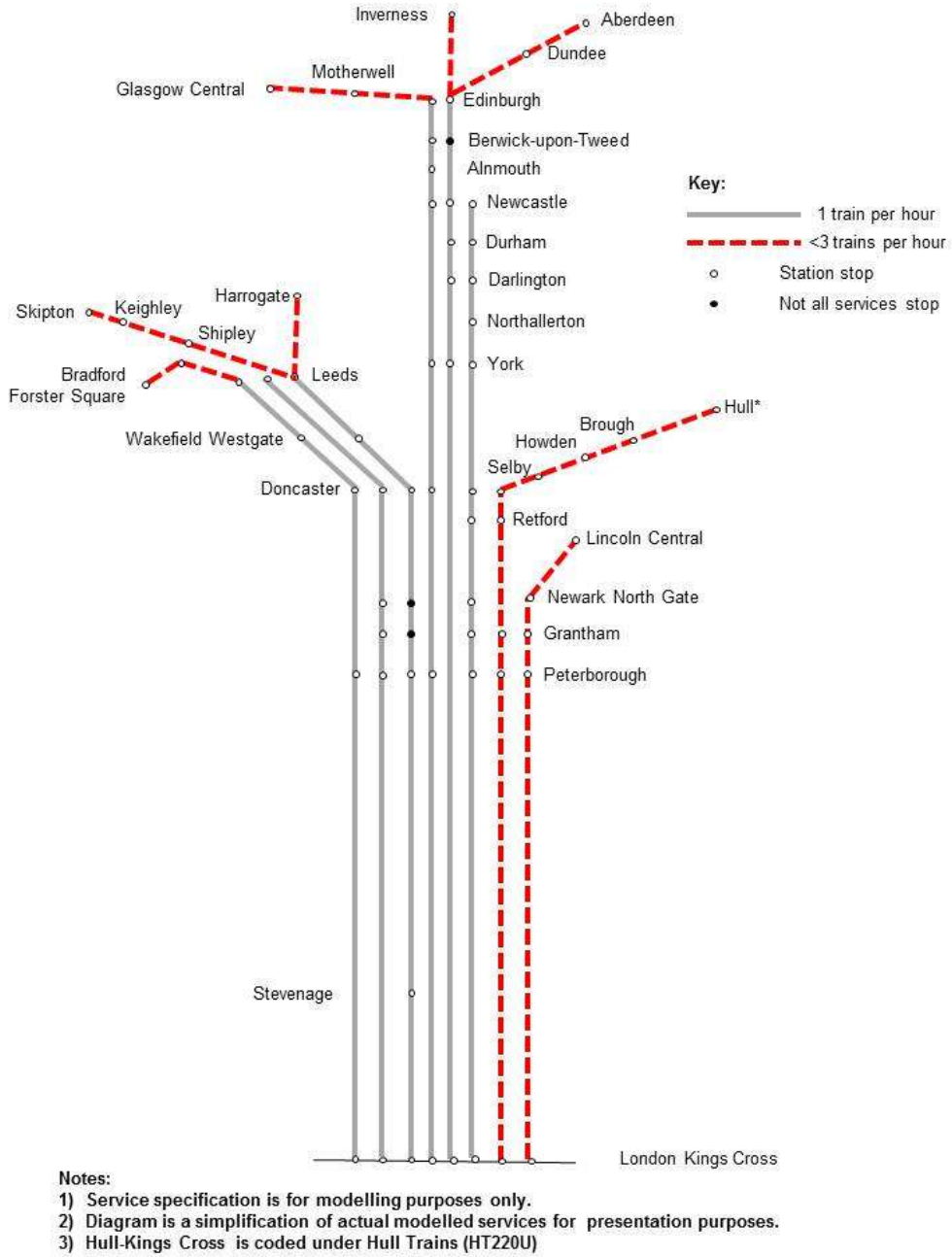
- Reduction of services operating each way between Glasgow Central and London Kings Cross;
- Additional trains operating between London Kings Cross and Leeds (14 additional trains each way per day); and
- Additional trains operating between London Kings Cross and Newcastle (4 additional trains each way per day).

5.1.13 Bi-mode IEPs trains are assumed to run on services to non-electrified destinations in Yorkshire and north of Edinburgh as per the current timetable though with some potential journey time benefits.

5.1.14 The PFMv4.3 'Do Minimum' specification journey time reductions of 15 minutes and 9 minutes between London Kings Cross to Edinburgh and Leeds respectively.

5.1.15 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 PFMv4.3 – 'Do Minimum'



Great Western

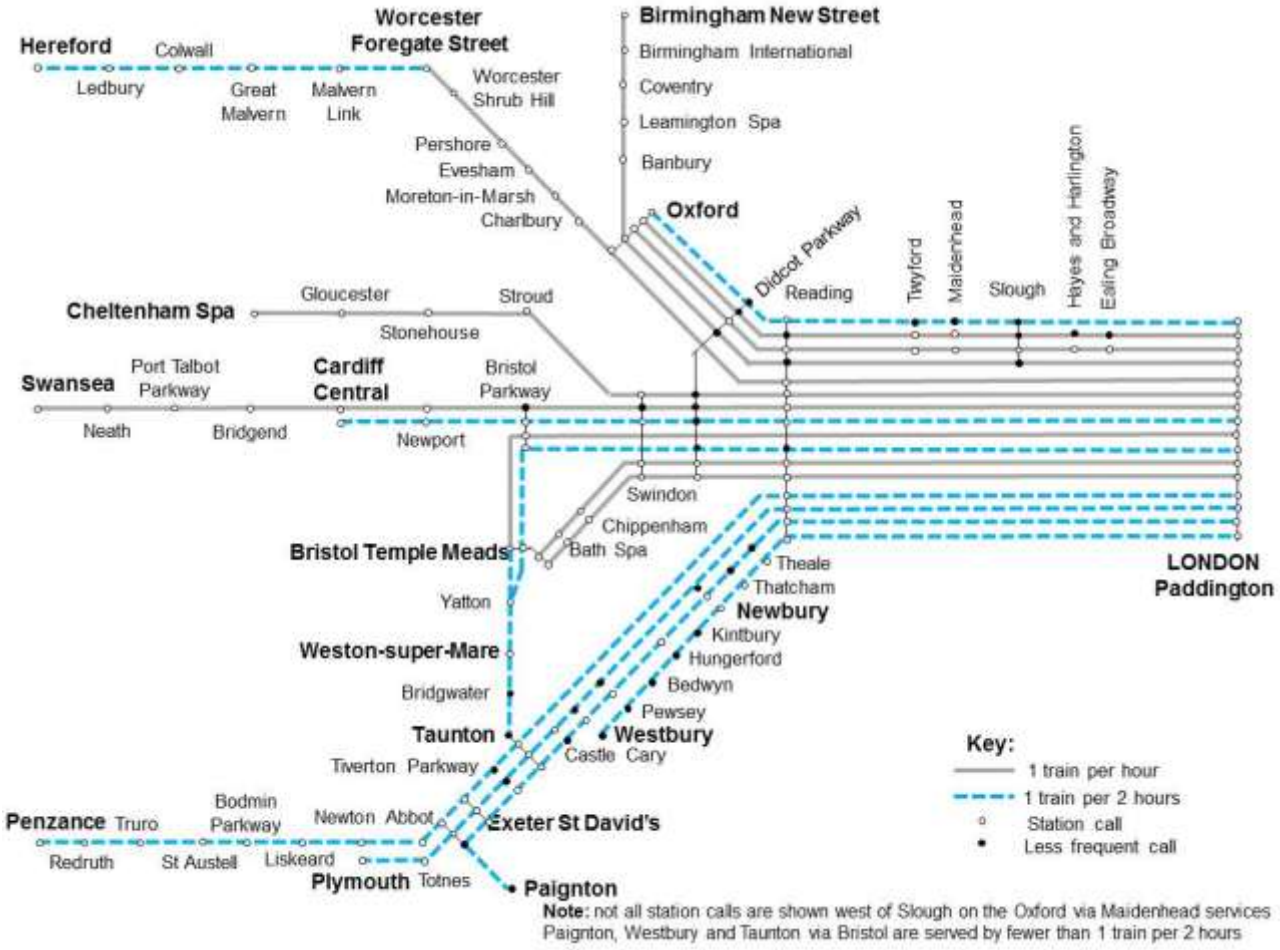
5.1.16 The key points of the specification assumed for PFMv4.3 are:

- 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.

5.1.17 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 PFMv4.3 – 'Do Minimum'



London Midland (LM)

5.1.18 The London Midland future year 'Do Minimum' timetable allows for 110mph running on the fast lines, and therefore provides some improvements to journey times. Three of the LM trains in each 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. However, the Watford Junction call is omitted from the Crewe services, resulting in some loss of direct-train connectivity to/from Watford Junction.

5.1.19 The timetable includes the additional path created by the future year West Coast timetable, with a consequent increase in service frequency between London Euston and Northampton. There is also some train lengthening assumed in the future year timetable.

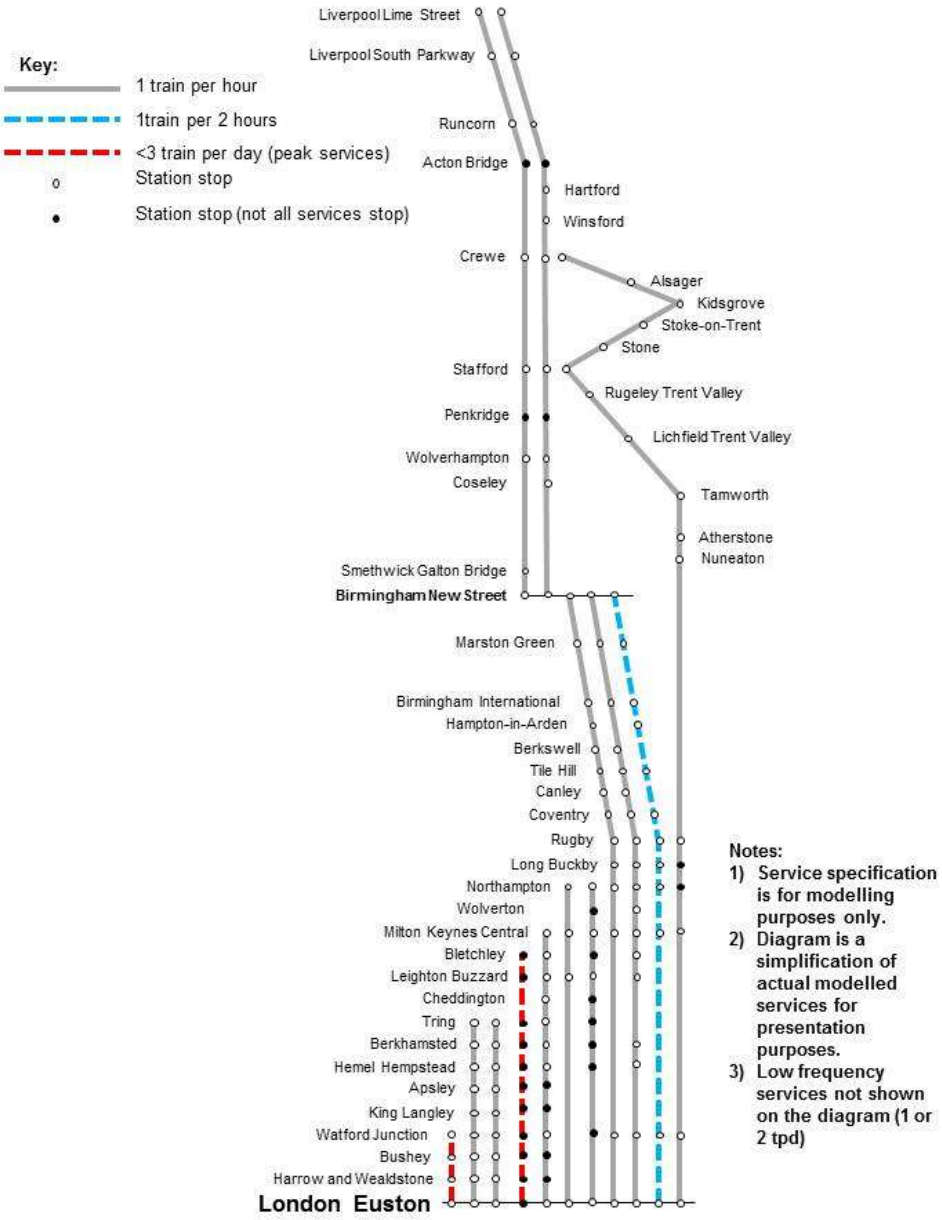
5.1.20 The key points of the specification are:

- The introduction of additional trains between Birmingham New Street and London Euston; and

- The introduction of additional trains between Northampton and London Euston.

5.1.21 Figure 5-5 shows a summary of the service and stopping pattern assumed in the PFM4.3 'Do Minimum' for London Midland services.

Figure 5-5: London Midland – Average Service Pattern used in PFMv4.3 – 'Do Minimum'



East Midland

5.1.22 The future year 'Do Minimum' PFMv4.3 timetable assumes electrification takes place, with appropriate shortening of the handful of services that currently originate (or terminate) on non-electrified routes (Leeds, Lincoln and York). The post-electrification timetable includes the following:

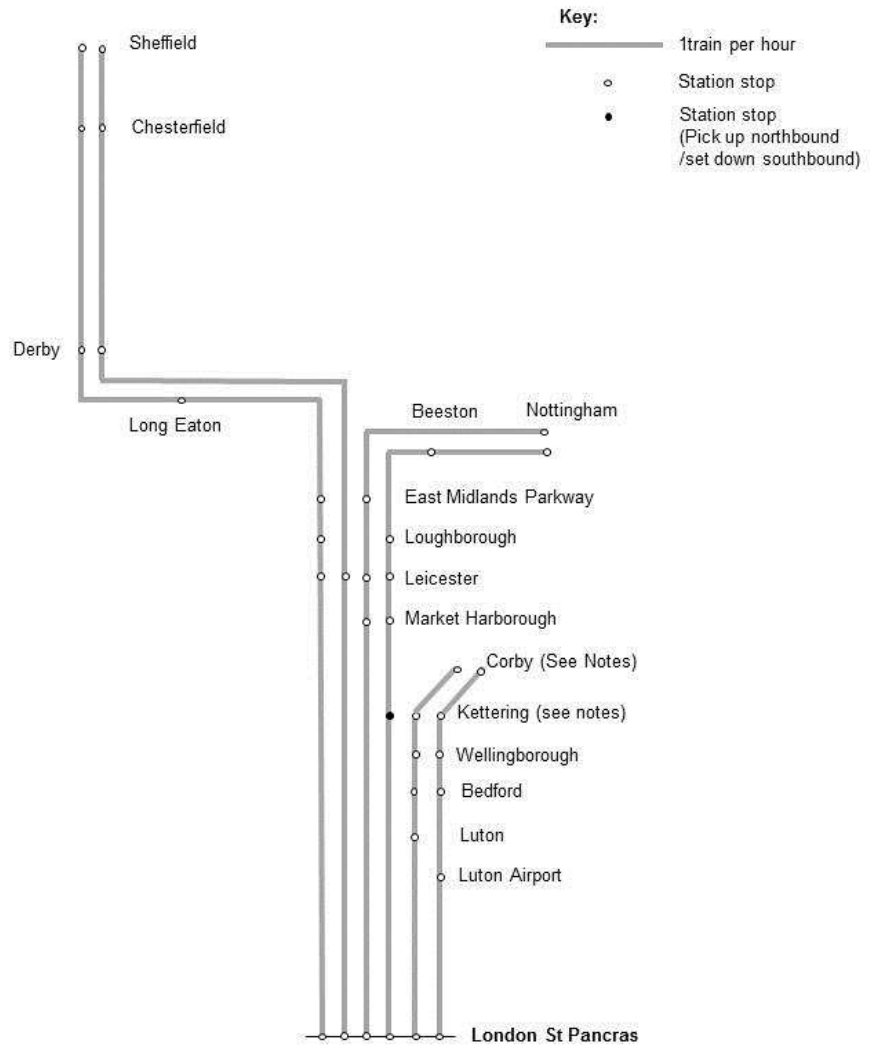
- two trains per hour between Corby and London St Pancras;
- two trains per hour between Nottingham and London St Pancras; and
- two trains per hour between Sheffield and London St Pancras.

5.1.23 The timetable assumes all services into London St Pancras operate using electric stock with a mixture of formations, which results in an increase in capacity. Furthermore, the longer distance services stop less frequently, with related journey time benefits.

5.1.24 The PFMv4.3 specification assumes substantial journey time improvements along the Midland Mainline, with reductions in journey time of 10 to 20 minutes.

5.1.25 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 PFMv4.3 – 'Do Minimum'



Notes:
1) Service specification is for modelling purposes only.
2) Diagram is a simplification of actual modelled services for presentation purposes.
3) Services to/from Corby are coded to/from Kettering, as Corby is not a station that is modelled in PLD.

West Coast Main Line

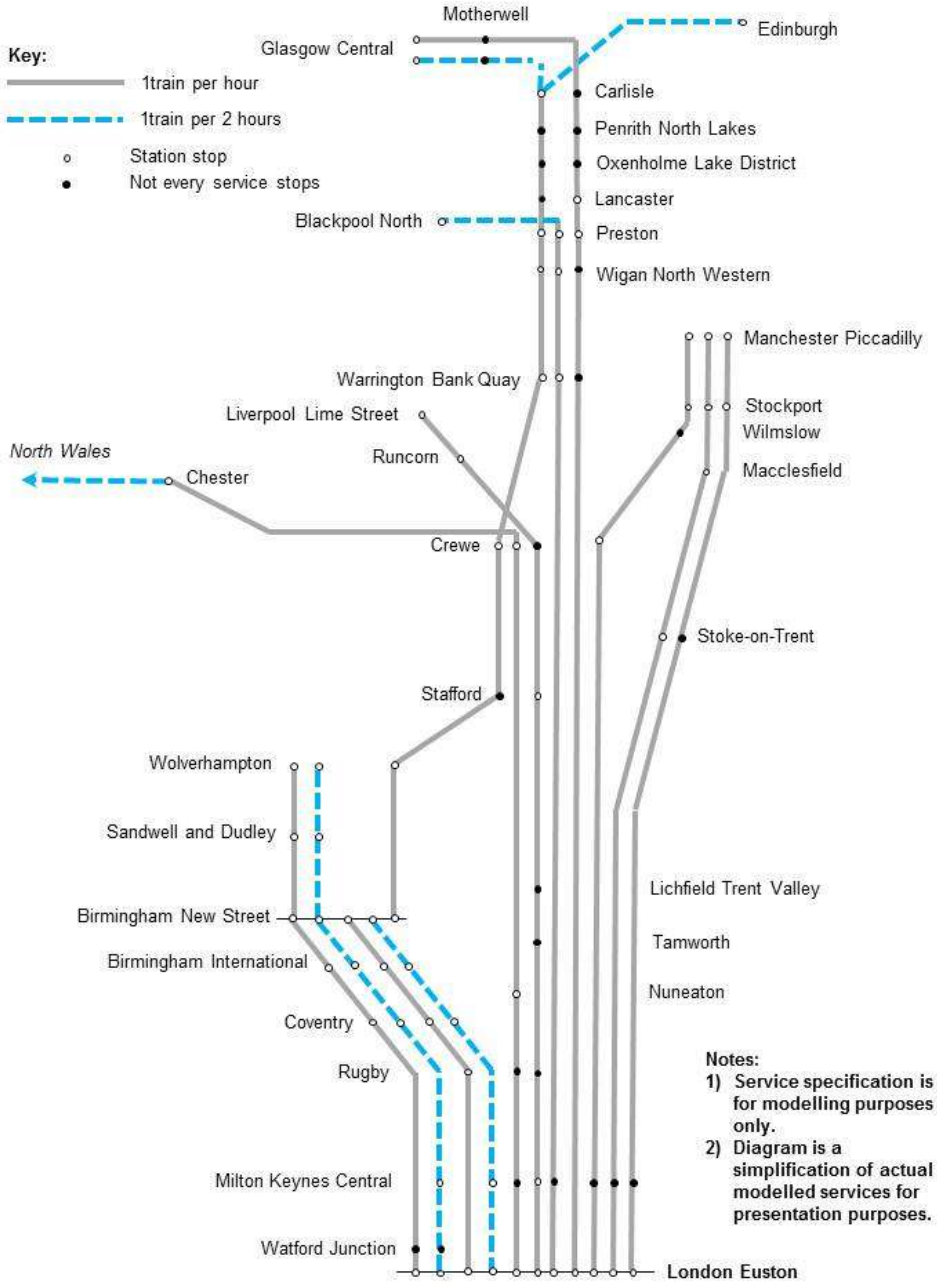
5.1.26 An indicative future year 'Do Minimum' timetable was prepared by DfT which utilises the remaining spare capacity on the southern half of the West Coast Main Line. In each off-peak, contra-peak and most shoulder peak hours there are two additional arrivals and departures at London Euston. One of these paths is allocated to London Midland and another to Inter City West Coast (ICWC).

5.1.27 It is assumed the additional ICWC path provides a new train in each hour to Preston, making the London Euston-Preston service half-hourly all day, with one extension to/from Blackpool North every two hours. The hourly Warrington and Wigan stops are transferred from the Glasgow services to the new trains, enabling London Euston-Glasgow services to be accelerated.

5.1.28 An all-electric fleet is assumed, with electric trains being loco-hauled (with new diesel locomotives capable of rapid coupling/uncoupling manoeuvres) on non-electrified routes. Most routes are assumed to use a mix of nine-car and eleven-car units, with the Birmingham to Scotland route using new-build six-car units.

5.1.29 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 PFMv4.3 – 'Do Minimum'



TransPennine

5.1.30 The indicative Northern Hub timetable was prepared by DfT for PFMv4.3 modelling purposes only. It includes timetable changes resulting from:

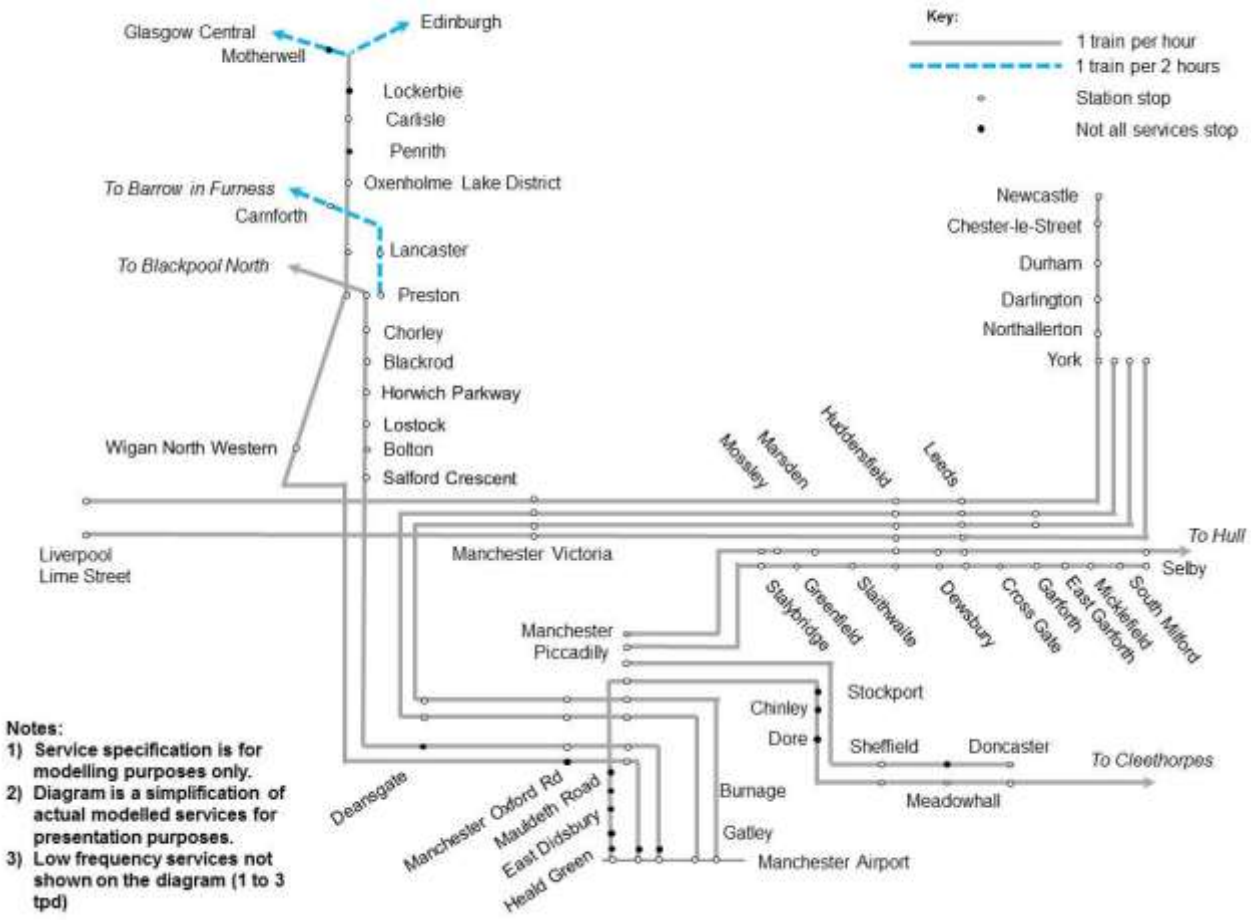
- Increased capacity between Liverpool and Manchester (via Chat Moss);
- A fourth platform at Manchester Airport;
- Increased capacity on the Castlefield corridor and additional through platforms at Manchester Piccadilly;
- Ordsall Chord enabling services to run direct between Manchester Piccadilly and Manchester Victoria stations;
- A new turn-back facility at Rochdale;
- Increased capacity on the Hope Valley Line between Sheffield and Manchester; and
- Line speed improvements on routes between Liverpool and Leeds, Manchester and Blackpool North, Manchester and Bradford, and Manchester and Sheffield.

5.1.31 On the North TransPennine route the future year timetable assumes the following services through the Manchester – Leeds core:

- two trains per hour between Liverpool – York/Newcastle, both routed via Manchester Victoria;
- two trains per hour between Manchester Airport – York;
- one train per hour between Chester – Hull;
- two trains per hour between Manchester Piccadilly – Leeds (all stations Stalybridge to Huddersfield);
- one train per hour between Huddersfield – Leeds (all stations); and
- one train per hour between Manchester Victoria – Calder Valley Route – Brighouse – Leeds).

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

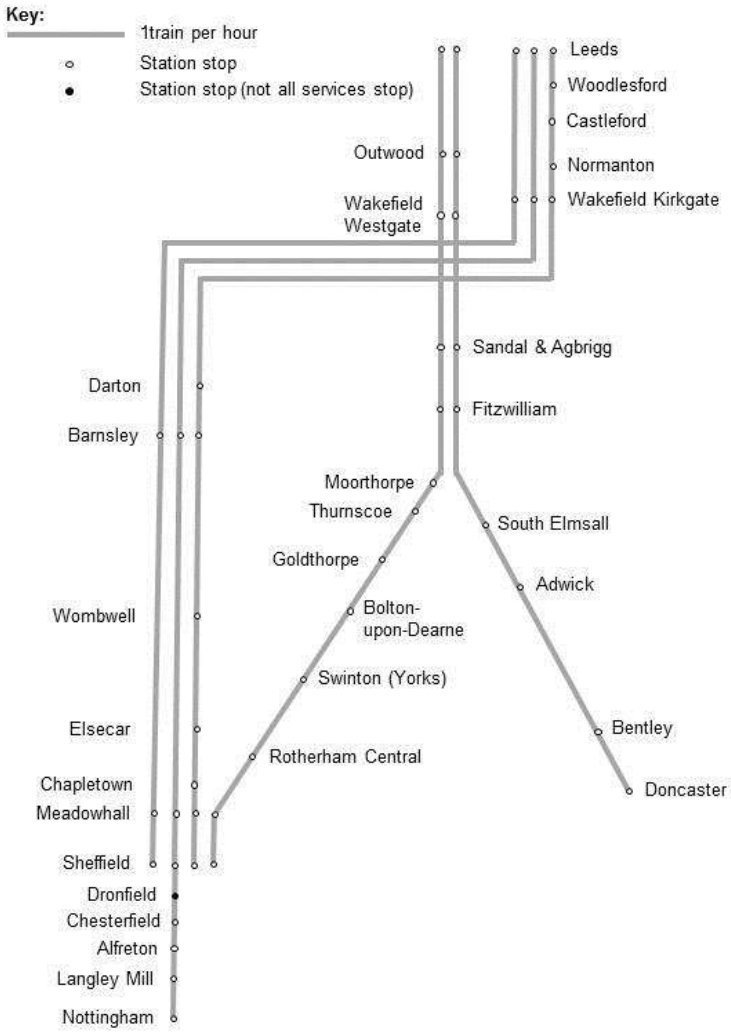
Figure 5-8: TransPennine – Average Service Pattern used in PFMv4.3 – 'Do Minimum'



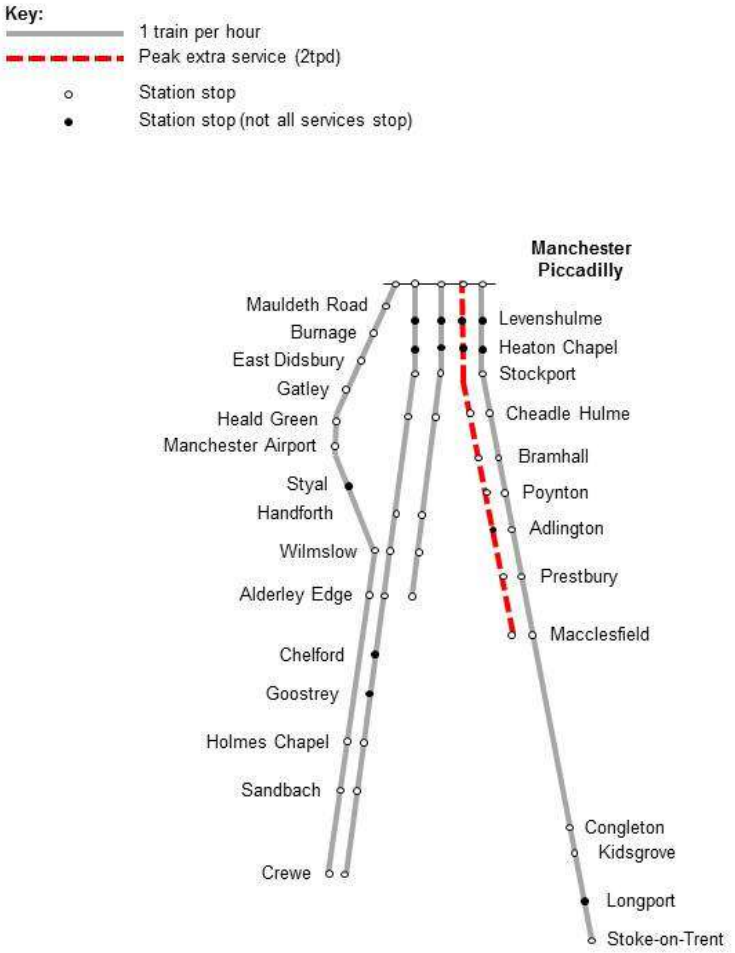
Northern Trains

5.1.33 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 PFMv4.3 – 'Do Minimum'



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



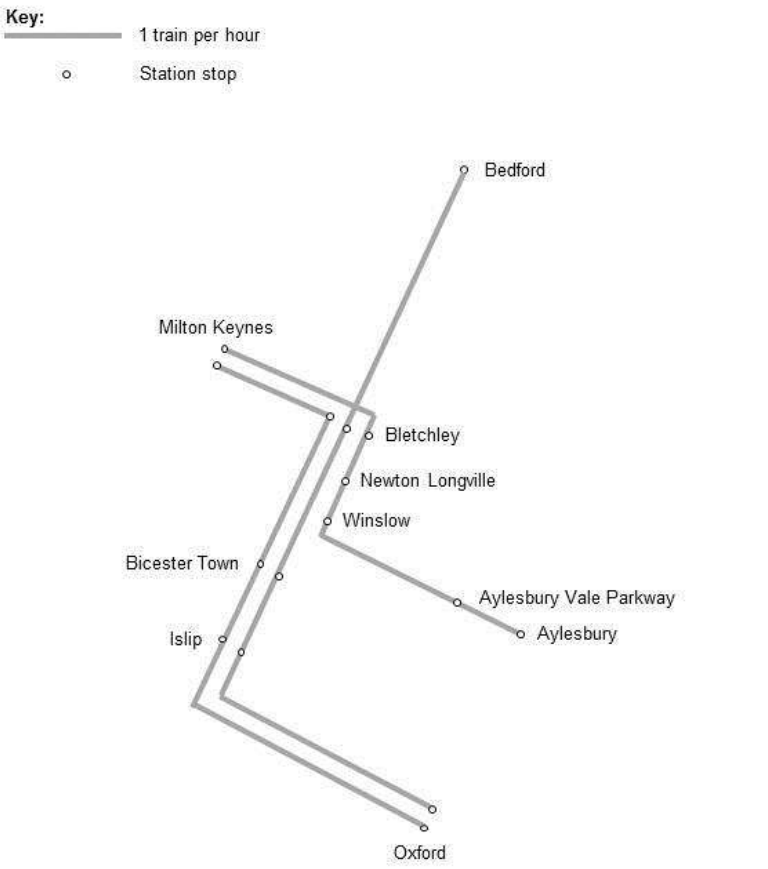
Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

East-West Rail

5.1.34 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 PFMv4.3 – 'Do Minimum'



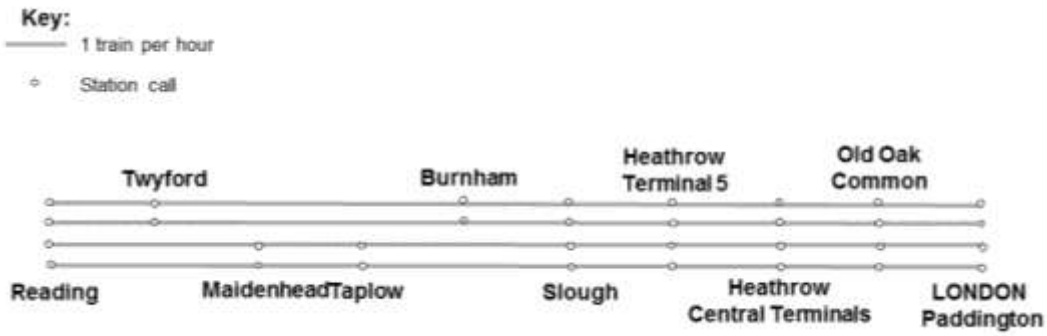
Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**

Other services

5.1.35 Crossrail services are assumed in the PFMv4.3 forecasts based upon the late 2012 view of likely service patterns supplied by the DfT operating between Maidenhead, Shenfield and Abbey Wood.

5.1.36 A Western access to London Heathrow has been included within PFM4.3. The Heathrow Express service pattern is assumed to utilise this. 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 PFMv4.3 – 'Do Minimum'



London Underground transit line data

5.1.37 In addition to updating National Rail services the PFMv4.3 rail network also included updating both the base year and forecast year LUL network and services. TfL supplied LUL transit line data extracted from TFL's Railplan model which was combined with vehicle type data extracted from Railplan.

National Rail update – rolling stock

5.1.38 PFM holds only a selection of rolling stock types as defined vehicles within the model. These are generally units that are used for strategic services that are generally not combined with other units. The assumptions used are shown in table 5-1 and have been sourced from the DfT MOIRA model.

5.1.39 To allow for combinations of units to be modelled, for example, a two-car unit joined to a three-car unit, or to allow for changes in type of units during a modelled period, bespoke capacities can be input on the transit line as user defined transit line attributes. These are attributed vehicle type 888 within the model.

Table 5-1: Rolling Stock Capacity Assumed in PFMv4.3

Rolling stock type	Seated capacity	Total capacity
Class 91 9-car	477	747
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 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

Rolling stock type	Seated capacity	Total capacity
Class 222 4-car	190	310
Class 222 5-car	252	410
Class 222 7-car	343	520
Class 319 3-car	217	294
Class 319 4-car	289	392
Class 350 4-car	226	396
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 6-car	335	518
Class 390 9-car	440	715
Class 390 11-car	597	933
HST 5-car	271	436
HST 6-car	325	523
HST 8-car	446	658
IEP 03E15	313	465
IEP 07E18	539	814
IEP 14Bi5	313	465
IEP 14Bi5 x2	627	916
IEP T16	626	930
57 9-car	539	814

6 'Do Something' rail changes

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 fully integrate HS2 services 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 PFMv4.3 model the impacts of these are combined.

6.2 HS2 service patterns

Phase One

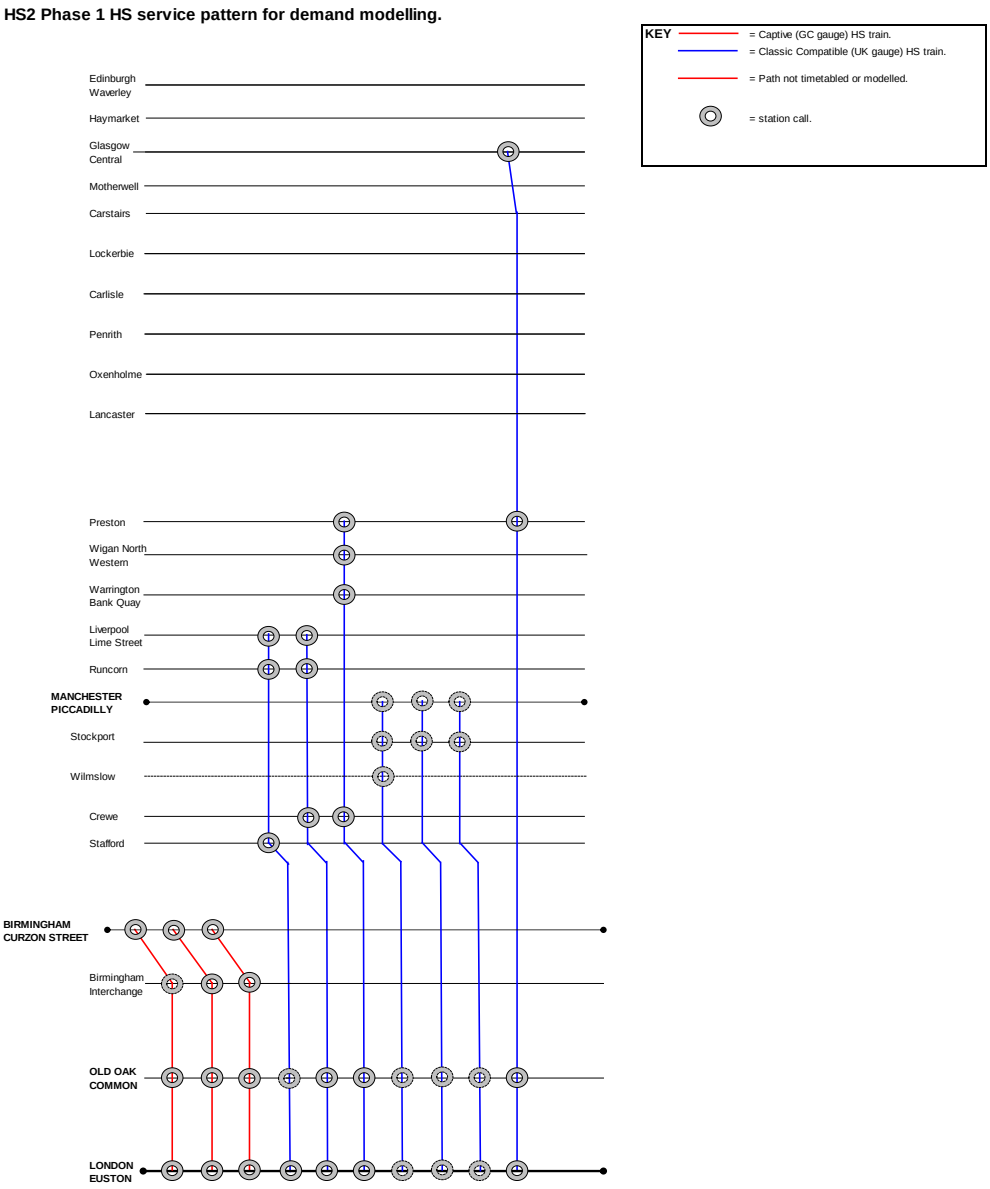
6.2.1 There are four stations assumed on the Phase One route; Birmingham Curzon Street, Birmingham Interchange, Old Oak Common and London Euston. Phase One would also include a link to HS1 north of Euston and St Pancras.

6.2.2 The Phase One service pattern is shown in Figure 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)

Figure 6-1: HS2 Service Pattern used in PFMv4.3 – Phase One



6.3 Phase Two and the full network

6.3.1 Since the August 2012 Economic Update, plans for the full network have been developed considerably. A consultation of the preferred route for Phase Two was launched on 17 July 2013. Phase One and Phase Two together will form the full Hs2 network, which is the extent of the high-speed network that is currently being considered.

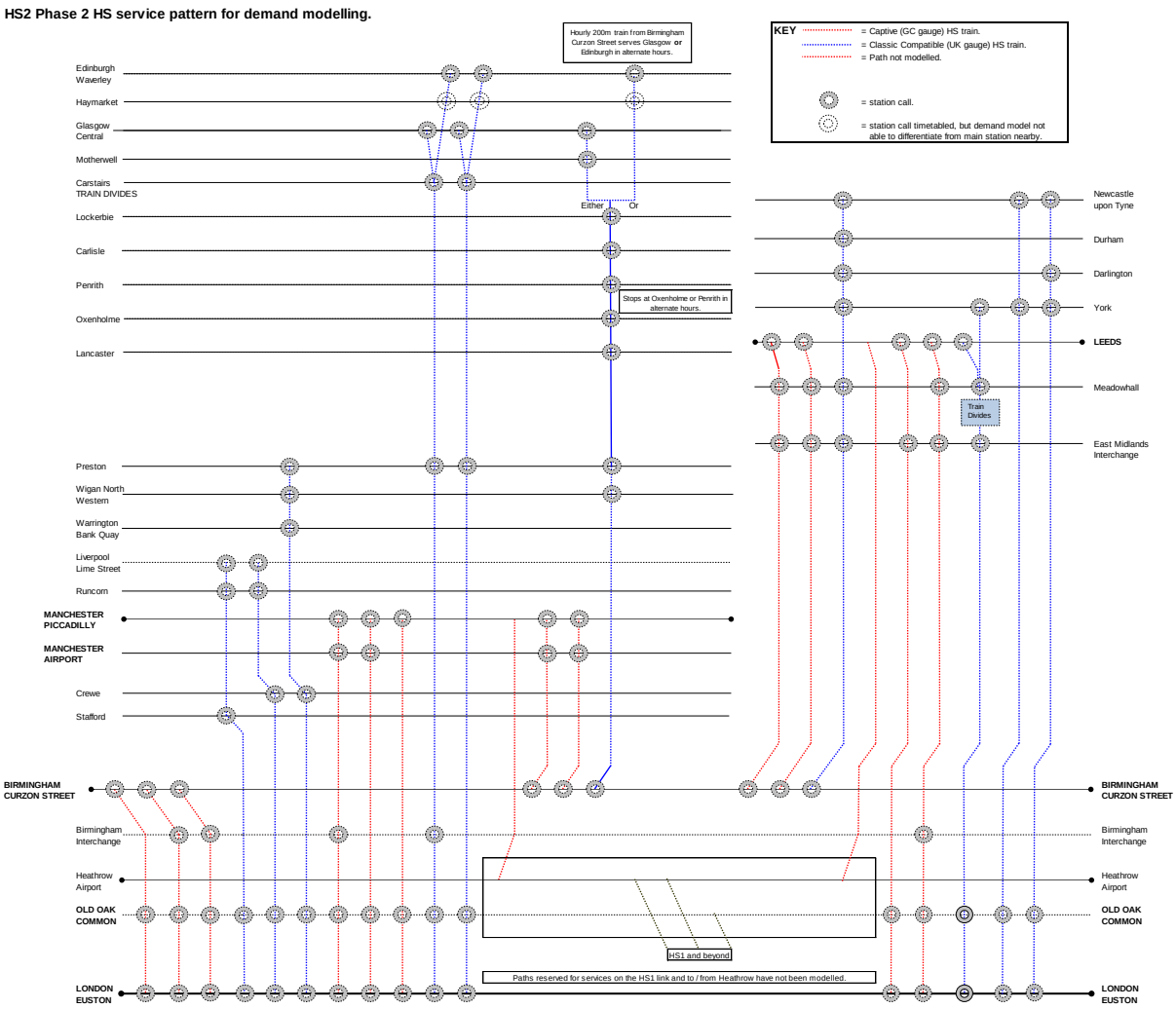
6.3.2 A decision on the Government's preferred route for Phase Two is expected by the end of 2014. Within PFMv4.3 we have assumed the proposed route that was released for public consultation on 17 July 2013.

6.3.3 The Phase Two service pattern is shown in figure 6-2 and comprises:

- HS2 services:
  - London Euston to Birmingham Curzon Street (three trains per hour);
  - London Euston to Manchester Piccadilly (three trains per hour);
  - London Euston to Leeds (three trains per hour*);
  - Birmingham Curzon Street to Manchester Piccadilly (two trains per hour); and
  - Birmingham Curzon Street to Leeds (two trains per hour);
- 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 (two trains per hour);
  - London Euston to Preston (one train per hour);
  - London Euston to Glasgow Central/ Edinburgh Waverley (two trains per hour);
  - Birmingham Curzon Street to Glasgow Central/ Edinburgh Waverley (one train per hour);
  - Birmingham Curzon Street to Newcastle (one train per hour);
  - London Euston to Leeds/ York (one train per hour*); and
  - London Euston to Newcastle (two trains per hour).
  - Note*: One of the Leeds trains and the York train combine/split at Meadowhall

6.3.4 The specification in PFMv4.3 has removed the services to Heathrow, but retained the two paths for future use to reflect that consideration of the Heathrow spur is currently paused, while the Airports Commission conducts its review

Figure 6-2: HS2 Service Pattern used in PFMv4.3 – Phase Two



6.4 Released capacity

6.4.1 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.

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

6.4.3 Assumptions about released capacity have been included within the PFMv4.3 modelling. There are many other potential combinations of released capacity. The assumptions in PFMv4.3 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**.

6.4.4 The released capacity specification varies between Phase One and Phase Two of HS2. The train operating companies (TOCs) where services are modified as a result of the introduction of HS2 in Phase One and Phase Two are summarised in table 6-1.

Table 6-1: TOCs Impacted by Released Capacity Specification

Train Operating Company	Phase One	Phase Two
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

6.4.5 A summary of services and stopping patterns for the West Coast is included in figure 6-3 for Phase One.

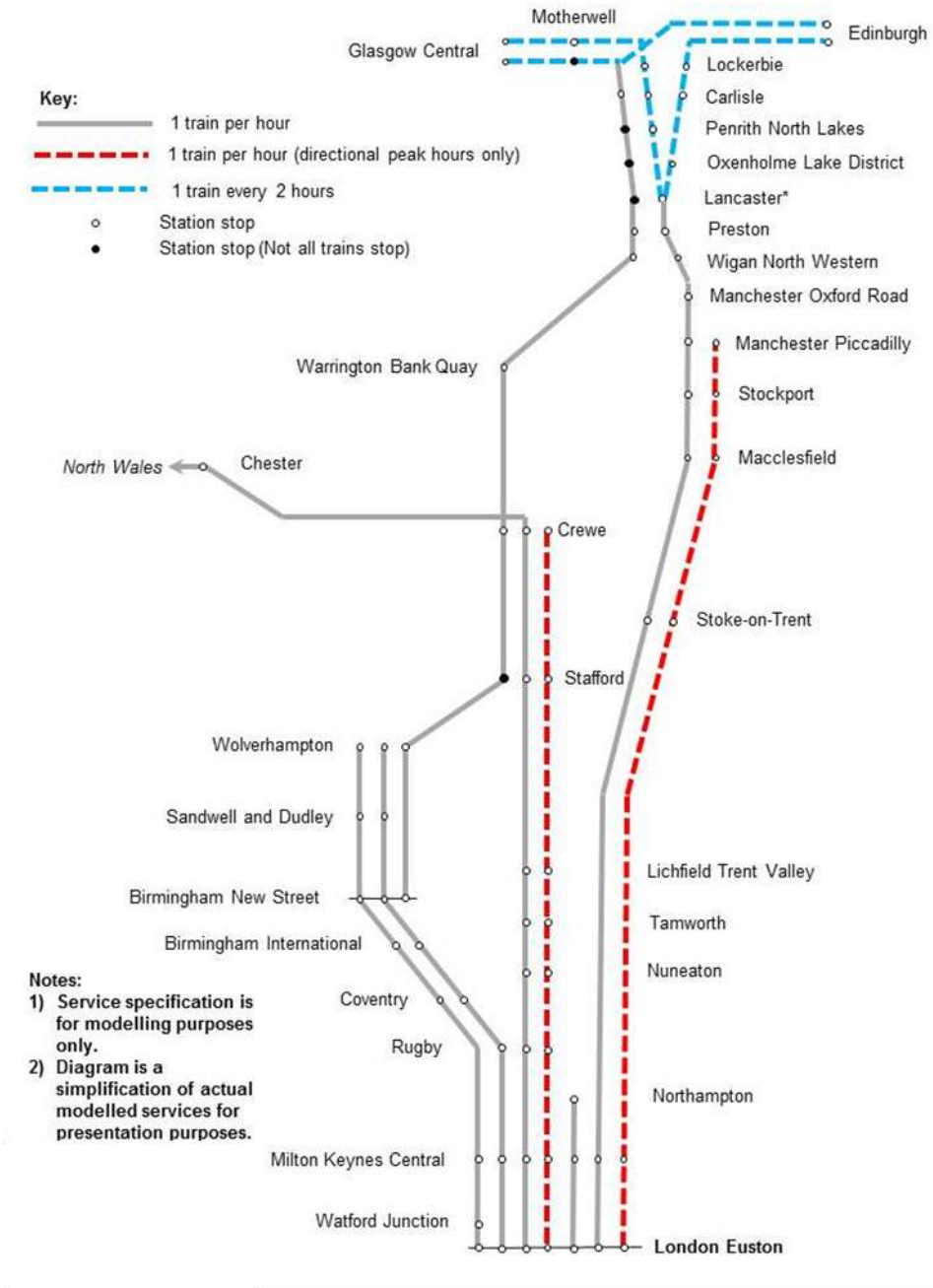
6.4.6 The service pattern for Phase Two is shown on figure 6-4.

6.4.7 The Phase One and Phase Two timetable assumes the following services to/from London Euston:

- two trains per hour to Wolverhampton;
- one train per hour to North Wales;
- one train per peak hour in the peak direction to Crewe;
- one train per hour to Northampton;
- one train per hour to Scotland via Manchester (alternating between Glasgow and Edinburgh); and

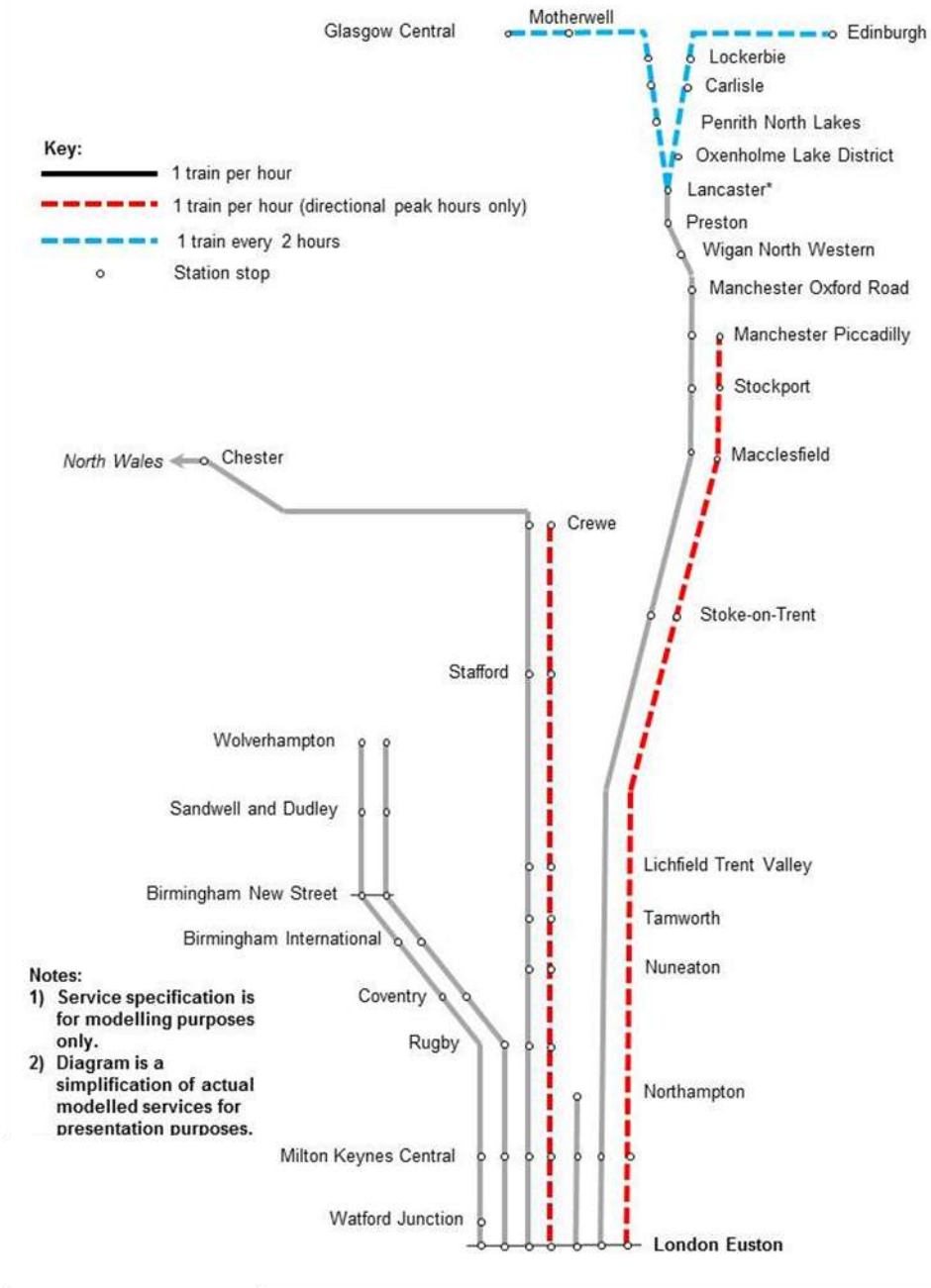
- one train per peak hour in the peak direction to Manchester.

Figure 6-3: West Coast Long Distance Services assumed in PFMv4.3 – Phase One



6.4.8 In addition, in the Phase One specification, there is an hourly service from Birmingham to Scotland (alternating between Glasgow and Edinburgh) in the phase Two specification this service only runs to Preston, as shown in Figure 6.4 below

Figure 6-4: West Coast Long Distance Services assumed in PFMv4.3 – Phase Two



East Coast Main Line

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

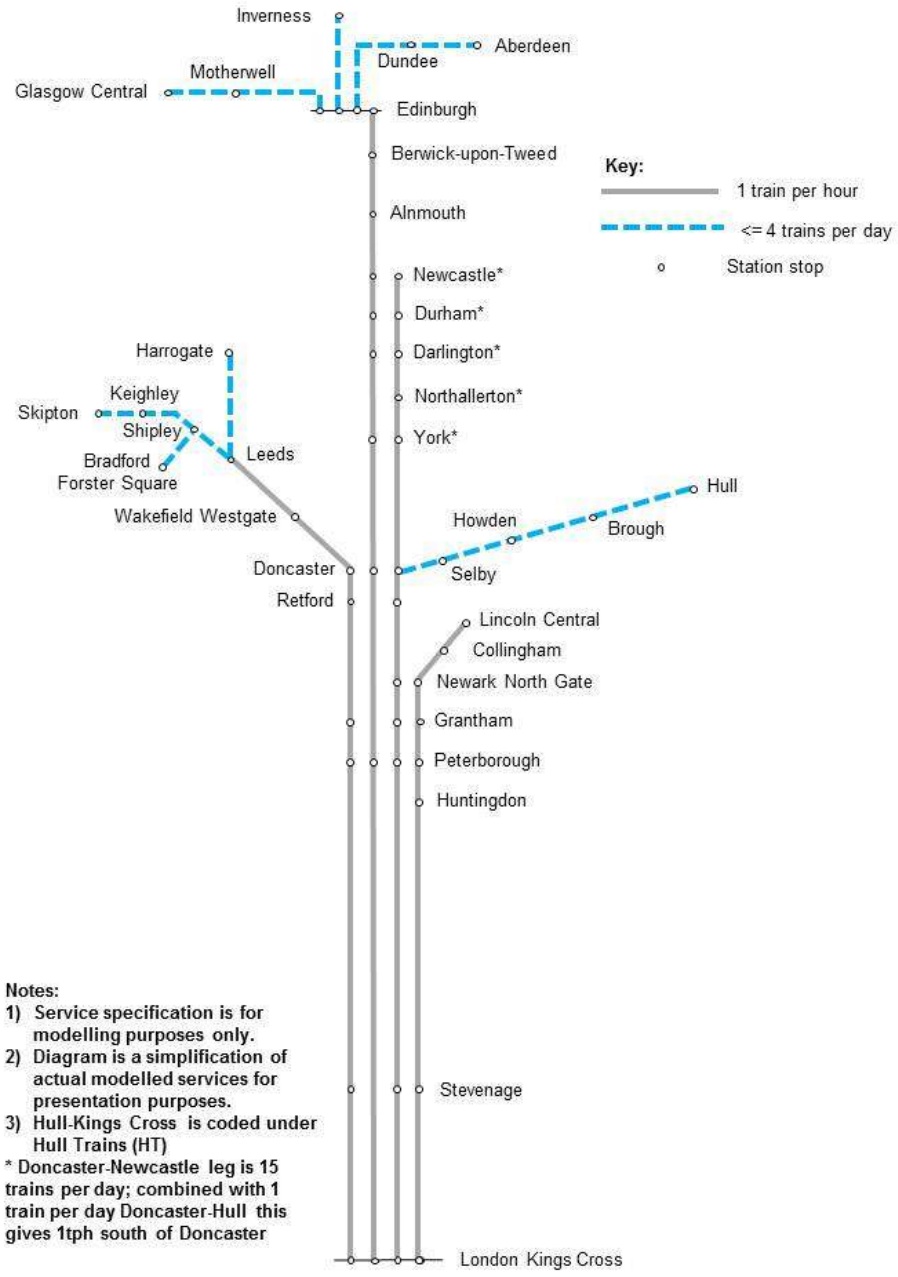
6.4.10 The Phase Two timetable assumes the following services to/from London:

- one train per hour to Leeds (with occasional services continuing to either Bradford, Skipton or Harrogate);
- one train per hour to Edinburgh;
- 15 trains per day to Newcastle with one train per day to Hull;
- one train per hour to Lincoln; and

- occasional East Coast services between Edinburgh and Glasgow, Aberdeen and Inverness (In addition to Scotrail services).

6.4.11 A summary of services and stopping patterns for East Coast Main Line in Phase Two is included in figure 6-5. Phase One is not presented as it is unchanged from the 'Do Minimum'.

Figure 6-5: East Coast Service – Average Service Pattern used in PFMv4.3 – Phase Two



London Midland

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

- one train per hour to Crewe via Stoke-on-Trent;

- two trains per hour to Birmingham New Street via Northampton;
- one train per hour to Milton Keynes;
- two trains per hour to Bletchley;
- three trains per hour to Tring;
- two trains per hour in the peak time to Northampton;
- two trains per hour in the peak time to Rugby with alternate trains extended to Lichfield; and
- one train per hour in the peak time to Watford Junction.

6.4.13 It also assumes the following services starting at Birmingham New Street:

- two trains per hour to Liverpool Lime Street
- One train per hour in the peak period to Crewe

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

- one train per hour to Crewe via Stoke-on-Trent;
- two trains per hour to Birmingham New Street via Northampton;
- one train per hour to Milton Keynes;
- two trains per hour to Bletchley;
- three trains per hour to Tring;
- one train per hour in the peak time to Northampton;
- two trains per hour in the peak time to Rugby with alternate trains extended to Lichfield; and
- one train per hour in the peak time to Watford Junction.

6.4.15 It also assumes the following services starting at Birmingham New Street:

- one train per hour to Preston (taking over the path of West Coast Birmingham-Scotland service); and
- two trains per hour to Liverpool.

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

Figure 6-6: London Midland Service Pattern used in PFMv4.3 – Phase One

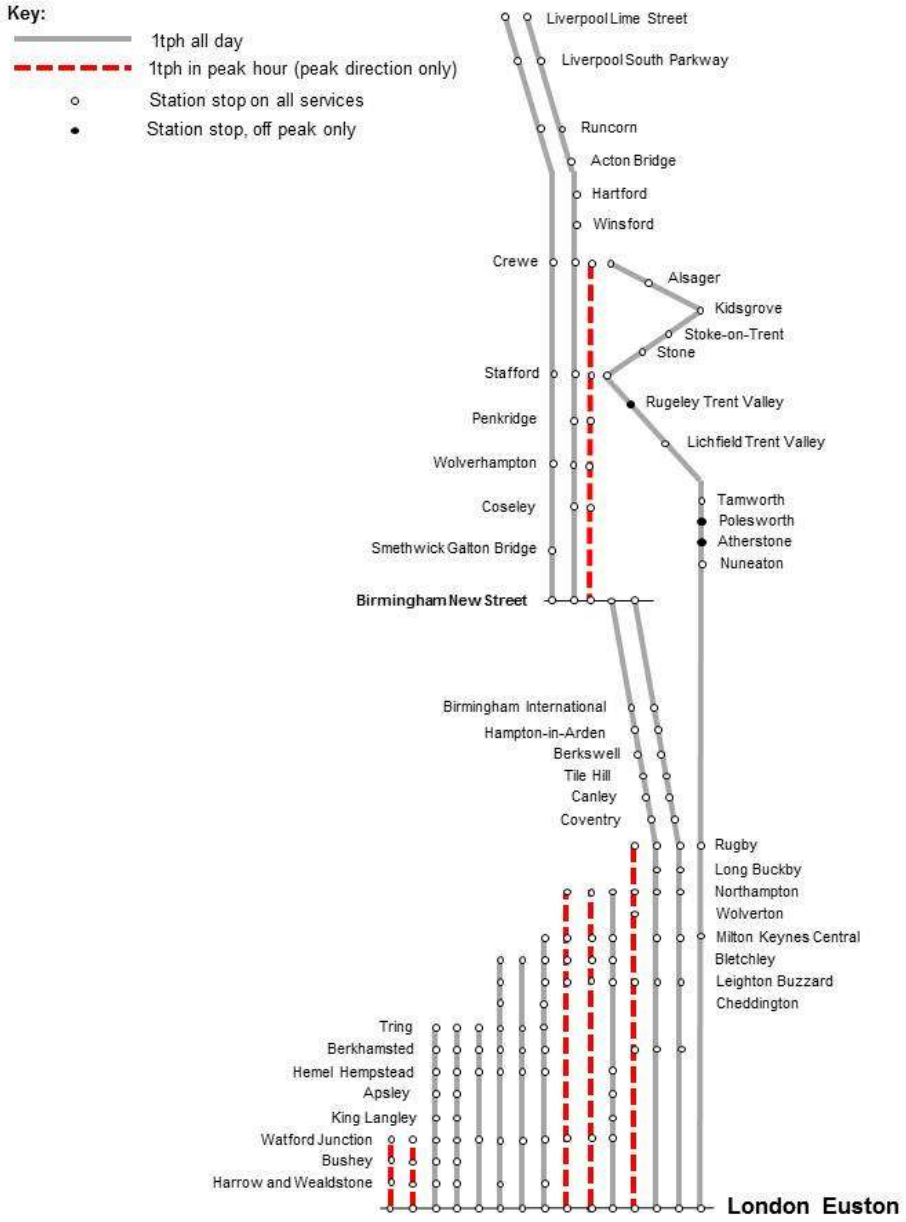
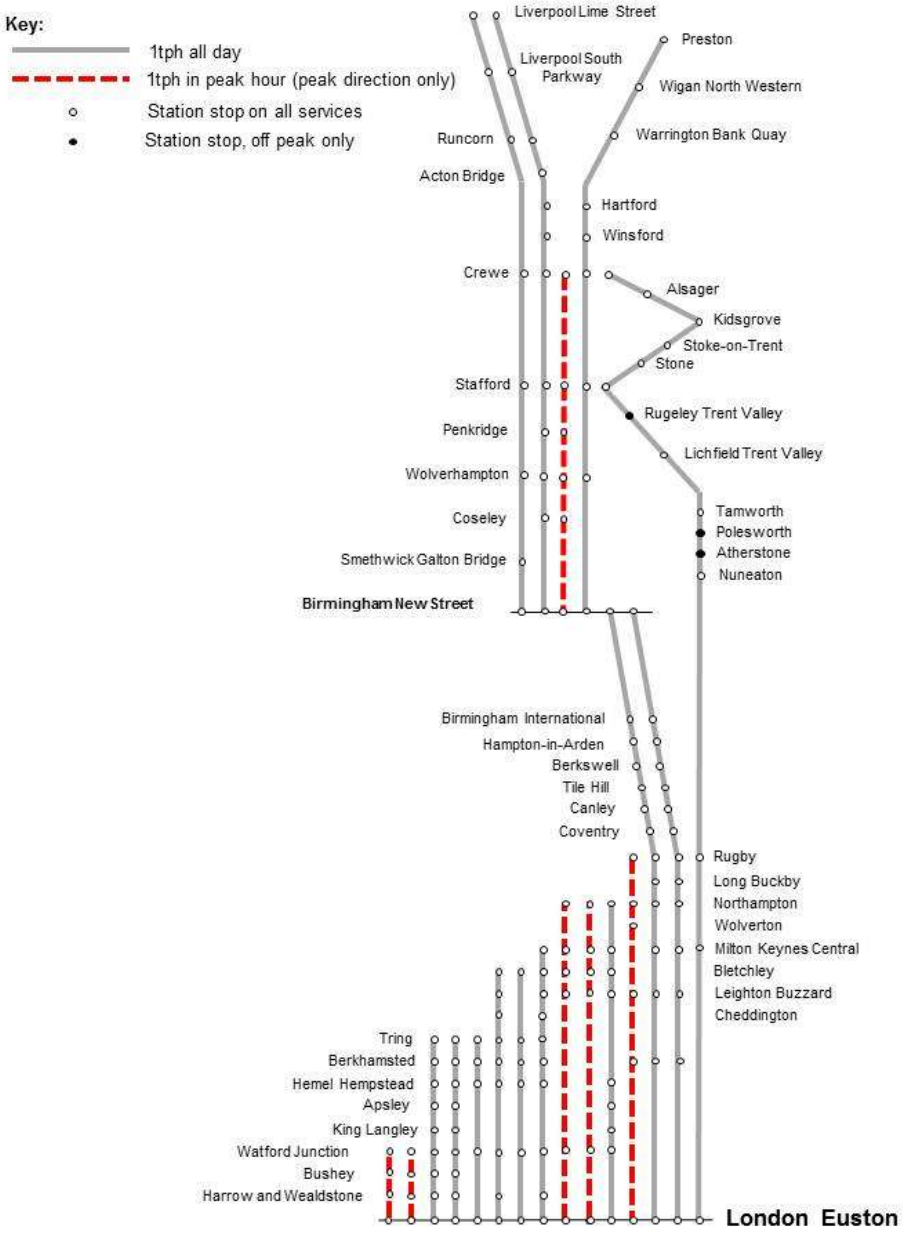


Figure 6-7: London Midland Service Pattern used in PFMv4.3 – Phase Two



East Midlands Trains

6.4.16 The Phase One timetable is as the 'Do Minimum'.

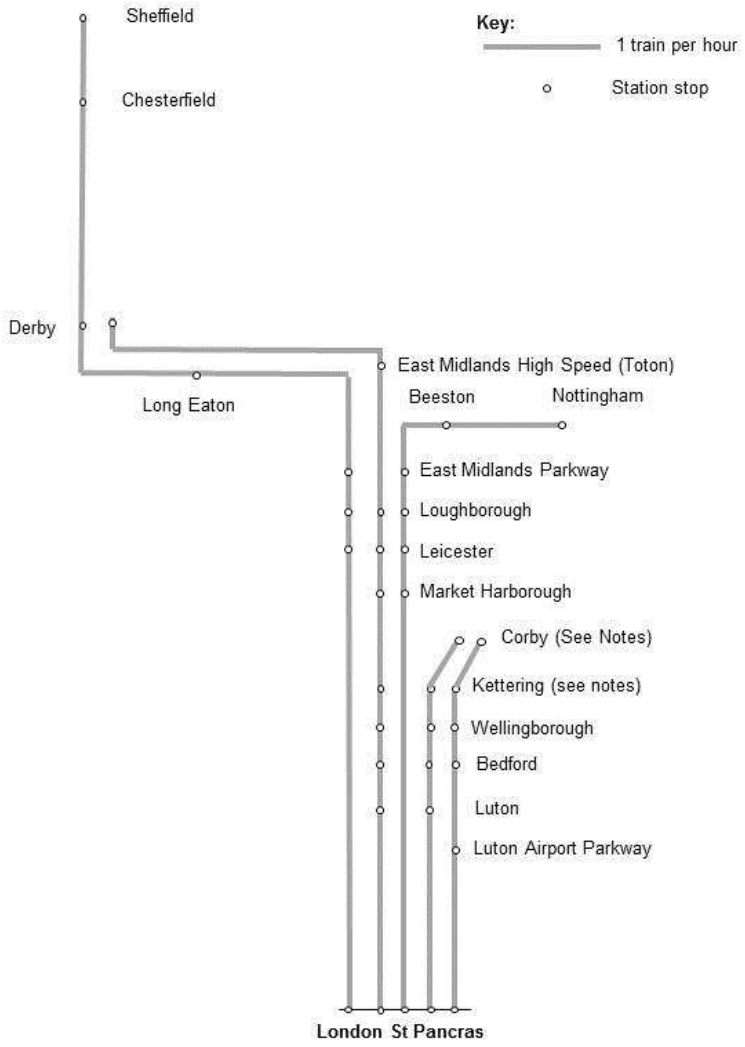
6.4.17 The Phase Two timetable assumes:

- two trains per hour between Corby[26] and London;
- one train per hour between Derby and London via the new East Midlands HS station;
- one train per hour between Nottingham and London; and
- one train per hour between Sheffield and London via Derby.

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

[26] Corby is not a station that is modelled in PLD and therefore services are coded to/from Kettering, which is the nearest point on the network

Figure 6-8: East Midlands Service Pattern used in PFMv4.3 – Phase Two



Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Services to/from Corby are coded to/from Kettering, as Corby is not a station that is modelled in PLD.**

TransPennine Trains

6.4.19 The Phase One timetable for TransPennine Trains assumes:

- the following services to / from Manchester Airport:
  - one train per hour to Manchester Piccadilly (the truncation of the do minimum Manchester Airport Scotland service);
  - one train per hour to Blackpool North;
  - two trains per hour to York via Leeds; and
  - one train per hour to Cleethorpes via Sheffield.

- the following services from Manchester Piccadilly:
  - one train per hour to Selby via Leeds;
  - one train per hour to Doncaster via Sheffield; and
  - one train per hour to Hull via Leeds.
- the following services from Preston
  - six trains per day to Barrow-in-Furness.
- Phase One also includes the following service to/from Liverpool Lime Street:
  - one train per hour to Newcastle via Manchester and Leeds; and
  - one train per hour to York via Manchester and Leeds.

6.4.20 In the Phase Two timetable, this is as the Phase One specification:

- an additional one train per hour from Manchester Airport to Scotland (alternating between Edinburgh and Glasgow) assumes:
- peak time services between Liverpool Lime Street and Newcastle are extended to Edinburgh;

6.4.21 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 PFMv4.3 – Phase One

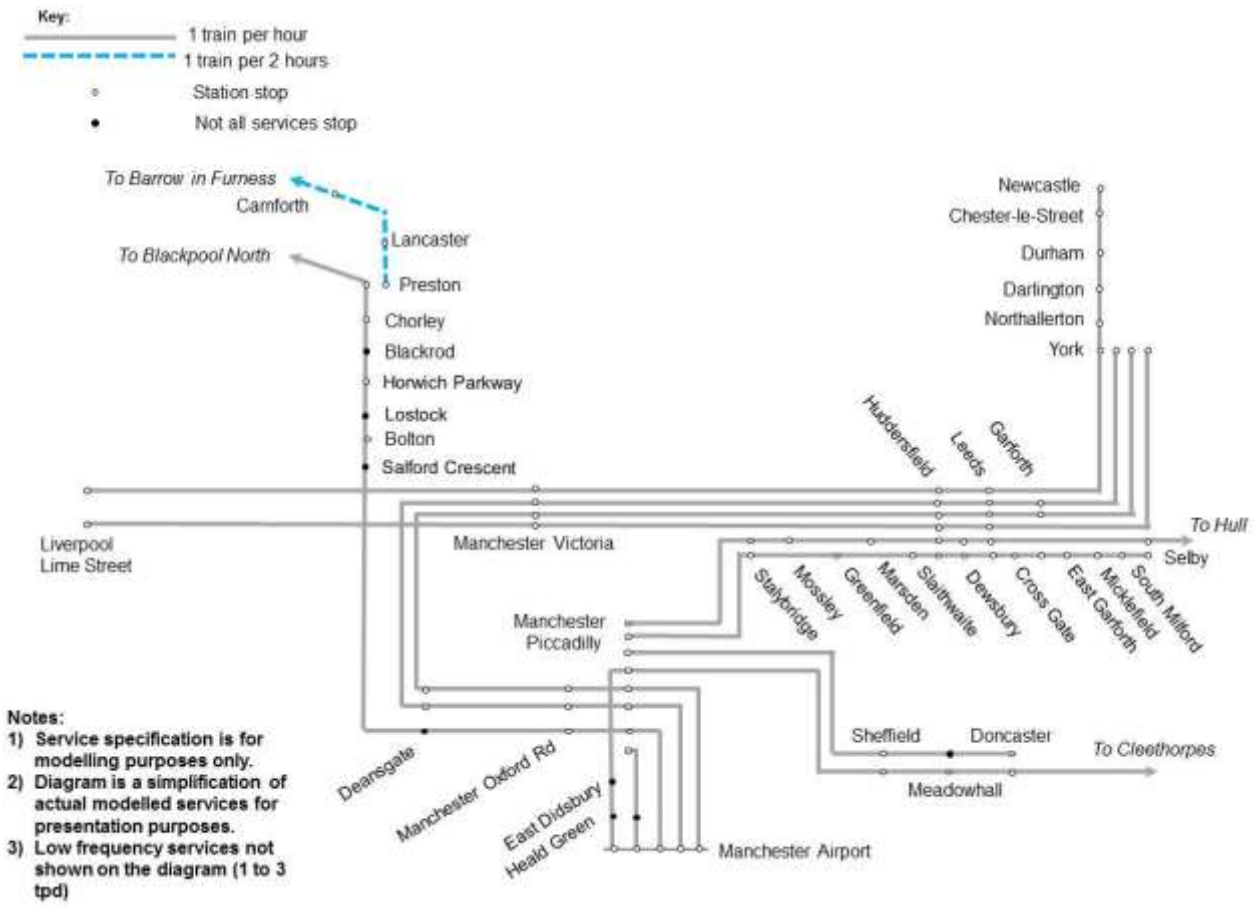
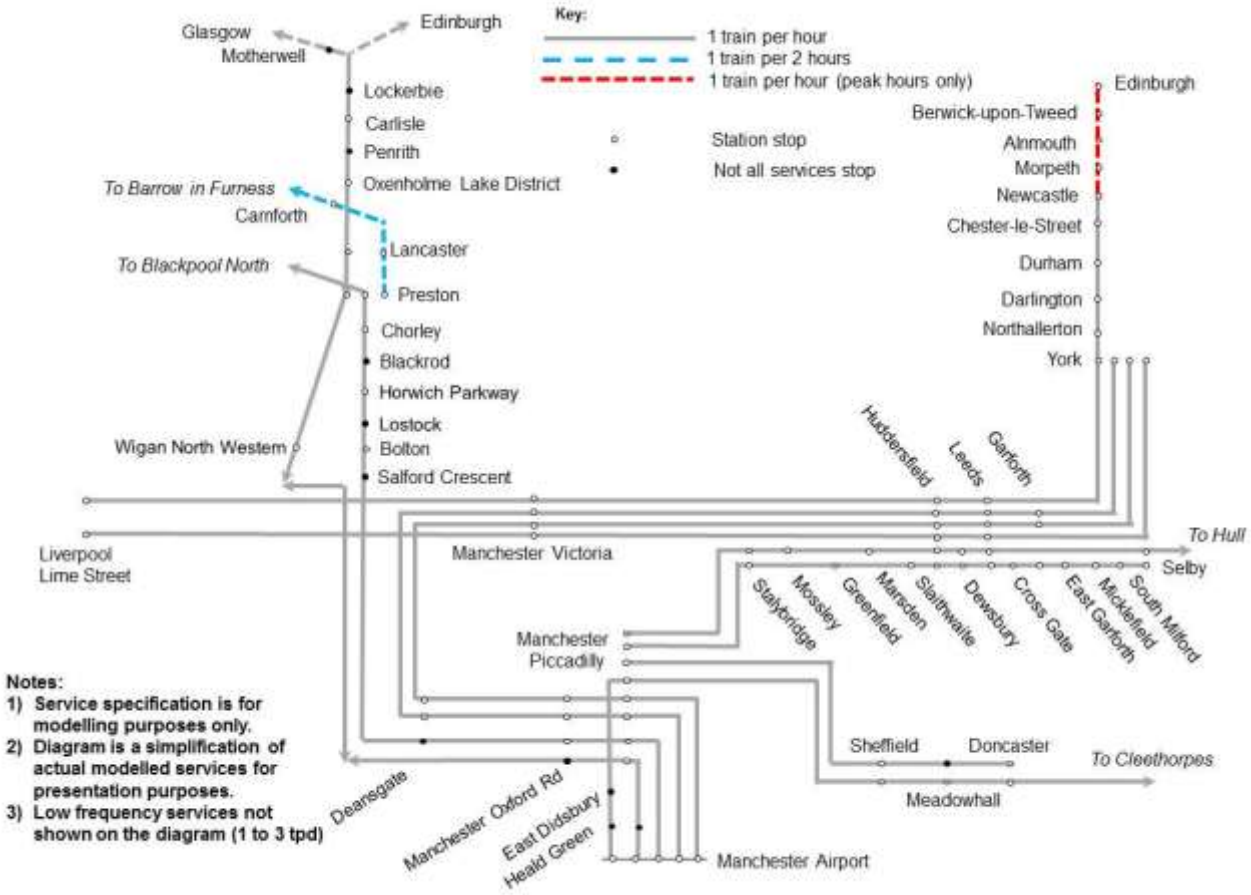


Figure 6-10: Trans Pennine Service Pattern used in PFMv4.3 – Phase Two



Cross Country

6.4.22 The Phase One timetable for Cross Country services is as assumed for the 'Do Minimum'.

6.4.23 The Phase Two timetable is broadly the same as that in the Do Minimum except that there are additional calling points are provided as follows:

- 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)

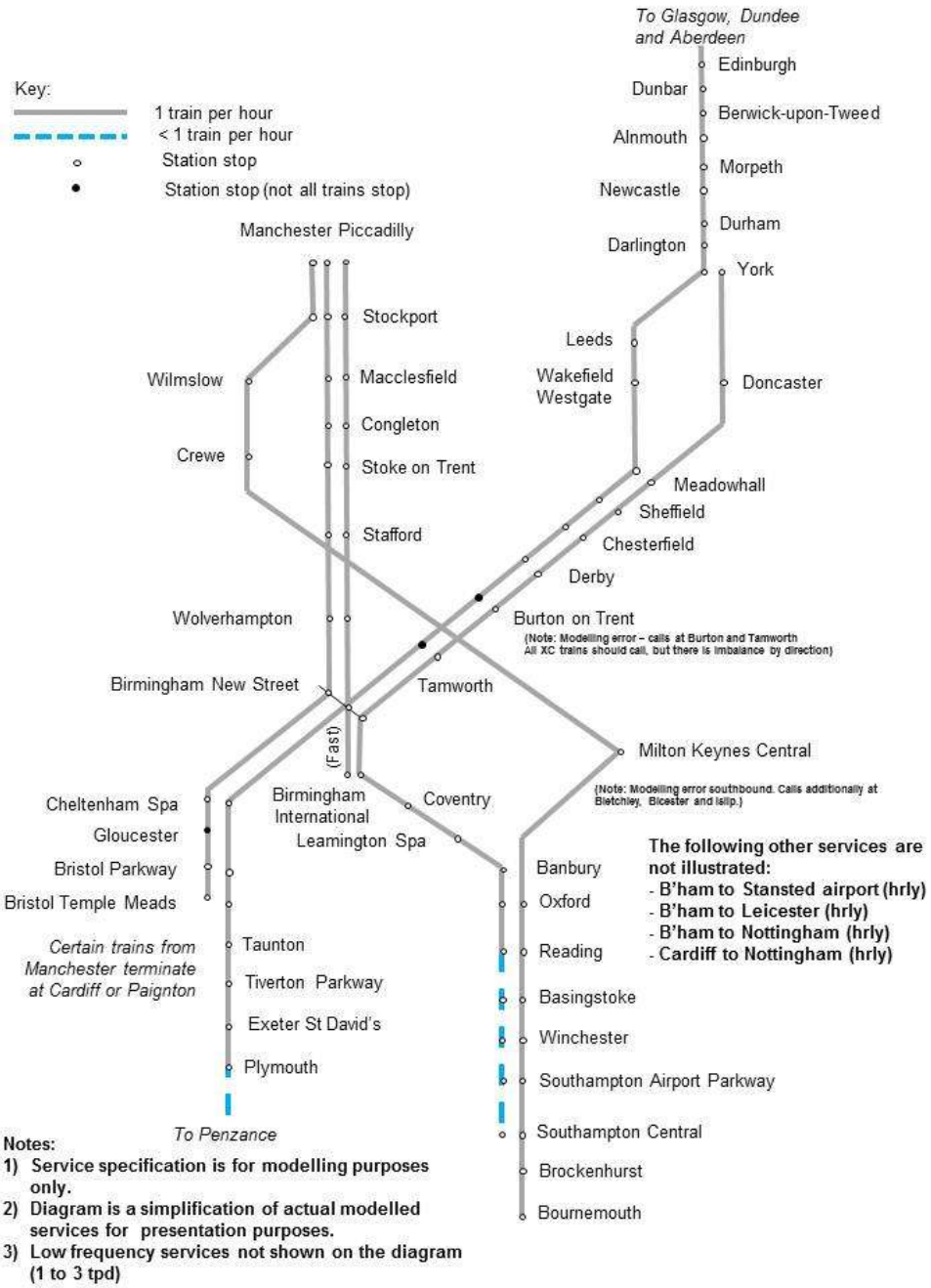
This then provides a service pattern as follows:

- one train per hour between Manchester and Bournemouth via Milton Keynes;
- one train per hour between Manchester and Bristol via Birmingham (with some services continuing on to Cardiff or Paignton);

- one train per hour between Manchester and Birmingham International;
- one train per hour between Plymouth and Edinburgh, with some services continuing on to Penzance in the South West or Glasgow, Dundee or Aberdeen in Scotland; and
- one train per hour between Reading and Newcastle, with some services continuing on to Southampton or Guildford in the south, or Edinburgh in the north.

6.4.24 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 PFMv4.3 – Phase Two



Southern Trains

6.4.25 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

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 PFMv4.3 – Phase One and Phase Two

Thameslink and Great Northern Trains

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

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

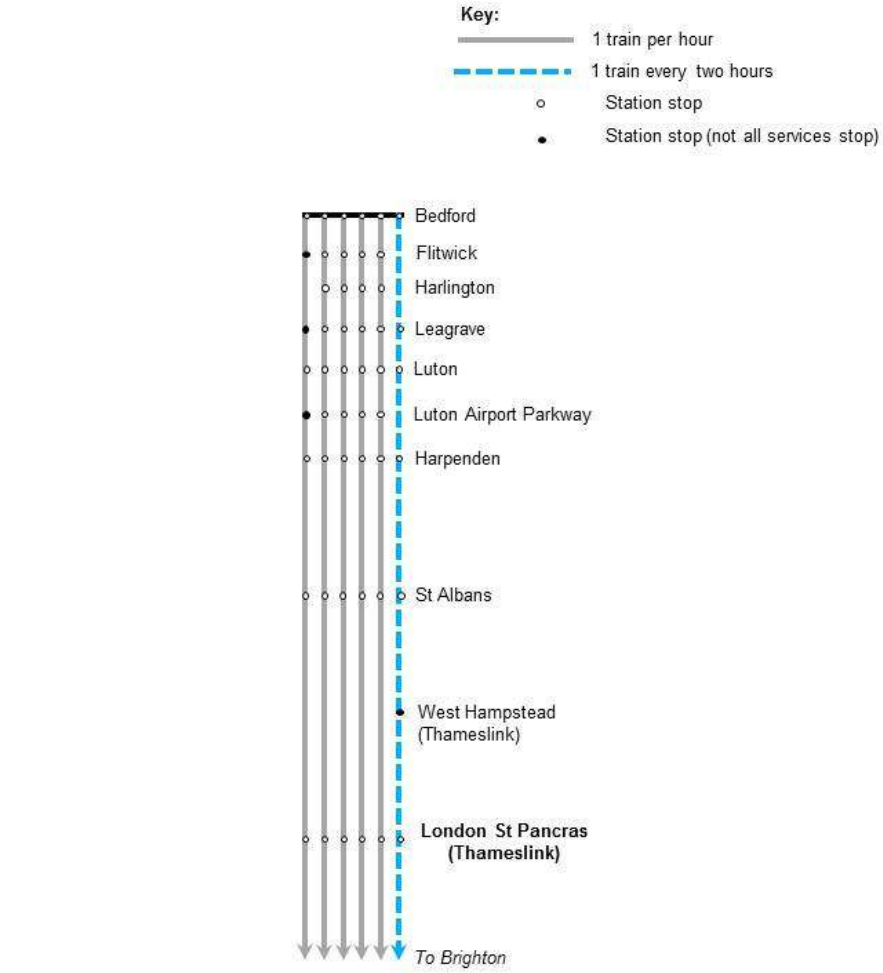
- On the Great Northern Peterborough corridor:
  - one train per hour peak only between Kings Cross and Peterborough;
  - two trains per hour between Three Bridges and Peterborough via Central London
- and on the Thameslink Midland corridor:
  - four and a half trains per hour between Bedford and Brighton via Central London; and
  - one train per two hours between Bedford and London St Pancras.

6.4.28 Phase Two assumes the following:

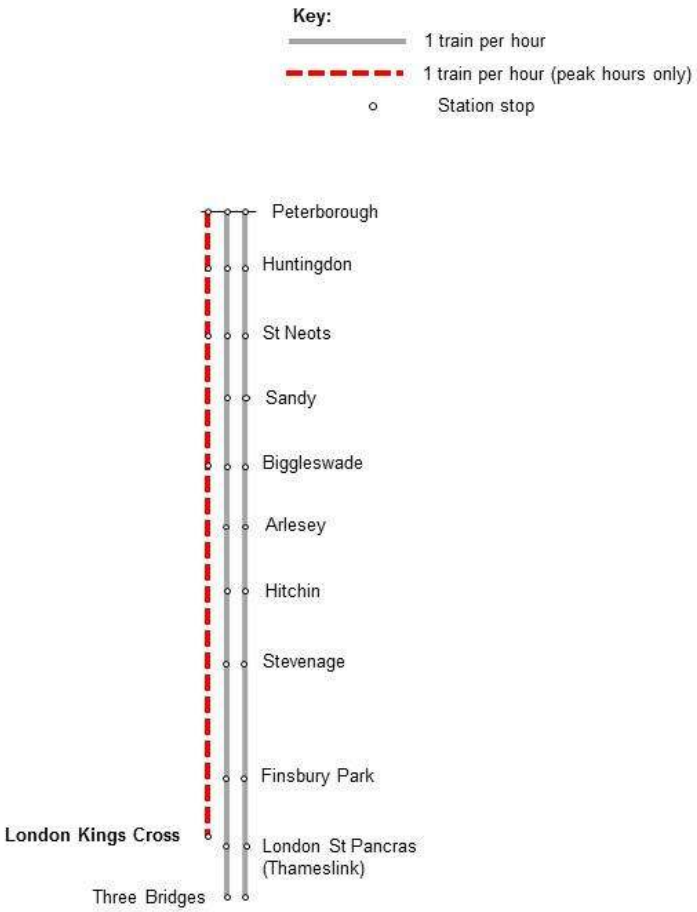
- On the Great Northern Peterborough corridor:
  - one train per hour peak only between Kings Cross and Peterborough semi fast;
  - one train per hour peak only between Kings Cross and Peterborough stopping service;
  - two trains per hour between Three Bridges and Peterborough via Central London; and
  - one train per hour between King's Cross and Peterborough semi-fast.
- and on the Thameslink Midlands corridor:
  - four and a half trains per hour between Bedford and Brighton via Central London; and
  - one train per hour between Bedford and London St Pancras semi-fast.

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

Figure 6-13: Thameslink- Great Northern and Midlands Corridor Service Pattern used in PFMv4.3 – Phase One

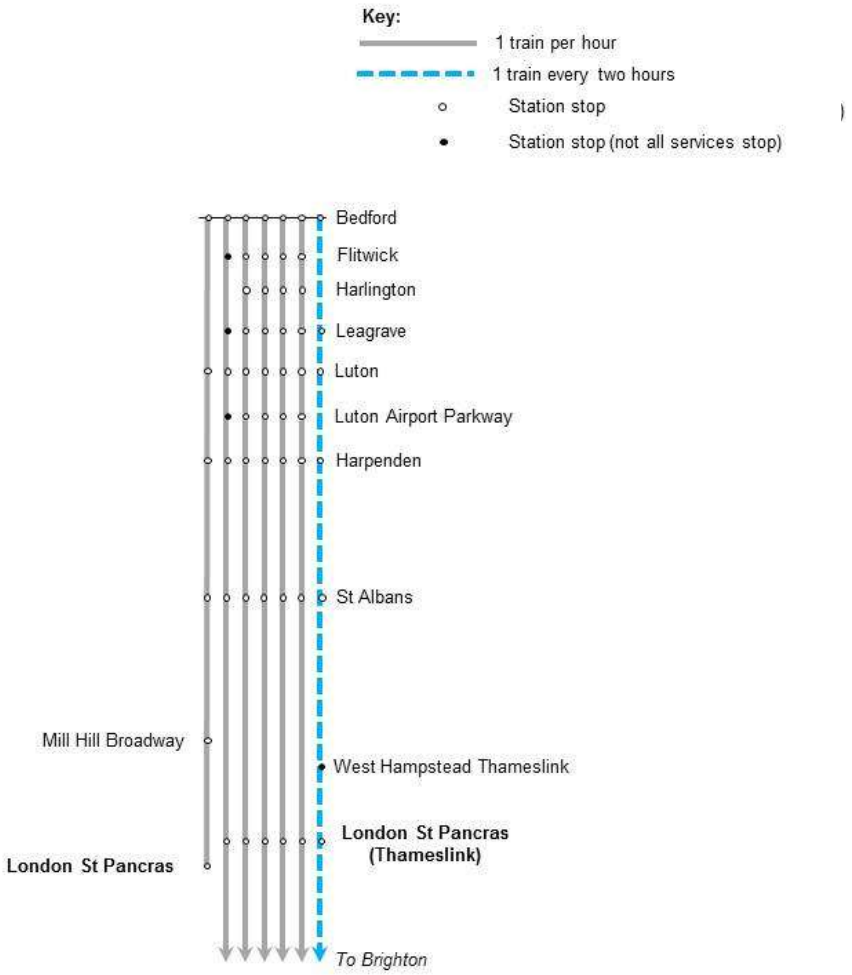


Notes:
1) **Service specification is for modelling purposes only.**
2) **Diagram is a simplification of actual modelled services for presentation purposes.**
3) **Only shows trains starting at Bedford, plus any released capacity services**



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: Thames link- Great Northern and Midlands Corridor Service Pattern used in PFMv4.3 – 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

Northern Trains

6.4.30 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.

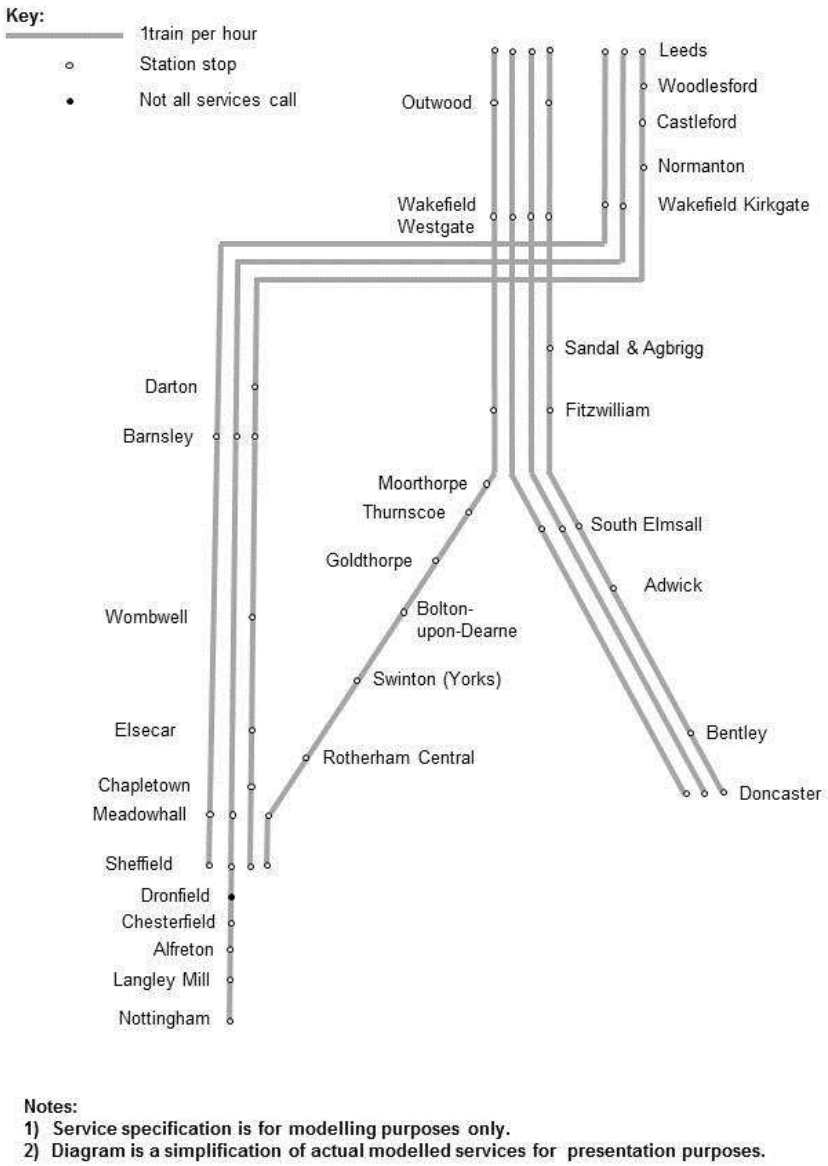
6.4.31 The Phase One timetable is as per the 'Do Minimum'.

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

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

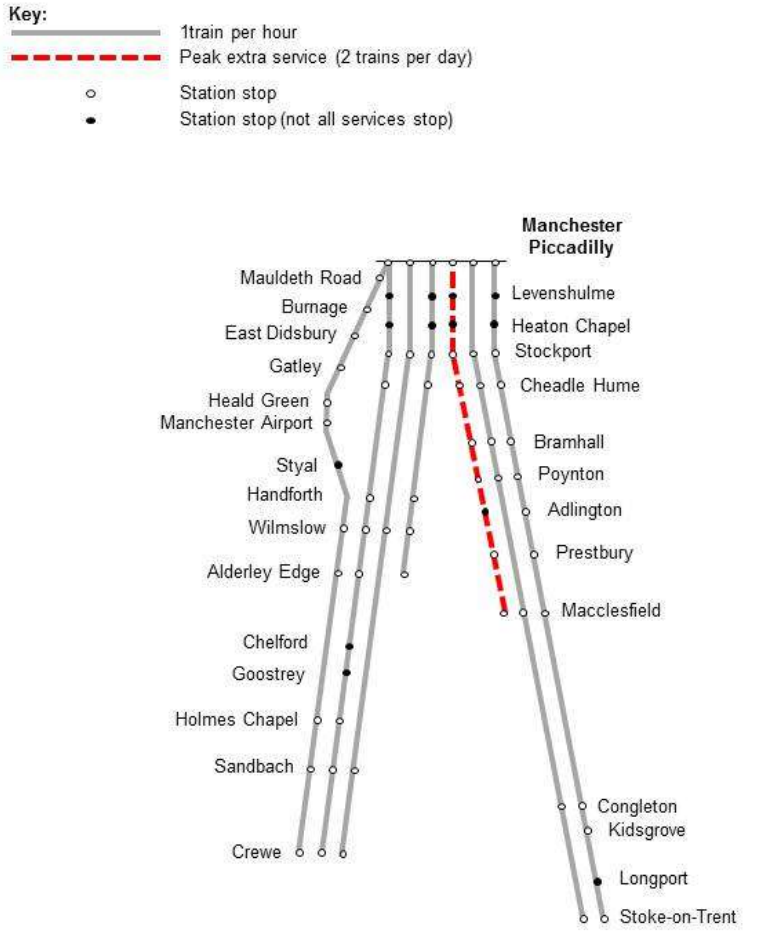
6.4.33 A summary of services and stopping patterns for Northern services on the Leeds Corridor are presented in figure 6-15 for Phase Two. A summary of the service patterns assumed in the South Manchester corridor are shown on figure 6-16 for Phase Two. Phase One services for Northern Trains are not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

Figure 6-15: Northern Train Services- Leeds Corridor Service Pattern used in PFMv4.3 – 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 PFMv4.3 – 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

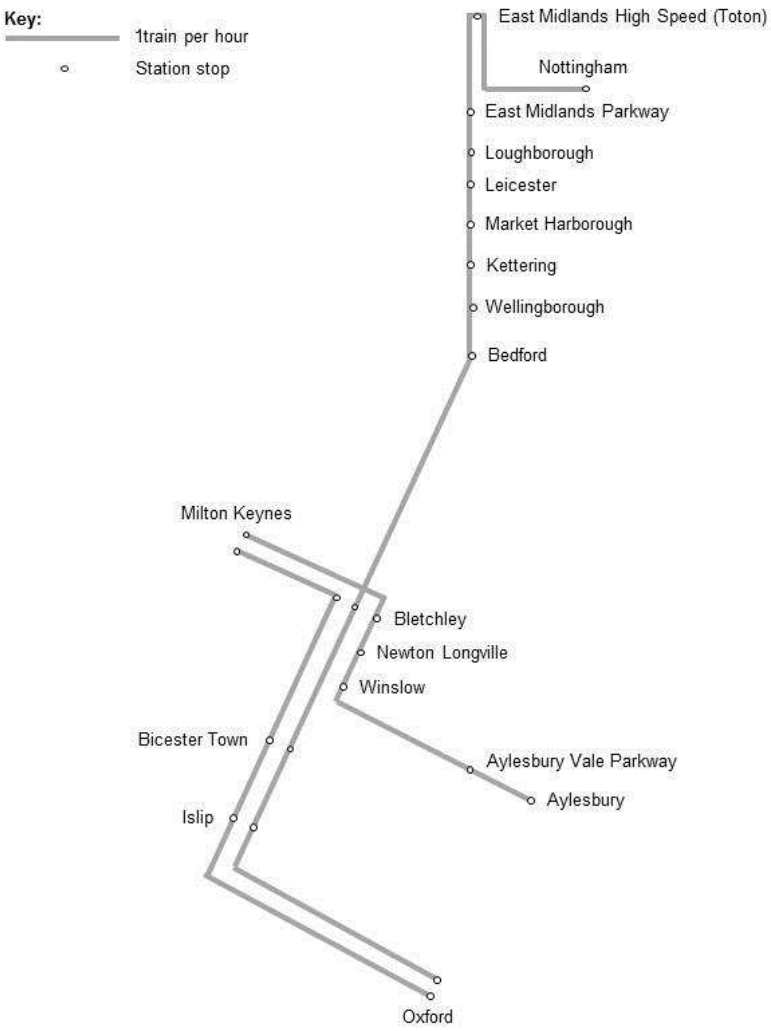
6.4.34 The Phase One timetable is as the 'Do Minimum' specification.

6.4.35 The Phase Two timetable assumes:

- one train per hour between Oxford and Nottingham via Bedford (projected on from the Do Minimum Oxford-Bedford service);
- one train per hour between Oxford and Milton Keynes; and
- one train per hour Aylesbury and Milton Keynes.

6.4.36 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 PFMv4.3 – Phase Two



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

Crossrail, Great Western and Heathrow Express

6.4.37 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 three minutes.

7 Reliability assumptions

7.1 PFMv4.3 Assumptions

7.1.1 The approach to modelling reliability in PFMv4.3 involves making adjustments to the journey times as a proxy for changes in reliability.

7.1.2 The approach considers the potential improvement in reliability that HS2 can deliver by examining one measure of reliability – average minutes lateness (AML).

7.1.3 Improvements in AML as a result of HS2 are then converted into an equivalent journey time saving based on evidence in PDFH and WebTAG[27], which suggests that passengers value 1 minute average lateness as equivalent to three minutes of journey time. This perceived reduction in journey time is then input into the model to forecast the change in demand due to reliability improvements. The tables below show the reliability adjustments made within PFMv4.

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

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	0.1	2.5	8
London - Preston	4.8	2.8	2	6
London– Manchester	2.9	1.9	2	6
London– Liverpool	3	1	2	6
London - Scotland	4.4	2.4	2	6

Table 7-2: Reliability Benefits of HS2 extended to Leeds and Manchester

HS2 Service Group	AML Classic Rail	AML HS2	Change in AML	Equivalent Journey Time Reduction
London - Birmingham	2.6	0.1	2.5	8
London - East Midlands / Sheffield	1.8	0.1	1.7	5
London - Leeds	2	0.1	1.9	6
London - Birmingham	2.6	0.1	2.5	8
London - Manchester	2.9	0.1	2.8	8
London - Liverpool	3	0.2	2.8	8
London - Scotland	4.4	1.6	2.8	8

[27] WebTAG unit 3.15.4

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 PFMv4.3. This section outlines the weights used within the model.

Generalised cost element weights for rail

8.1.2 Within the PFMv4.3 Model 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 – PFMv4.3

	Model Values (all purposes)		
Rail Element	**PLD**	**Planet South**	**Planet Midlands &Planet 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 Prices Framework
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
hybrid Bill	Consents process for major projects deemed to be in the national interest that also affect a large number of private interests
ICWC	Inter City West Coast
IEP	Intercity Express Programme
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 Regulation
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 Prices 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 documentation for Transport Appraisal Guidance