HS2 Phase Two
Model Development Report: PLANET Framework Model version 4.3-5.2

January 2016

CS392J_3

Department for Transport

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1 Introduction

1.1 Background

1.1.1 HS2 Ltd is preparing for the Strategic Outline Business Case (SOBC) for Phase 2A of the HS2 scheme. The SOBC is the next iteration of the HS2 Economic Case for publication. The previous publication of the HS2 Economic Case was to support the hybrid Bill for Phase 1 of the HS2 scheme, which was presented to Parliament during the 2013/14 session.

1.1.2 The HS2 scheme comprises a network of new high speed rail lines that are due to be connected and completed in a series of phases:

- Phase 1 is due for completion in 2026 and will see high speed train services linking London and Birmingham;
- Phase 2, which is forecast for completion in 2033, completes a Y-shaped network, with lines running on to Manchester and Leeds; and
- Phase 2A is an intermediate phase, which aims to bring forward high speed services into Crewe to provide a fast link to the West Coast Mainline (WCML) by 2027, just one year after completion of Phase 1.

1.1.3 The PLANET Framework Model (PFM) is the primary tool for forecasting HS2 ridership and calculating associated benefits and revenue to support the HS2 Economic Case. Since the hybrid Bill in 2013/14, the PFM has been enhanced in order to better support the business case.

1.2 Model development

1.2.1 The model development undertaken since the publication of the previous business case has been carried out in a series of step-changes which are presented in chronological order in the remaining chapters of this Model Development Report (MDR). The updates were to PFMv4.3, the version of the model that was used to support the hybrid Bill.

Table 1 - Model Development Step Changes since PFMv4.3

Step-change	Description of change and reasoning
PFMv4.4	PFMv4.4 incorporates minor model improvements to address known issues identified during the audit and quality assurance processes carried out on PFMv4.3. PFMv4.4 also includes the automation of the Numerical Integration (NI) appraisal process.
PFMv4.5	PFMv4.5 consists of a series of development opportunities which had been identified as part of the previous model audit and quality assurance of PFMv4.3, along with some previously identified automations which improve the running of the model.
PFMv4.6	Compared to PFMv4.5, model version PFMv4.6 incorporates minor model improvements to resolve some of the issues raised by the audit and quality assurance process. There are also a number of changes designed to improve the usability and efficiency of the model.
PFMv4.7	Compared to PFMv4.6, PFMv4.7 incorporates a number of significant changes, including: • updated future-year demand matrices that take account of revised growth forecasts of rail, air and highway demand. The rail growth takes account of the WebTAG update in Autumn 2014[1], as well as incorporating elements of the Passenger Demand Forecasting Handbook (PDFH) v5.1 guidance and the latest forecasts of the economic and cross-modal demand drivers, including gross domestic product (GDP), employment, population and rail fares; • as a result of revised rail growth assumptions, the cap year on demand growth has changed from 2036 to 2040; • as well as the forecasting models, assumptions within the demand and appraisal models have also been updated to be consistent with the guidance contained within the WebTAG Autumn 2014 release. Most importantly, this involves updating the GDP assumptions used to grow values of time in the appraisal model to be consistent with those used by the demand forecasts; and • there have also been updates to the control matrices, highway preloads and air transit lines, together with a number of fixes to small bugs within the model.
PFMv4.8	Compared to PFMv4.7, PFMv4.8 incorporates updated HS transit line service coding that takes into account revised reliability assumptions.
PFMv5.0[2]	Further to PFMv4.8, PFMv5.0 incorporates a partial 'Do Minimum' (DM) network update. These updates to the DM have been derived from: • a review of the existing DM networks based around the individual Train Operating Company's (TOC) coding; and • updated DM specifications from the Department for Transport (DfT).
PFMv5.1	PFMv5.1 is the model release which combines the following updates: • Further updates to the DM transit line coding, in particular focusing on East Coast Mainline (ECML), East Midlands (EM), London Midland (LM) and Chiltern TOCs. • Revised HS2 timetable for high speed services in Phase 1 and Phase 2. • Revised rail demand forecasts through an amendment to the employment growth driver applied within the forecasting process. • Update to the generalised journey time (GJT) elasticity applied in the regional models to be consistent with PDFHv5.1 rather than PDFHv4.1.

[1] WebTAG Databook Autumn 2014 Forthcoming Changes

[2] It should be noted that this test was originally called 4.9, but was renamed for release as PFMv5.0.

Step-change	Description of change and reasoning
PFMv5.2	PFMv5.2 contains changes to the rail fares growth assumptions contained within the model. These changes altered the cap year which became 2037. This change has been made to align with the government's election manifesto that rail fares will not grow faster than RPI during the 5-year term from May 2015.

1.3 Quality assurance

1.3.1 When model development updates are made to the PFM, the work carried out under these model developments is subject to rigorous quality assurance (QA) processes to ensure that they are correctly implemented. This is carried out by the model developers and HS2 Ltd.

1.3.2 In general, three standard levels of checking that may be used:

- **Yellow check** – These are carried out by the model developers and includes checks of the setup of model runs, checks that model run outputs have been produced correctly and checks that results from the model are sensible through a key indicators form;
- **Orange check** – Carried out by the model developers, this is a more detailed check of the model inputs and outputs and also involves the production of a note detailing the checks. For changes to model code (macros and batch files, etc), it involves a line-by-line check of changes implemented, documented in tabular form; or
- **Red check** – This involves a full QA of all aspects of the model, with a full acceptance criteria note produced by the model developer. This also includes line-by-line checks of all files within the modelling framework.

1.3.3 Further to the above checks, some additional checks may be performed by HS2 Ltd or through an independent peer review.

1.3.4 HS2 Ltd's independent auditor has also checked the model at each stage of the development process and signed off the changes made.

1.3.5 The QA processes carried out during this period of model development are documented within this MDR.

1.4 Report structure

1.4.1 The remaining chapters of this report each discuss a separate step change. Each chapter presents:

- the model developments that have been implemented during the step change process; and
- a discussion of the (QA) procedures undertaken to ensure correct implementation of the model development updates.

1.4.2 Where further or more in-depth information is required, this has been captured within the MDR appendices.

1.4.3 A glossary of technical acronyms is provided at the end of the main report.

1.4.4 The MDR document at times refers to further related documentation that supports the HS2 Economic Case. These documents are as follows:

- 'Summary of Key Changes to the Economic Case since October 2013'– the impact of the model development changes, documented within this report, on the HS2 Economic Case is presented in detail within this document, where similar updates have been themed into steps in order to analyse in detail the effect of the changes.
- 'Assumptions Report: PLANET Framework Model version 5.2' – the assumptions that underpin the latest version of the PFM are discussed in detail within this document.
- 'PLANET Framework Model (PFM V5.2): Model Description' – a report which documents the technical detail of the methodology and modelling practises which are implemented within the PFM.
- 'Atkins Model Development Report – PFM V4.3 to PFM V5.2 updating the exogenous forecasts' – full documentation of the forecasting procedures applied to obtain future-year demand for rail, highway and air modes which are input into the PFM in matrix format, in particular for updates within PFMv4.7 and PFMv5.1.

2 PFMv4.4

2.1 Summary of changes

2.1.1 PFMv4.4 incorporates minor model improvements to address known issues identified during the audit and quality assurance processes carried out on PFMv4.3. PFMv4.4 also automated the Numerical Integration (NI) appraisal process.

2.2 Model development

2.2.1 The table below gives details of the changes from PFMv4.3 which are included within PFMv4.4.

Table 2- Changes included in PFMv4.4

Change	Description of Change
Correction to the Heathrow Airport Access Model	The Heathrow Access Model (HAM) requires as inputs highway vehicle operating costs (VOC) for the base year, and future-year DM and Do Something (DS). These inputs should be in pounds (£). In an update to the PFM prior to PFMv4.3, the calculation of vehicle operating costs was updated and they are now calculated and stored in units of pence. This causes two issues: first, the HAM has not been updated to expect inputs in units of pence; second, the base-year vehicle operating costs in the PFM remained in pounds. In both the future-year DM and DS, the HAM pivots off base-year costs, this means that vehicle operating costs input to the mode choice model increase by a factor of about 100 between the base year and future year. This has been corrected in PFMv4.4.
Correction to public transport catchments for Leeds and Toton in the Station Choice Model (SCM)	In PFMv4.3 there was an inconsistency in the catchment areas for Leeds New Lane HS2 station and East Midlands Hub (Toton) HS2 station in the Station Choice Model (SCM). A small number of the zones attached to these have access to a local PLANET Long Distance (PLD) station and therefore these zones should use these to access the rail network. The catchment area definitions have been updated in PFMv4.4 to reflect this.
Correction to transit lines in the regional models	A number of corrections have been made in DS transit line stopping patterns in the four sub-models PLD, PLANET South (PS), PLANET Midland (PM) and PLANET North (PN). This primarily affects Cross-Country (XC), Trans-Pennine (TP), London Midland (LM) and West Coast (WC) Mainline services. Further details of the specific changes that have been made are given in Appendix A1.1.
Correcting issues with the preload process	A series of corrections were undertaken to the preload process within the model. Further information is presented in Appendix A1.2.
Correction to the Phase 1 2026 highway and air DM networks	Correction to the Phase 1 2026 highway and air DM networks which were incorrect in PFMv4.3. The 2026 version of the test had old files in place. Network and transit line files taken from the 2036 DM which was correct and replaced in 2026, as the DM scenario in 2026 and 2036 forecast years are the same in terms of network structure.
Automation of Numerical Integration	The manual process to undertake NI which was developed as an add-on to PFMv4.3 has been automated to be undertaken at the end of a model run as well as standardising outputs and their names. This has reduced a manual process which took 2 to 3 days down to 2 hours and hence any Numerical Integration results are more robust and quicker to generate.

2.3 Quality assurance

2.3.1 The QA processes that have been carried out on PFMv4.4 are documented in the table below.

Table 3 - PFMv4.4 QA Processes

Type of QA check	Level of check	Details of check
Theory & Methodology	HS2 Ltd and Technical Advisor Review	The scoping note which detailed the process of automating the NI process was reviewed by HS2 Ltd and their independent technical advisor, who was happy with the process outlined.
Theory & Methodology	Model developer: Orange check	An orange check on the manual NI outputs was undertaken on PFMv4.3.
Model Implementation	Model developer: Orange check/ Auditor	The automated NI process has been orange checked by checking the updated macros and batch files line-by-line. It was found that the implementation had been undertaken correctly compared with the specification. This implementation has also been checked by the model auditors.
Model Implementation	Auditor	The implementation of the HAM changes have been checked in the model coding by the model auditor and were found to have been implemented correctly.
Model Implementation	Auditor	The implementation of the SCM catchment area changes have been checked in the SCM input files by the model auditor and were found to have been implemented correctly.
Model Implementation	Auditor	The implementation of the stopping pattern changes within the transit lines files have been checked by the model auditor and were found to have been implemented correctly.
Model Implementation	Auditor	The implementation of the preload process changes has been checked by the model auditor and were found to have been implemented correctly.
Model Implementation	Auditor	The implementation of the Phase 1 Highway and Air 2026 DM Networks have been checked by the model auditor and were found to have been implemented correctly.
Model Results	Model developer: Orange check	PFMv4.4 version of the model has undergone a full orange check. This has included the standard model input and output checks and the completion of documentation. As part of the check of the model inputs a check was performed that ensured that the implementation items were all incorporated in the final model run As part of this orange checking process the version of the model has been checked to ensure that the automated NI process has had no impact on the standard model results. This orange checking process has not identified any issues in this version of the model and as such has been signed off internally by the model developers.
Model Results	Third-party review	PFMv4.4 and its outputs have been reviewed and replication runs performed by a third party to ensure accuracy of model results.

Type of QA check	Level of check	Details of check
Model Results	Auditor	As part of the implementation checks the auditor ran the SCM and NI elements of the model in isolation: • The SCM operated as expected. • The majority of the NI process operated correctly, but not the calculation of the intermediate cost matrices. The reason for this could not be determined due to the complexity of the model. Given the successful implementation of the NI process, as verified by the audit checks, the failure to run the NI process in isolation was not a cause for concern. Nevertheless, the auditors recommended the "isolation" test run should be undertaken again in the future, if and when the model code has been reviewed and simplified.

3 PFMv4.5

3.1 Summary of changes

3.1.1 PFMv4.5 consists of a series of development opportunities which had been identified as part of the previous model audit and quality assurance of PFMv4.3, along with some previously identified automations which improve the running of the model.

3.2 Model development

3.2.1 The model development updates implemented in PFMv4.5 as a result of the audit and quality assurance processes carried out on PFMv4.3 are:

- updates to the wormhole/ensemble process in the PFM;
- further updates to the preloads process within the PFM;
- minor updates to the SCM and associated processes;
- updates to the appraisal pre-processing functionality;
- minor changes to the modelling of high speed services in the PS network; and
- other small network corrections identified in the audit review.

3.2.2 Further to this, a number of model processes have been automated to reduce the likelihood of failed model runs and to create the standard model outputs to improve efficiency and reduce the possibility of error.

Wormhole and ensemble updates

3.2.3 The PFMv4.3 model audit identified a number of issues with the implementation of the wormhole and ensemble processes within the model, which have been corrected within PFMv4.5. A detailed description of the wormhole and ensemble process within the PFM can be found within 'PLANET Framework Model (PFM V5.2): Model Description'. The issues that were identified are listed below:

- Additional calculation to include Outward/Return trip split factors to incorporate revised assumptions on home/non home based demand is missing. This had been included in some previous models but was not included in PFMv4.3. Further details of this can be found in Appendix A2.1;
- Free flow journey time skims are to be produced for each model run to reflect any changes in network/service coding. The process was in place in PFMv4.3 however the generation of new skims in each model run was not active. Further details of this can be found in Appendix A2.1;
- A number of residual issues relating to the "gs" ensemble used to aggregate select demand for transfer to PS, further details of this can be found in Appendix A2.1; and
- Inconsistent definition of HS2 cordon zones in PS within "ge" ensemble.

3.2.4 In addition to the above corrections further checks were also carried out to ensure that ensemble definitions were consistent across all sub-models and any redundant ensembles have been removed to reduce the potential for any future confusion within the ensemble processes.

Preloads updates

3.2.5 A number of residual preload process issues identified from PFMv4.3 that were not addressed in the PFMv4.4 updates have been addressed within PFMv4.5. These are documented in Appendix A2.2.

Station choice model updates

3.2.6 The SCM in PFMv4.3 was found to have spurious trips accessing stations by public transport (PT) modes where PT access should not be allowed in the model. The SCM uses high generalised costs of "9999" to prevent invalid movements however in PFMv4.3 this cost is not sufficiently high to stop these PT trips being made.

3.2.7 This has been resolved in PFM v4.5 by increasing the cost of PT unavailable movements in the SCM to "99999".

3.2.8 Also within this update of the SCM the Shrewsbury, Chester and East Riding zones have all been reclassified as non–core stations to help avoid this problem and future proof the modelling.

Appraisal pre-process functionality

3.2.9 The appraisal pre-processing program within the PFMv4.3 model, was identified to have an issue with insufficient array sizes. This has been identified through the audit process for model release PFMv4.3.

3.2.10 The issue highlighted by the auditor would cause a model error if the final PLD zone, zone 235, was attached to the maximum number of stations allowed which is 20. In PFMv4.3 this is not the case and so no error occurs however in order to future proof the model updates have been implemented in PFMv4.5 to ensure that this error cannot occur.

Network updates

3.2.11 In PFMv4.3 High Speed services in PS are represented by a dummy service serving Euston, Old Oak Common (OOC) and Birmingham Interchange. These transit lines are intended to facilitate the fixed amount of demand transferred between PLD and PS via the wormhole process and the demand transferred between PS and PLD on HS services though the preload transfer process. However, the coding set up of the dummy HS transit lines can allow non-HS2 demand to utilise the service. This makes it difficult to accurately extract information on the usage of Old Oak Common and Euston stations by long-distance passengers.

3.2.12 This has been rectified by increasing the journey time on the dummy link between Old Oak Common and Birmingham Interchange from 0.1 minutes to 960 minutes to prevent local passengers using the dummy link.

3.2.13 The PFMv4.5 model has also incorporated some other network issues raised during the audit of PFMv4.3. These are:

- Updated output macros which are compatible with the latest standard outputs template.
- In PFMv4.3 zone 212 is connected to Meadowhall station; however, it is not used as part of the model run as Meadowhall's active station zone is 207. Although this does not impact on the model run, for clarity zone 212 has been relocated in PFM v4.5 to Cornwall and attached to a spare node, 7022.
- In PFMv4.3 London Midland services from Bletchley to London have an unspecified stop at Harrow and Wealdstone. This coding error has been rectified in PFMv4.5.

Model automation

3.2.14 The processes that have been automated within PFMv4.5 are documented in the table below. None of the model automation processes had any impact on results.

Table 4 - Model Automation in PFMv4.5

Change	Description of change
File Checking Processes	Implementation of pre-model run checking processes, these are as follows: • Checking disk space; • Checking file names; • Checking EMME coding for known standard errors; • Checking SCM input files for known common errors and construction problems; • Undertaking a pre-model run build and assign to ensure the networks are acceptable for use in a full model run; and • Check of the "create_net.prn" EMME output file for issues not picked up by the model build process. Each of the above checks produces an error file. If an error has been found, the PFM alerts the user to the existence of the error by terminating the model run; the text appearing in the PFM DOS box will turn red and an error message will appear. If no error is found but the checks find insufficient space on the hard drive to complete the model run the text in the DOS box will turn yellow to alert the user to create more space. If the checks return no issues at all the text in the DOS box will turn green for the remainder of the model run.
Model Output Automations	The production of the standard output files has been automated. The files now produced automatically are: • Standard Outputs Spreadsheet; • Sectoral benefits (Standard and NI); • OD Benefits (Standard and NI); • SCM MZone analysis; • PLD to Station analysis; and • Demand Curves (NI Only).

Automation of WITA	Outputs required for the Wider Impacts in Transport Appraisal (WITA) workstream have been automated to be produced as part of the model run itself.

3.3 Quality assurance

3.3.1 The QA processes that have been carried out on PFMv4.5 are documented in the table below.

3.3.2 Within the automation implementation QA process, a number of checks were available to ensure the code written within the executable files, batch files, EMME macros and VBA macros were functioning correctly:

- line-by-line checking of the new code;
- attempts to break the code;
- testing sections of code in isolation;
- testing them in a full model run; and
- ensuring the model results are identical with the inclusion of the executable files within the model.

Table 5 - PFMv4.5 QA Processes

Type of QA check	Level of check	Details of check
Theory & Methodology	Peer Review / HS2 Review	The methodology for the changes to PS has been agreed with HS2 Ltd and the auditor.
Theory & Methodology	Peer Review / HS2 Review	The methodology for the changes to the wormholes and ensembles has been agreed with HS2 Ltd and the auditor.
Model Automation	Orange	**Check_Create_Net.exe -** Attempt to break the code by inserting errors to ensure the process picks them up, which it does.
Model Automation	Orange	**closeexcel.exe -** Excel is closed and this does not affect the results of the model, which operates correctly.
Model Automation	Orange	**CheckEMME.exe -** Attempt to break the code by inserting errors to ensure the process picks them up, which it does.
Model Automation	Orange	**CheckSCM.exe -** Attempt to break the code by inserting errors to ensure the process picks them up, which it does.
Model Automation	Orange	**RunStandardOutputs.exe -** The standard output spreadsheets are created correctly and the results are identical to the manual method of creating the results.
Model Automation	Orange	**Run_All.bat -** Visual Line-by-line check, disk space verification compares closely to other examples. All variations of possible input text accounted for and colours correct. Run within a full model run and acts appropriately as errors are introduced.
Model Automation	Orange	**Inputs_all.bat -** Line-by-line check of new code.
Model Automation	Orange	**2026_DM.bat -** Line-by-line check of new code.
Model Automation	Orange	**2026_DS.bat -** Line-by-line check of new code.

Type of QA check	Level of check	Details of check
Model Automation	Orange	**2036_DM.bat -** Line-by-line check of new code.
Model Automation	Orange	**2036_DS.bat -** Line-by-line check of new code.
Model Automation	Orange	**del_crap.bat -** Line-by-line Check. Also performed a test run.
Model Automation	Orange	**WITA_Output.bat -** Line-by-line check of new code.
Model Automation	Orange	**Correct.bat -** Run independently to test, functioning as expected.
Model Automation	Orange	**RunTests.bat -** Line-by-line check of new code.
Model Automation	Orange	**Prebuild.bat -** Line-by-line check of new code.
Model Automation	Orange	**RptErrs.bat -** Line-by-line check of new code.
Model Automation	Orange	**ChkNet_PLD.mac** - Ran through the macros in "debug mode" within EMME to ensure each step was correct. Line-by-line inspection of the code.
Model Automation	Orange	**Matreset.mac** - Ran through the macros in "debug mode" within EMME to ensure each step was correct. Line-by-line inspection of the code.
Model Automation	Orange	**TAssign.mac** - Ran through the macros in "debug mode" within EMME to ensure each step was correct. Line-by-line inspection of the code.
Model Automation	Orange	**Demand_Curve_Template_v4.5.xlsm, O_D_Benefits_Template_v4.5.xlsm, PLD_Analysis_Template_v4.5.xlsm, SCM_Analysis_Template_v4.5.xlsm, Sec_Benefits_Template_v4.5.xlsm, Standard_Out_Template_v4.5.xlsm** Used a text comparison programme to find all the edits. Line-by-line check of the edited text. Compared the results from the automatic spreadsheet and manually created version to find the same results are produced.
Model Automation	Orange	**Convert_WITA_Matricies.xls, Weight_Transit_Times.xls** Used a text comparison programme to find all the edits. Line-by-line check of the edited text.
Model Implementation	Orange	SCM input checks to confirm core stations have been updated as suggested. <<Stnattributes.txt>> has been checked to see that the correct stations (Chester, Shrewsbury and Hull) have been converted to non-core. <<SCM_hsl_logsum_v6_33z.cpp>> code has been checked to confirm all "9999"'s in the code have been correctly updated to "99999". These updates were tested in a standalone run which was fully orange checked.
Model Implementation	Orange	The wormhole updates were tested in a standalone run which was fully orange checked.
Model Implementation	Orange	Each of the preload process updates was tested offline to check the functionality and that there were no major changes in model results.

Type of QA check	Level of check	Details of check
Model Implementation	Orange	Appraisal Pre Processing Program Updates were tested in isolation and found to make no difference to model results.
Model Implementation	Orange	The PS HS network updates were tested in a standalone run on which yellow checks were completed. Results had a larger impact on the economics than expected, however further investigation did not suggest an error in the model setup. This has fixed a known error in PS and as such as been included. It is deemed that the previous result was incorrect.
Model Implementation	Orange	The other network changes were tested in a standalone run which was yellow checked and no major impacts were found.
Model Results	Orange	PFMv4.5 version of the model has undergone a full orange check. This has included the standard model input and output checks and the completion of documentation. As part of the check of the model inputs a check was performed that ensured that the implementation items were all incorporated in the final model run. This orange checking process has not identified any issues in this version of the model and as such has been signed off internally by the model developers.
Model Results	Third-party review	PFMv4.5 and its outputs have been reviewed and replication runs performed by a third party to ensure accuracy of model results.

4 PFMv4.6

4.1 Summary of changes

4.1.1 Compared to PFMv4.5, model version PFMv4.6 incorporates minor model improvements to resolve some of the issues raised by the audit and quality assurance process. There are also a number of changes designed to improve the usability and efficiency of the model.

4.2 Model development

4.2.1 A series of themed intermediate development versions were created between PFMv4.5 and PFMv4.6 to incorporate the updates. These were as follows:

- PFMv4.5.1b – Development work undertaken prior to the release of PFMv4.5, but not included in PFMv4.5 model release. This included a number of automation items, an alteration to the regional model assignment algorithm as well as some minor updates to the transit lines;
- PFMv4.5.2 – Appraisal updates and improvements, including strengthening the accuracy of use of financial year and calendar year data;
- PFMv4.5.3 – Updates to the wormhole, ensembles and to transfer.exe (the mechanism which changes demand from geographical to station to station in the PN and PM regional models and vice versa);
- PFMv4.5.4 – Further minor network updates emanating from the Network Review process;
- PFMv4.5.5 – Automations and corrections / improvements based on an auditor review of 4.5.1 to 4.5.4. This was subsequently renamed as PFMv4.6.

PFMv4.5.1b

4.2.2 PFMv4.5.1b was built in two step-change tests. The first, PFMv4.5.1a, combined a set of updates which had previously been tested in isolation and found to have small impact to the model results. PFMv4.5.1b was built on top of this test and a further item was addressed which sought to improve rail assignment procedures in the regional models. A description of each of the issues addressed in PFMv4.5.1b is given in the tables below.

Table 6 - Summary of changes Implemented in PFMv4.5.1b

Step change	Description of issues that have been addressed
PFMv5.1a	Incorrect TLC codes in the model changed.
PFMv5.1a	Removal of unused node from the network.
PFMv5.1a	HS10-U segment 99704 - 6849 6843, is duplicated in the coding. This has been rectified.
PFMv5.1a	In Phase 2 network, links between nodes 502 and 799 have been deleted.
PFMv5.1a	Zone 220 in Phase 1 and Phase 2 networks, label changed to BNY not BRN.
PFMv5.1a	Zone 221 label has been changed to RMC.
PFMv5.1a	Zone 212 label has been updated to MHS.
PFMv5.1a	Zone 207 label has been updated to HMHS.
PFMv5.1a	Links 799-502 (Paddington - Acton) and 96663-96664 (Meadowhall - CLN) not required, for neatness these have been deleted.
PFMv5.1a	In Phase 2 network link 92966-92970 is 3.54 in length, should be 1.77 to be consistent with Phase 1 and DM.
PFMv5.1a	The tram service that connects Toton to the wider classic network is included in the Phase 1 networks but not the Phase 2, this has been corrected to be included in Phase 2.
PFMv5.1a	A review of transit line coding has revealed that Harrow & Wealdstone has been incorrectly coded as a stop for a number of LM services. The Harrow & Wealdstone stop has been removed from the following lines in the PLD DM scenarios: LM173U; LM230U; LM270U; LM325U; LM346U; LM358U; LM361U; LM363U; and LM369U. The Harrow and Wealdstone stop has been removed from the following lines in the PLD Phase 1 and Phase 2 DS scenarios: LM403U; and LM405U. The service LM421U is also affected by this amendment in the DS scenario, though this issue has been addressed elsewhere.
PFMv5.1a	Phase 2 DS networks: transit line (TP136) has been updated such that it is no longer curtailed between Manchester Airport and Manchester Piccadilly, but it is curtailed north of Manchester Piccadilly instead.
PFMv5.1a	A review of transit line coding has identified that Euston to Litchfield services (LM421 and LM422) were incorrectly coded in PLD Phase 1 and Phase 2 DS scenarios. These services have now been updated to ensure connections to Litchfield Trent Valley (LTV) are now coded; and that the stopping patterns have been updated to include stops at the following stations: Berkhamsted; Leighton Buzzard; Wolverton; Northampton; Rugby; Nuneaton; Atherstone; Tamworth; and LTV.
PFMv5.1a	From a review of coding for PM Phase 2 network, it was identified that services WC310U and WC311U were incorrectly coded to include stops at Lichfield Trent Valley (LTV) and Tamworth (TAM). The PM Phase 2 coding for services WC310U and WC311U have been updated to exclude stops from nodes: 91291 (LTV) and 91322 (TAM).
PFMv5.1a	From a review of coding for PS Phase 1, it was identified that service LM411U was incorrectly coded to exclude a call at Bushey. The PS Phase 1 coding for service LM411U has been updated to include a stop at node 560 (BSH).

Step change	Description of issues that have been addressed
PFMv5.1a	The PS network has been updated for DM, Phase 1 and Phase 2 to include a walk link between HS Stratford and HS Stratford DLR (10867 - 1055).
PFMv5.1a	The following services have been updated in the preload process to better match Cross-Country services between the PLD and PS sub-models. XC106-, XC124-, XC126-, XC139- and XC140- in PS; andXC113-, XC115-, XC117-, XC119-, XC121-, XC124-, XC165-, XC169-, XC174-, XC206-, XC181-, XC185-, XC187-, XC188-, XC189-, XC190-, XC191-, XC240-, XC241-, XC242-, XC243-, XC244- and XC245- in PLD.
PFMv5.1a	The following services have been updated in the preload process to better match East Coast services between the PLD and PS sub-models. EC313D and EC316D in PS; and EC313D, EC314D, EC317D, EC208U, EC211U, EC212U and EC226U in PLD. This has been carried out for DM and Phase 1 preload process only.
PFMv5.1a	Removed service EC200U from the preload process for all forecast scenarios.
PFMv5.1a	Updated the matching of network nodes between the PLD and PN sub-models to better represent the network structure and directionality on the edges of the PN network. The macro code has also been edited to ensure that preloads are correctly mapped between affected links. This has been carried out within the preload process for all forecast scenarios.
PFMv5.1a	Removed service HT220U from the preload process in the Phase 2 scenario.
PFMv5.1a	Updated the matching of London Midland services LM401U and LM402D between PLD and PS sub-models to better represent the directionality in the Phase 2 preload process.
PFMv5.1a	The process for importing the following model inputs has been reviewed and where necessary has been converted from manual to automated inclusion, before the commencement of a model run: • PS demand matrices; • Fares; • Ensembles; and • HAM base year costs. More details can be found on this in Appendix A.3.1.
PFMv5.1b	The procedures used to call the rail assignment in all of the regional models have been updated to be consistent with PLD to facilitate post assignment analysis. The actual assignment algorithm was not changed just the procedures used to call it. More details on this can be found in Appendix A3.1.

PFMv4.5.2 updates

4.2.4 The updates made in version PFMv4.5.2 relate to the appraisal issues identified by QA procedures. It also includes updates required to the TOC (Train Operating Company) codes.

As well as the items reported here the DM*year*.BAT and DS*year*.BAT files have been updated so that the year in their names is not present. This is to make the model more robust. Table 7 - Summary of the changes implemented in PFMv4.5.2

Item	Description of change in 4.5.2
1	All macros that reference individual TOC codes were reviewed. The following macros in PM did not reference TOC code ZZ and were updated to include it: TOC_PM.mac, PM-Economic.mac, setup_2009.mac and net.mac. Details of the review process are presented in Appendix A3.2.

Item	Description of change in 4.5.2
2	An adjustment has been implemented in both PLD and in the appraisal to convert WebTAG parameters from calendar year to financial year in line with the demand and fares data in the model. This is simply implemented as 75% x current year value + 25% x following year value for each item from WebTAG. Within PFM this related to vehicle operating costs and air fares. The review of air fares identified that they were still in 2008 prices so this update included uplift from 2008. Details of these changes are shown in Appendix A3.2.
3	The convergence tab has been included and completed in v4.5.2 of the appraisal spreadsheet.
4	The model contained outputs which are imported into the appraisal template with date stamps in the file name. On a small number of occasions the model has reached this point around midnight, which results in some files being generated before midnight and some afterwards. The spreadsheet is unable to import the necessary set of input files if they have different time stamps. To prevent this happening the time stamps have been entirely removed from the file names.
5	Highway access and egress vehicle kilometres have been included in the total vehicle kilometres used for the MECC calculations. This has been incorporated into the appraisal import macro which takes in the demand as well as access and egress distances from the SCM and calculates the kilometres from this.
6	As requested by HS2 Ltd all VLOOKUP statements in the appraisal spreadsheet replaced with INDEX / MATCH statements instead.
7	The MECC's data was originally included in the model from WebTAG 3.13.2. There was another version of the MECC's data in another unit which was more up to date. This is currently up to date with TAG unit A5.4.
8	The following ranges were found during the audit to be blank: DM/DS: PLD HSLPassKM, PassKm, HSL Train KM For DM: Economics. In v4.5.2 these have been removed.
9	The audit found that in the "OtherAssumptions" tab of the appraisal spreadsheet, "Cell C136 is redundant and currently confusing." In v4.5.2 this has therefore been removed.
10	The audit found that in the "Other Assumptions" tab cell C38 contained a switch that appeared to be intended to let the user choose between CPI and RPI for converting benefits to 2002 prices. The associated conversion factors in cells D39 to D41 were hardwired, so that choice did not, in fact, exist. This redundancy has been removed in v4.5.2[3].
11	The audit found that there was potential confusion in the appraisal spreadsheet by having two places where weights could be input. This has been updated so that there is now only one location this can occur on the "WebTAG" sheet.
12	The carbon value for phase 1 within the model was incorrect. This has been amended in v4.5.2 of the appraisal spreadsheet template.
13	The 40% reduction on GP1 (the impact on GDP from more/less people working) has been removed as it was being applied twice.
14	The appraisal spreadsheet assumed that the kilometres from the highway model were in person kilometres and divided through by an average occupancy factor to convert to vehicle kilometres for the MECC's calculations. It is actually the case that what was being imported into the spreadsheet was vehicle kilometres (this has been checked and verified) so the division by occupancy factor was an error. As a result in v4.5.2 of the appraisal spreadsheet this has been removed.
15	The appraisal spreadsheet has been updated so that all MECC categories are calculated. Those which are not included in the final calculation have been annotated as such in the spreadsheet. Changes in indirect tax changes from the MECC's have also been included in the final numbers.
16	The macros that produce train, seat and vehicle kilometre outputs that feed into the standard appraisal spreadsheet were not located in the correct directory in the model structure and were not picked up in a model run. These macros - TOC_PM.mac, TOC_PS.mac and TOC_PN.mac have been copied into the correct locations.

[3] This has been further refined in PFMv4.8.

Item	Description of change in 4.5.2
17	A full spell check has been undertaken on the appraisal spreadsheet to remove any items which were previously picked up.
18	The vehicle occupancy factor of 1.14 in the WebTAG sheet, which was used to calculate a highway VOT, has been annotated as to its origin within the latest version of the spreadsheet (v4.5.2). The value used is the standard one from WebTAG 3.5.6 grown to 2010 (i.e. the base year) using the standard growth rates from WebTAG. Additionally this time a financial year adjustment has been applied to make the value 2010 / 11.
19	The annotation within the spreadsheet has been updated and enhanced where possible.
20	The WITA excel macros have been amended so that they are no longer looking for a specific line of code in Run_All_36.bat or Run_All_26.bat. These have been replaced with a single Run_all.bat. The WITA excel macros have been updated to be called in the same way as the standard output spreadsheets with parameters being passed directly from the model to excel rather than excel reading in from a text file.
21	It was identified by the auditor that the standard output spreadsheets use "vcaps" instead of "@vcaps" in the summary of train kilometres and that this was an error. The macros that created the outputs for the standard output spreadsheets have been updated to address this.

PFMv4.5.3 updates

4.2.5 The following table details the updates made in relation to ensembles, wormholes and transfer.exe which were included in PFMv4.5.3.

Table 8 - Summary of the changes implemented in PFMv4.5.3

Item	Description of change in 4.5.3
1	The wormhole zone (999111) which was thought to be incorrectly assigned in ensemble group "ge" of the PS01base databank has been found to be extraneous. This zone has been removed from the PS DM network file. In order to facilitate this, the removal of a number of extraneous scenarios in the PS 01base databanks has also been necessary.
2	The file "Heathrow_Inscope_gx.301" has been removed from the model structure. In addition, the two ensembles defining in-scope movements for the HAM have been amalgamated into one.
3	The outputs from the macros "EnvMat_DS.mac" and "Top10_DS.mac" have been found not to be used. These macros have been disabled and the associated ensembles from ensemble group "gb" in the PLD demand databanks have been removed. The macro "batchin_gsensemble.mac" has also been removed from the model structure.
4	The batch files that control the DS runs for two of the regional models (PN and PM) were modified. Previously the base Percentage Split files were used when converting station to station skims into OD skims, but new DS Percentage Split files are created during each iteration based on the change in GJT. This update fixes the code so that the DS Percentage Split files are used when converting the DS skims.

PFMv4.5.4 updates

4.2.6 The following table details the network and transit line updates included as part of PFMv4.5.4.

Table 9 - Summary of the changes implemented in PFMv4.5.4

TOC	Model(s) affected	Issue found	Action
Crossrail	PLD	Services do not all stop at Liverpool Street.	All services reviewed and updated to stop at Liverpool Street station where required
East Coast	PN	**Newcastle – Edinburgh:** Inconsistent link journey times in PN compared to PLD on this section of the ECML network.	Journey times updated in PN to match those in PLD
East Midlands	PLD	**Derby – St Pancras:** Services found to not be coded into PLD.	Services added to PLD transit lines
East Midlands	PLD	**Lincoln – Peterborough (and reverse route):** Lincoln – Peterborough should be 8 daily services, rather than 5.	Headway updated in the PLD transit lines in both directions.
East Midlands	PLD	**Mansfield Woodhouse – Nottingham:** There should be 11 daily services in PLD.	Headway has been updated in the PLD transit lines.
East Midlands	PLD, PM, PN	**Worksop – Lincoln:** No direct trains operated by East Midlands, but services coded into PLD, PM and PN.	These services have been removed from PLD, PM and PN.
East Midlands	PLD	**Nottingham – Sheffield (and reverse route):** No service found in timetables operated by East Midlands, but one daily service coded into PLD.	Removed services from PLD model East Midlands transit lines.
East Midlands	PLD	**Corby – Melton Mowbray:** One service modelled in PLD, however no services found in timetables operated by EM.	Removed service from transit lines.
East Midlands	PLD	**Kettering – Sheffield:** One service modelled in PLD, however no services found in timetables operated by EM.	Removed service from transit lines.
Cross Country	PLD, PM, PS	**Cambridge – Birmingham New Street (and reverse route):** Should be one daily service operating in PLD and regional models.	These services have been added to the three affected sub-models.
Cross Country	PN	**Cardiff – Manchester Piccadilly:** Service not modelled in PN model.	Service has been added to PN sub-model.
Cross Country	PLD	**Manchester Piccadilly – Exeter St Davids:** Timetabled services call at Stafford whereas modelled services do not.	Added Stafford stop to required services.
Cross Country	PLD	**Newcastle – Southampton:** One service timetabled during AM peak period but not coded into models.	Added this service to the regional models.
Cross Country	PLD, PM, PN, PS	**Birmingham New Street – Edinburgh:** PN should only have one daily service coded instead of two, to be consistent with other regional models.	Headway updated in PN.
London Midlands	PLD	**Birmingham – Crewe:** Journey times reviewed for all services on this route in both directions, and differing directional journey times found on the section between Crewe and Stafford despite similar stopping patterns.	On PLD service LM202-, the journey time has been modified between Stafford-Crewe from 18 minutes to 21 minutes in order to better reflect reality and reduce

TOC	Model(s) affected	Issue found	Action
			journey time difference by direction.
London Midlands	PM, PN	**Birmingham – Liverpool:** Average journey times faster in PM and PN than in PLD for this route. This has been reviewed and found to be due to the balance between the fast and slow services that have been modelled. Comparison with the timetable suggests only one fast services should be modelled in the AM peak period rather than two which is what is currently modelled in PM and PN.	Headways of these services have been modified in PM and PN to represent one fast services and the remaining slow services.
London Midlands	PLD, PS, PM, PN	**Bletchley – Crewe:** 1 train per day (tpd) in PLD and PS, and 2 tpd in PM and PN, with no corresponding return journeys. Services not timetabled in the May 2012 National Rail timetable, on which the DM is based.	These services have been removed from all sub-models.

PFMv4.5.5 updates

4.2.8 The following table lists all the updates included in Model Development release PFMv4.5.5. These included:

- Resolution of residual issues from PFMv4.5.1 to PFMv4.5.4 updates (this includes items that have been updated after discussion with the auditor or items that were not completed in time to go into the version they were expected to);
- Additional automation items; and
- Any 'quick wins'.

Table 10 - Summary of the changes implemented in PFMv4.5.5

Table 1.

Item	Issues/Improvements	Action
Preload Process	Services missing on sections of Chiltern Line in PS	Updated preload process to include necessary services in Chilterns area – DM and DS
Preload Process	Services missing around Sheffield/Meadowhall due to new network structure	Updated preload process to include necessary services around Meadowhall – DM and DS
Preload Process	DM services unmatched between Phase 1 and Phase 2 schemes	Replace Phase 1 preloads with Phase 2 preloads – DM only
Standard Outputs Spreadsheet	Updated standard outputs spreadsheet – TOC code changes in 4.5.2 were found to be incomplete.	Updated standard outputs spreadsheet in 'Templates' folder
Appraisal	GAP statistics included in analysis.	Code python files for pre calculation and add complete statistics to spreadsheet
Appraisal	Vehicle occupancy updates found to be incomplete in PFMv4.5.2.	Correct vehicle occupancy and passenger kms in PFMv4.5.5 appraisal spreadsheet

Item	Issues/Improvements	Action
Batch files	Model clash upon exiting Excel.	Replace closeexcel.exe with taskkill /f /im excel.exe.
Winners and Losers Database Automation	Full data provided immediately from PFM model run and reduce Access file size by linking external sources to the database.	Recode python files and batch file.

4.3 Quality assurance

4.3.1 The QA processes that have been carried out on PFMv4.6 are documented in the following sub-sections.

QA: PFMv4.5.1b

4.3.2 PFMv4.5.1b updates were first tested in a series of development tasks to understand the impact. Each of these development tasks have been through at least a yellow checking process. The level of checks undertaken on each is shown in the table below.

Table 11 - QA Procedures undertaken on PFMv4.5.1b

Model Version	Type of QA Check	Level of QA Check	Check Description
PFMv4.5.1a	Model Implementation	Orange	Line-by-line checking of transit line and network file updates, along with detailed check of preload process.
PFMv4.5.1a	Model Results	Orange	PFMv4.5 version of the model has undergone a full orange check. This has included the standard model input and output checks and the completion of documentation.
PFMv4.5.1b	Model Implementation	Yellow	Yellow checks were completed. In addition, the modified macros were reviewed and set up checks undertaken.
PFMv4.5.1b	Model Results	Yellow	Outputs checks were carried out on changes to the Economic Case, levels of demand and assigned flows on the networks.

QA: PFMv4.5.2

4.3.3 Standard Orange checks have been carried out on version 4.5.2 of the model. This includes comparisons of change in demand, both overall and at the sector level, a review of passenger kilometres and HS2 loadings and a review of overall, sectoral and OD benefits. In addition, for each of the separate updates to the model, more detailed checks were carried out to ensure the updates were correctly implemented and the resultant outputs were as expected.

4.3.4 The updates to the appraisal template have been checked and are detailed in the table below.

Table 12 - PFMv4.5.2 Economic Appraisal Template – Orange Check

Assumptions	Nature of checks	Outcome	Status
Redundant Functionality has been removed.	Check that cells indicated to be removed have gone from spreadsheet.	The remaining cells are now blank.	PASS
Check VLOOKUP and HLOOKUP's have been replaced by index and match.	Check all worksheets to ensure VLOOKUP and HLOOKUP's have been replaced by index and match.	All sheets contain no VLOOKUP or HLOOKUP and contain index commands.	PASS
Appraisal results should only change where the specific updates have been made.	Changes to the values that are calculated and output by the spreadsheet have been compared back to those calculated by the previous version of the template.	Results only change as expected in the total outputs sheet.	PASS
References to specific cells have been given clearer descriptions to help with auditing.	Check labelling has been made clearer where stated in the audit.	Labels mentioned in the Planet Framework Automations note have been updated.	PASS

4.3.6 The adjustment factor to go from calendar year WebTAG parameters has also been checked and the outcome of those checks is detailed in the following table.

Table 13 -Mv4.5.2 Appraisal Spreadsheet Conversion to Financial Year

Assumptions	Nature of checks	Outcome	Status
Conversions need to be applied to modelling assumption inputs to produce financial year data from the calendar year data input.	Check formulas inserted into workbook to convert from calendar to financial years.	Formulas appear to be applying the correct conversion from calendar to financial year.	PASS
Conversions to financial year need to feed through to the calculations in the *YrBreakdown* sheets.	Check formulas in the *YrBreakdown* sheets to make sure they feed the data through correctly.	Formulas appear to be feeding through the correct financial year information.	PASS

4.3.7 Checks were also carried out on the implementation of changes to the TOC code macros and standard output spreadsheet. The outcome of those checks is detailed in the following table.

Table 14 - Update to TOC Codes in PFMv4.5.2

Assumptions	Nature of checks	Outcome	Status
Macros specifying TOC codes have all been updated to include all relevant TOC codes.	Check that TOC_PM.mac, PM_economic.mac, setup_2009.mac and net.mac have all been updated to include ZZ TOC.	All macros have been correctly updated.	PASS
TOC_PM.mac, TOC_PS.mac and TOC_PN.mac should all be in the correct macro directory associated with each regional model.	Check in all regional model directories to ensure correct version of TOC_PM.mac, TOC_PS.mac and TOC_PN.mac is in place.	Relevant macros all in correct directories.	PASS
Standard output spreadsheet included ZZ TOC.	Check that train kilometres, passenger kilometres and seat kilometres tables all contain ZZ TOC. Check ZZ TOC and all other TOCs populated with correct values.	All tables contain ZZ TOC and values for other TOCs correct.	PASS
Standard Output Spreadsheet use @vcaps in train seat kilometres summary.	Check that macros extract data using @VCAPS (TOC_PM.mac, TOC_PS.mac and TOC_PN.mac). Check that train and seat kilometres table in standard outputs contains data that correspond to @vcaps data	Macros extract @vcaps data. Data in standard output spreadsheet corresponds to @vcaps data.	PASS

4.3.9 Finally checks were also carried out on the adjustment factors to go from calendar year to financial year for PFM model inputs. The outcome of those checks is detailed in the following table.

Table 15 - PFMv4.5.2 Conversion between Calendar and Financial Year

Assumptions	Nature of checks	Outcome	Status
Conversion from calendar year to financial year need to be applied to vehicle operating costs values in VOC.mac.	Check that the recalculation of vehicle operating costs has been undertaken correctly and the appropriate values are included in VOC.mac.	Vehicle operating costs have been recalculated correctly. Vehicle operating costs have been correctly transposed to VOC.mac.	PASS
Air fares need to be Converted from 2008 to 2010/2011 calendar year.	Check that factor to get from 2008 to 2010/2011 prices has been calculated correctly. Check that factor correctly applied to air fares.	Growth factors have been recalculated correctly. Air transit lines for both modelled years and DM and DS scenarios contain updated air fares.	PASS

4.3.10 The inclusion of the vehicle kilometres has been checked by undertaking a manual process to complete the same task. Both the manual test and automated version within the spreadsheet gave the same result.

4.3.11 The additional code within the spreadsheet along with formulas and added lines within the spreadsheet have also been checked.

QA: PFMv4.5.3

4.3.12 Standard Orange checks have been undertaken on model version PFMv4.5.3. This has included checks on the individual components of this model run. These checks are detailed in the table below.

Table 16 - PFMv4.5.3 Orange Checks

Assumptions	Nature of checks	Outcome	Status
Wormhole zone 999111 in PS 01base is extraneous and can be removed from the model.	Logic check as to why this zone is in the model. Check to ensure that no links to this zone carry any flow in model results.	Zone is left over from a previous version of the model – there is no reason why this zone should remain. Model results have shown to carry no flow through this zone, nor do any DM transit lines pass through it	PASS
Wormhole zone 999111 and associated links removal has been carried out properly.	Comparison of network files.	Wormhole zone 999111 and associated links have been removed, no other changes present between network files.	PASS
Scenarios 100 and 1999 in PS 01base databanks are extraneous and can be removed.	Isolated testing of removal.	Isolated testing of removal has shown no alteration to model run results.	PASS
"HeathrowInscope_gx.301" is extraneous.	Check where file is called. Test removal in model run.	Line where file was previously called is now a comment. Removal has shown no effect upon model runs.	PASS
Ensemble group gto1 can be absorbed into gtoo.	Check they are always mentioned in macros in conjunction. Check no effect on model results.	gtoo and gto1 are always mentioned in conjunction. Amalgamation shows no effect on model results.	PASS
The macros "EnvMat_DS.mac" and "Top10_DS.mac" are extraneous and their calls can be disabled in "Output_PLD_Demand.mac".	Search through VBA code within the standard outputs and economic appraisal templates. Check results when change is isolated.	Search found nothing in output spreadsheet macros. Isolated removal has shown no effect upon model results.	PASS
Removal of "batchin_gsensemble.mac" from model structure is acceptable.	Model will crash if macro is called but not present.	Model runs without the presence of the macro.	PASS
Only gb04 is used in ensemble group "gb".	Search through macros where "gb" is utilised.	There is no mention of "gb" ensembles except for gb04.	PASS
New versions of the following ensemble files have been created correctly, in which gto1 is absorbed into gtoo and all "gb" ensembles are removed except for gb04: Ens_PLD_01base_demand.301 Ens_PLD_02base_demand.301 Ens_PLD_03test_demand.301	Comparison of original and edited file.	gto1 is now in gtoo. All "gb" ensembles have been removed except from gb04 in all files.	PASS

"logit10comp_PM.bat" and "logit10comp_PN.bat" replaced with new files which pick up new percentage split files (output from logit functionality) to produce geographical OD pair skims, rather than the original percentage split files.	Logic checks on the code. Sample OD check – both when new files picked up and with old files to confirm our understanding of the code.	Code correctly picks up new percentage split files with the correct iteration suffix used. File output by process shows correct, rather than original, percentage split file used when examining sample ODs. Calculation matched for old files with original percentage split files.	PASS
Check sensibility of new "logit10comp_PM.bat" and "logit10comp_PN.bat".	Use of echo commands and pause to confirm value of suffix variable at each stage of loop.	Suffix variable correct at each loop.	PASS

QA: PFMv4.5.4

4.3.13 The code within the model has been checked using file text comparison software to ensure the changes have been implemented throughout all the versions of the model where appropriate.

4.3.14 The coding checks undertaken have identified that the transit line corrections have been incorporated correctly into the transit lines.

4.3.15 Once the model was complete, the seat, passenger and train kilometres have been analysed to make sure the changes to the transit lines files were reflected in these outputs.

QA: PFMv4.5.5

4.3.16 PFMv4.5.5 is the final intermediate step through model run of each of the individual changes. This is also known as PFMv4.6 and has been subjected to a full orange check and approval procedure.

Table 17 - PFMv4.5.5 Model changes – Orange Check

Assumptions	Nature of checks	Outcome	Status
GAP Statistic	Check of the python script with a manual stand-alone spreadsheet.	Manual spreadsheet replicates the python script for one iteration.	PASS
Appraisal Spreadsheet Updates	Check of the implementation of the changes to the appraisal spreadsheet to include GAP statistic and updates.	Changes were found to have been implemented correctly.	PASS
Closeexcel.exe changes	Check all calls to closeexcel.exe have been replaced with DOS command.	Check confirms all instances have been found.	PASS
Winners and Losers Database automation	Python script and batch file have been checked.	Outputs have been checked and are being produced correctly.	PASS
Preload Process Updates	Check that correct version of the preload process has been used in DM.	Checked and verified.	PASS
Updated Standard Output Spreadsheets	Updates to the standard output spreadsheet have been checked.	Updates implemented correctly.	PASS
Updated preload process	The changes to the preload process has been checked that the changes have been implemented correctly.	The changes have been checked and have been found to have been implemented correctly.	PASS

5 PFMv4.7

5.1 Summary of Changes

5.1.1 Compared to PFMv4.6, PFMv4.7 incorporates a number of significant changes, including:

- updated future-year demand matrices that take account of revised growth forecasts of rail, air and highway demand. The rail growth takes account of the WebTAG update in Autumn 2014[4], as well as incorporating elements of PDFHv5.1 guidance and the latest forecasts of the economic and cross modal demand drivers, including GDP, employment, population and rail fares;
- as a result of revised rail growth assumptions the cap year on demand growth has changed from 2036 to 2040;
- as well as the forecasting models, assumptions within the demand and appraisal models have also been updated to be consistent with the guidance contained within the WebTAG Autumn 2014 release. Most importantly this involves updating the GDP assumptions used to grow values of time in the appraisal model to be consistent with those used by the demand forecasts; and
- there have also been updates to the control matrices, highway preloads, air transit lines, together with a number of fixes to small bugs within the model.

5.2 Model development

5.2.1 PFMv4.7 has been built in three step change iterations in order to assist with implementation and quality assurance. These are:

- *PFMv4.6.1* incorporates non-economic growth related updates from the latest release version of WebTAG (TAG data book: forthcoming changes, Autumn 2014).
- *PFMv4.6.2* incorporates updates to economic growth driven inputs from the same WebTAG release, alongside revised assumptions regarding the growth of rail fares.
- *PFMv4.7* builds upon PFMv4.6.2 and includes demand forecast changes and subsequent cap year change. The demand forecast year changes also includes an update to the control matrix functionality.

5.2.2 The following table contains a summary of the updates implemented in the PFMv4.7 model in a step through approach.

[4] WebTAG Databook Autumn 2014 Forthcoming Changes

Table 18 - Updates included within PFMv4.7

Area of change	Description of change
PFM v4.6.1 - Updated WebTAG Assumptions	
Model	Future-year vehicle operating costs updated in line with WebTAG data book Autumn 2014 forthcoming change.
Model	Vehicle Operating Costs (VOC) and Growth indices in the HAM updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Value of Time (VOT) assumptions for Employer's Business updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Car Occupancy per vehicle KM travelled (work), updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Green Book Discount rates updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Market Price Adjustment Factor updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Passenger km increase diverted from car updated in line with WebTAG unit A5.4.
Appraisal	Wider impact assessment value updated in line with WebTAG unit A5.4.
Appraisal	Average vehicle speed - 'WebTAG' worksheet –updated using data extracted from PLD model.
Appraisal	Central value of non-traded carbon, £ per tonne CO_2e - 'WebTAG' worksheet updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	VOT (work and non-work) growth rates (2003-2010) - 'VOT' worksheet - updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Rail Fares growth rates – 'Other assumptions' worksheet updated in line with Government policy at the time[5].
Appraisal	Vehicle Fleet Proportions- 'WebTAG' worksheet, updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Marginal external costs by road type and congestion band - 'Hwy from WebTAG' worksheet, updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Fuel consumption parameters - 'WebTAG' worksheet and fuel costs per litre - 'WebTAG' worksheet updated in line with WebTAG data book Autumn 2014 forthcoming change.
PFM v4.6.2 - Updated GDP applied to VOT Growth	
Model	Growth factors for VOT updated in line with WebTAG data book Autumn 2014 forthcoming change.
Model	Rail fare growth factors for VOT, updated in line with WebTAG data book Autumn 2014 forthcoming change.
Model	Rail fare growth updated in line with Government policy at the time.
Model	VOT growth indices in the HAM updated in line with WebTAG data book Autumn 2014 forthcoming change.
Model	Rail and coach fare growth indices in the HAM updated in line with WebTAG data book Autumn 2014 forthcoming change.
Model	Airport parking charge and tax fares in the HAM updated in line with WebTAG data book Autumn 2014 forthcoming change.
Appraisal	Short-term GDP forecasts – 'VOT' worksheet – updated using latest Office of Budget Responsibility (OBR) forecasts.

[5] Note this has since been further updated in PFMv5.2

Area of change	Description of change
Appraisal	Long-term GDP forecasts – 'VOT' worksheet – updated using latest OBR forecasts.
Appraisal	Population annual forecast growth rate – 'VOT' worksheet – updated using latest Office for National Statistics (ONS) forecasts.
Appraisal	GDP Deflators – 'WebTAG' worksheet –updated using latest HM Treasury forecasts.
PFM v4.7 Matrix and cap year updates	
Model	New PLD forecast year matrices (2026 and 2040) for rail, highway and air modes based on updated growth forecasts.
Model	New PS, PM and PN forecast year matrices (2026 and 2040) for rail, highway and air modes based on updated growth forecasts.
Model	Updated control matrices for PLD (highway and rail).
Model	Updated control matrix for PS.
Model	Updates to highway link preload values in PLD to reflect new forecasts and revised cap year.
Model	Updates to the air networks in order to incorporate revised forecast year air transit lines.
Model	Airport demand in HAM updated to represent new cap year.
Model	Vehicle operating costs in PLD updated to reflect new cap year.
Model	Vehicle operating costs in HAM in PLD updated to reflect new cap year.
Model	HAM modified to allow a 2040 cap year.
Appraisal	Updates to the sectorial benefits spreadsheet to reflect updated growth in value of time and revised cap year.
Appraisal	Manual adjustment to appraisal spreadsheet to reflect new cap year.
Other miscellaneous changes	
Model	Updates to ensure the automatic inclusion of the highway control matrix.
Model	Alterations to ensure the automatic inclusion of the PS demand matrices for scenario 2000 of the 02test demand databank.
Model	Changes to the call of taskkill with respect to closing excel in DM.bat and DS.bat.
Model	Updates to Run_All.bat and RunTests.bat to ensure that Python files can be called on all modelling machines.
Model	Updates to Python files which had previously not been included on the Y26 model.

5.2.3 In addition, there were a number of elements included in the WebTAG Autumn 2014 release that potentially required corresponding updates in the PFM. These have been reviewed but updates were found not to be necessary. These are shown in the following table.

Table 19 - Updates found not to be necessary within PFMv4.7

Item	Reason
VOT – base year	The base year values of time included in the demand model have not been updated as the demand model was calibrated using these values. The base year values of time in the HAM are Heathrow specific and have not been recalculated.
VOC – base year	The base year VOCs are derived from the National Travel Survey 1999-2001. These are journey purpose and origin-destination specific. WebTAG only includes data for 2000 and change factors by journey purpose (not by origin-destination).
Vehicle occupancies – future year	Although WebTAG provides guidance pertaining to the change in vehicle occupancies over time, the current modelling approach is to retain the use of base year vehicle occupancies in the forecast years. To allow a change in future-year vehicle occupancies further model development would be needed, which given the very small impact on appraisal results this change is expected to have has not been prioritised to date.

Update of WebTAG and other values

5.2.5 Updates have been made to the application of rail fare growth to bring the approach in line with the Government guidance at the time. This guidance placed a cap on rail fare growth at a rate of RPI + 1% for all years except for 2014 and 2015 which have a growth rate of RPI + 0%. This change results in a reduction in generated rail fares revenues however the change of cap year to 2040 from 2036 drives more revenue with the additional growth in rail fares over these four years.

5.2.6 New growth indices for VOT have been obtained from the WebTAG Autumn 2014 release data, and incorporated into the model. These values are directly derived from the growth in average GDP per capita. The growth indices used are consistent between work and non-work demand segments. This results in a reduction of 0.5% in VOT for 2026 and a reduction of 0.4% for 2036.

5.2.7 VOCs for cars are expressed in pence per kilometre per vehicle for fuel and non-fuel components. These are hard coded into the model for each forecast year. These figures have been calculated using guidance contained within the WebTAG Autumn 2014 release data and the new figures inserted into the model. The updated guidance resulted in minimal change to non-fuel costs, an average of a 1% reduction in 2026 fuel costs, and a 10% increase in fuel costs for 2036. A subsequent update has been carried out as part of the work to change to a 2040 cap year, although the effect of this on VOC values is negligible.

5.2.8 Growth indices for business VOT in the HAM have been updated on the same basis as the wider model. Growth in leisure VOT within the HAM has an elasticity of approximately 0.804 applied and this approach has been retained, whilst updating to use inputs from the WebTAG Autumn 2014 release data. This resulted in an approximate reduction of 1% in forecast VOT in the HAM for 2026 and 6-7% increase in the cap year for both business and leisure travellers.

5.2.9 Base year VOCs in the HAM have been recalculated for the two demand segments based upon the latest guidance. The previous simplifications have been retained and

the growth indices for the forecast years have been recalculated with the WebTAG Autumn 2014 release data on the basis of a demand weighted average between the UK business and UK leisure segments. The effect of this change upon the VOCs was variable depending upon year and demand segment. The most significant change was a 30% increase in VOCs for leisure travellers in the cap year.

5.2.10 Rail fare growth in the HAM has been updated on the same basis as for the wider model, at a rate of RPI + 1% per annum with the exception of 2014 and 2015 which have a growth rate of RPI + 0%. This has resulted in a reduction in rail fares for both modelled years. Note that this is different to the impact observed in PLD, which implies that rail fare growth was not previously modelled consistently between PLD and the HAM.

5.2.11 Coach fares for the HAM have been previously grown on the same basis as for rail fares, and this approach has been retained.

5.2.12 The growth in taxi fares and airport parking charges is applied in line with the growth in GDP per capita. The indices which do this have been updated using the values in the latest release of the WebTAG databook.

5.2.13 More details on this can be found in Appendix A4.1.

Demand forecast and cap year changes

5.2.14 Future-year demand matrices for all elements of the model have been updated to reflect the WebTAG Autumn 2014 release data on forecasts of economic growth.

5.2.15 This process was first carried out during the PFMv4.7 update and it was revised for rail demand growth in PFMv5.1 when it was found that an incorrect employment growth demand driver had been used during the forecasting process (see chapter 8). The amendments at this stage had a small effect on rail demand though not large enough to alter the cap year.

5.2.16 The process for forecasting future-year demand by mode is documented in full in the report '5130012 Atkins Final Report v4' in which the future-year levels of demand by mode are also presented (for the updated version of the forecasting). The revised forecasting to incorporate WebTAG Autumn 2014 release data produces the following updated inputs to the PFM:

- future-year rail demand matrices for PLD, PS, PM and PN sub-models;
- future-year highway demand matrices for PLD, and future-year highway preloads for the highway network contained within PLD;
- future-year air demand for PLD.

5.2.17 The change in cap year that results from the updated forecasting process also necessitates the further following updates to the PFM, which are discussed below:

- recalculation of Vehicle Operating Costs (VOC) for the new cap year;
- network changes; and

- Heathrow Access Model (HAM) forecast updates.

Vehicle Operating Costs

5.2.18 The cap year change has necessitated the Vehicle Operating Costs (VOC) be recalculated and input to the PFM. These have been calculated using the WebTAG Autumn 2014 release data using a method consistent with the derivation for previous versions of the PFM.

5.2.19 These are documented with the WebTAG updates in Appendix A4.1.

Network changes

5.2.20 The air networks in the PFM require the input of air fares for each air service represented within the PFM. This is in order to calculate an accurate representation of the generalised cost for the air journey to compare against alternative routes.

5.2.21 The air fares that are input to the PFM within the network files are grown from base year values using a set of projections for domestic air fare growth in the UK by journey purpose. This same projection has been used to recalculate the air fares for PFMv4.7 and the cap year of 2037.

Heathrow Access Model Updates

5.2.22 The Heathrow access model (HAM) within the PFM is a spreadsheet mode choice model representing surface access trips to/from Heathrow airport. The model includes DfT demand forecasts for air passenger demand accessing Heathrow airport along with a catalogue of costs associated with accessing the airport by varying modes.

5.2.23 The cost assumptions and demand forecasts have been updated in PFMv4.7 to reflect the change in demand cap year. The cost assumptions that have been updated are listed below and the revised values have been calculated using the existing range of values within the HAM. Where values were not already existing for 2040 specifically these have been calculated by assuming the average yearly growth rates over the range of years, and interpolating to calculate intermediate years:

- values of time for business and leisure purposes;
- vehicle operating costs;
- rail fares;
- airport parking charges; and
- taxi/minicab fares.

5.2.24 The DfT demand forecasts within the HAM for the cap year have been updated in PFMv4.7 by extrapolating the existing forecasts for 2026 and 2036 in PFMv4.6.

Other cap year changes

5.2.25 A number of other adjustments have also been necessary within the VBA code which runs the HAM to allow a modelled year of 2040. These are only minor mechanical changes.

5.2.26 An update to the sectorial benefits analysis has also been included with PFMv4.7. This includes changes to the growth in VOT over time, to be consistent with the appraisal spreadsheet updates.

Control matrix updates

5.2.27 The rail matrices used in PFM have trips removed from them to ensure that any one PLD zone-to-zone movement is represented in only one of the four PLANET models ensuring that no origin-destination journey pairs are double counted.

5.2.28 Prior to PFMv4.7 the following matrices were provided as input to a run of PFM:

- For the PLD matrices, all trips internal to PS are removed. Trips that are internal to PM are also removed. This masking process is applied to the base year matrices as part of the demand forecasting;
- For the PS matrices, all trips are removed other than the internal ones. This masking process is applied to the base year matrices as part of the demand forecasting; and
- The PM and PN matrices contained all trips.

5.2.29 During a run of the model a control matrix was applied to remove the following:

- PLD trips internal to the East Midlands Travel to Work Area (TTWA) and the TTWAs in PN;
- For PM and PN, all trips other than those internal to the defined TTWAs;
- All intra-zonal trips; and
- Trips wholly within Scotland and South Wales.

5.2.30 In PFMv4.7 the removal of trips has been undertaken at the exogenous forecasting stage in a single process. The exogenous forecasting has been undertaken on the full base year matrices, and the control matrices have been applied to these matrices prior to inclusion in PFM.

5.2.31 During the update to PFMv4.7 process four zones on the edge of the Planet South (PS) boundary and previously included in PS were moved to PLD. These zones were:

- 28 (Corby);
- 59 (East Northants);
- 98 (Kettering); and
- 165 (Peterborough).

5.2.32 The full details of the zones allocated to each area in the PLD model are included in Appendix A4.2.

Other miscellaneous changes

5.2.33 The automated process used to batch in the PLD highway control matrix was found to be ineffective in PFMv4.3, since the matrix slot containing this matrix is not initialized prior to its inclusion. This would mean that the control matrix already within the databank has been applied. The correct control matrix was included in the existing model, but any updates would not be automatically read in. This has been corrected by updating the macro controlling this process to initialize the relevant matrix slot prior to the batching in of the highway control matrix.

5.2.34 In the course of updating the matrices, it was noted that the automated process to include the PS matrices prior to an assignment did not update the matrices for the run of scenario 2000 in the 02test databank. Scenario 2000 corresponds to PLD 02base. The demand matrices are only copied forwards at scenario 2001, which corresponds to PLD 03test databank. This problem had previously been hidden since the matrices in the databank at the end of a model run had been updated just prior to the running of scenario 2001, and hence date stamps appeared correct. A correction has been applied that ensures that the matrices are automatically batched into the PS 02test databank prior to the running of scenario 2000. This should have had no effect upon the results of previous models, since the original automation was carried out after the last demand update. As such, the matrices remaining within the databanks were correct.

5.2.35 It has been noted that "taskkill", which is used to close Excel after its use in the model, is incorrectly called in DM.bat and DS.bat. These batch files have been altered to correct the command.

5.2.36 The calling of a number of Python files has recently been implemented to process outputs at the end of a model run. These calls require the presence of another Python related file in a specific location on the storage drive of a modelling machine, which has been hard coded into Run_All.bat. Whilst this file is present in the correct location on all machines, the storage drives on the modelling machines do not all have the same drive letter. The correct path has now been included as an input that the user must alter as a part of RunTests.bat, which is carried through to the calling of these Python files in Run_All.bat.

5.2.37 The aforementioned Python files had not been updated to the final versions within the 2026 Phase 1 model of PFMv4.6. This has been rectified in PFMv4.7.

5.3 Quality assurance

5.3.1 The model development changes between PFMv4.6 and PFMv4.7 have been through a QA process; these are detailed in the table below.

5.3.2 The checks on the updating of WebTAG and other values within the model have included the following processes:

- checks to the calculation of updated values; and
- ensuring that the new values have been correctly incorporated into the model.

5.3.3 The checks to updating the matrices and cap year have included the following processes:

- checks to the source of the input files; and
- ensuring the new inputs are correctly located within the model run structure.

5.3.4 The checks to updating the matrices and cap year have included the following processes:

- checks to the source of the input files; and
- ensuring the new inputs are correctly located within the model run structure.

5.3.5 The checks to the other updates have included the following processes:

- line-by-line checks of altered code; and
- date stamp checks to ensure the correct functioning of altered automation.

Table 20 - PFMv4.7 QA Checks

Type of QA check	Level of check	Description of check
Theory & Methodology	Peer Review/HS2 Review	The methodology for the changes to the WebTAG values, cap year and matrices has been agreed with HS2 Ltd and the auditor.
Theory & Methodology	Peer Review/HS2 Review	The source of input data for the changes to the WebTAG values, cap year and matrices has been agreed with HS2 Ltd and the auditor.
WebTAG implementation checks		
Model Implementation	Orange	Rail fare growth - Checked the logic of changes and line-by-line check of the coding used. Comparison of old and new factors. Checked values were contained within updated file. Sample check of values produced by isolated code.
Model Implementation	Orange	VOT growth - Logic check of alterations. Comparison of new and old values. Check that correct source data has been used and calculated values are included within the updated files.
Model Implementation	Orange	Future-year VOCs - Checked values used for calculation have been correctly extracted from the latest version of WebTAG. Check of spreadsheet formulae used and the inclusion of the calculated values within voc.mac.
Model Implementation	Orange	HAM VOT Growth - Check values of time have been taken from appropriate sources and indices calculated correctly. Check that the correct values have been included in the updated HAM demand spreadsheet.
Model Implementation	Orange	HAM VOC Values - Checked source VOC values have been carried forward to index calculation and the logic of the index calculation. Check new values included within final spreadsheet. Comparison of old and new values.
Model Implementation	Orange	HAM Rail and Coach Fare Growth - Checked the external calculation of the calculation of growth indices. Checked correct source data has been carried through. Checked

Type of QA check	Level of check	Description of check
		new values have been included within updated files. Comparison of old and new values.
Model Implementation	Orange	HAM Taxi and Airport Parking Charges - Checked the external calculation of the calculation of growth indices. Checked correct source data has been carried through. Checked new values have been included within updated files. Comparison of old and new values.
Future-year demand and cap year changes		
Model Implementation	Orange	PLD matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match and the use of text file comparison program.
Model Implementation	Orange	PM matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	PN matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	PS matrices - Line-by-line check of macro code used to externally apply the PS control matrix. Check that the correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	PLD control matrices - New and old control matrices have same format. New control matrices have been created correctly. New control matrices have been included in the correct location within the model runs.
Model Implementation	Orange	HAM Demand - Logic check of the changes contained within the HAM spreadsheet. Logic check of methodology. Check that the correct values have been included at the specified location within the updated file.
Model Implementation	Orange	VOCs - Check external spreadsheet calculation of VOC values. Check the values from this spreadsheet have been correctly exported to voc.mac.
Model Implementation	Orange	Heathrow ADM VOCs - Worked through check of calculation of vehicle operating costs specified above and a check of the demand weighting process used to calculate the combined value for VOC figures. Comparison of old and new values.
Model Implementation	Orange	PLD demand networks - Check that highway preloads have been extracted from the correct locations and the correct preload values are included in the new networks. File name check for the new networks within the model runs. Format for new network files is correct. Data for the right year has been appropriately included.
Model Implementation	Orange	PLD demand transit lines - Logic check of Python code used to generate air fares in 2010 prices. Check that values generated by this code are consistent with those calculated in another manner. Check that format is consistent and new transit lines batch in correctly.
Other Updates		
Model Implementation	Orange	Automatic inclusion of highway control matrix - Line-by-line check of macro changes. Check that new macro has been inserted into the correct directories of the model run. Date stamp check to ensure that control matrix is now batched in automatically.

Type of QA check	Level of check	Description of check
Model Implementation	Orange	PS demand matrix inclusion fix - Logic check of changes made to batch files and macros. Creation of model runs set to end part way through process in order to enact an appropriate date stamp check. Check that updated files have been included within models.
Model Implementation	Orange	Fix to call of taskkill - Logic check of minor alteration. Text file string search within remaining batch files to ensure that all of the problematic calls to this command are fixed. Check that updated files have been included within the models.
Model Implementation	Orange	Python file path setting - Logic check of minor alterations. Check updated files have been included within the correct locations.
Model Implementation	Orange	Inclusion of Y26 Python files - Date stamp check of the .*.py files included within the model runs

Appraisal spreadsheet changes

5.3.6 The appraisal spreadsheet associated with this step through process has been checked. The individual updates for PFMv4.6.1 and PFMv4.6.2 were orange checked against each of the changes in the table in Appendix A4.1. These are documented in the QES sheet of the PFMv4.7 appraisal spreadsheet.

PFMv4.7 final model QA

5.3.7 The model run incorporating all of the changes between PFMv4.6 and PFMv4.7 has been through a thorough QA process and these checks are detailed in the table below.

Table 21 - Model Results QA Checks

Type of QA Check	Level of check	Description of check
Model Results	Model developer: Orange check	PFMv4.7 version of the model has undergone a full orange check. This has included the standard model input and output checks and the completion of documentation. As part of the check of the model inputs a check was performed that ensured that the implementation items were all incorporated in the final model run. This orange checking process has not identified any issues in this version of the model and as such has been signed off internally by the model developers.
Model Results	Third Party Review	PFMv4.7 and its outputs have been reviewed and replication runs performed by a third party to ensure accuracy of model results.

6 PFMv4.8

6.1 Summary of changes

6.1.1 Compared to PFMv4.7, PFMv4.8 incorporates updated HS transit line service coding, that takes into account revised reliability assumptions.

6.2 Model development

6.2.1 The reliability assumptions applied to the HS2 timetable have been reviewed and updated. As a result both the Phase 1 and Phase 2 transit line files have been updated to include the revised HS2 coding.

6.2.2 As the PFM model does not include reliability as a specific term within the GJT formulation, the reliability of HS2 is instead captured using the fairly simplistic approach of making adjustments to the journey times as a proxy for changes in reliability.

6.2.3 This approach to modelling reliability has been updated to take into account delay data from a new and more up to date source[6]. The modelling of reliability is documented in more detail in the report 'Assumptions Report: PLANET Framework Model version 5.2'; the change in journey time reductions between PFMv4.7 and PFMv4.8 is shown in the tables below.

Table 22 - Change in Reliability between PFMv4.7 and PFMv4.8 (Phase 1)

Service	PFM v4.7 HS2 Journey time reduction (minutes)	PFMv4.8 HS2 Journey time reduction (minutes)	Change (minutes)
HS1/HS2/HS3 London to Birmingham Curzon Street	-8	-6	2
HS4/HS5/HS6 London to Manchester	-6	-7	-1
HS7/HS8 London to Liverpool	-6	-7	-1
HS9 London to Preston	-6	-7	-1
HS10A London to Glasgow	-6	-7	-1

[6] 2012 PEARS Data for WCML, ECML and East Midlands Trains. PEARS refers to Paladin Data Extract and Report System, which is Network Rail's performance system.

Table 23 - Change in Reliability between PFMv4.7 and PFMv4.8 (Phase 2)

Service	PFM v4.7 HS2 Journey time reduction (minutes)	PFMv4.8 HS2 Journey time reduction (minutes)	Change (minutes)
HS1/HS2/HS3 London to Birmingham Curzon Street	-8	-6	2
HS4/HS5/HS6 London to Manchester	-8	-10	-2
HS7/HS8 London to Liverpool	-7/-6	-9/-7	-2/-1
HS9 London to Preston	-7	-9	-2
HS10A/HS11 London to Scotland	-8	-11	-3
HS12/HS13 London to Leeds	-6	-11	-5
HS14 London to Leeds/York	-6/-6	-11/-12	-5/-6
HS15/HS16 London to Newcastle	-6	-12	-6
HS21/HS22 Birmingham to Manchester	-2	-4	-2
HS23 Birmingham to Scotland	-2	-5	-3
HS24/HS25 Birmingham to Leeds	-6	-7	-1
HS26 Birmingham to Newcastle	-6	-8	-2

6.3 Quality assurance

6.3.1 The QA procedures that have been carried out on PFMv4.8 are documented in the following table.

Table 24 - PFMv4.8 QA Processes

Type of QA Check	Level of check	Description of check
Theory & Methodology	Peer Review	The methodology for modelling reliability benefits has been developed by a third party to HS2 Ltd.
Theory & Methodology	Orange	The updated classic line reliability assumptions based on 2012 PEARS data were supplied by HS2 Ltd and applied to the existing HS2 timetable through spreadsheet calculations, creating a final timetable in spreadsheet form. These spreadsheets have undergone rigorous checks to ensure the revised reliability assumptions have incorporated into the journey times correctly.
Model Implementation	Orange	Based on the finalised spreadsheet timetable produced, the transit line files have been manually updated to reflect the revised timetable. The transit line files in question have undergone a line-by-line check utilising a text file comparison program.
Model Results	Model developer: Orange check	PFMv4.8 has undergone a full Orange check. This has included the standard model input and output checks and the completion of documentation. As part of the check of the model inputs a check was performed that ensured that the implementation items were all incorporated in the final model run. This Orange checking process has not identified any issues in this version of the model and as such has been signed off internally by the model developers.
Model Results	Third Party Review	PFMv4.8 and its outputs have been reviewed and replication runs performed by a third party to ensure accuracy of model results.

7 PFMv5.0

7.1 Summary of changes

7.1.1 Further to PFMv4.8, PFMv5.0 incorporates a partial DM network update. These updates to the DM have been derived from:

- A review of the existing DM networks based around the individual Train Operating Company's (TOC's) coding; and
- Updated DM specifications from the DfT.

7.1.2 Not all the updates that were identified through the review above or from the DfT were incorporated within PFMv5.0 due to time constraints for model delivery in 2014. Those that did make it in were selected based on:

- when the data required for the update was available;
- the complexity of the updates; and
- a priority list of TOCs.

7.2 Model development

7.2.1 Throughout 2014 a detailed review of the DM coding within the PFM was undertaken which focussed on six main TOCs, namely:

- East Coast Mainline;
- West Coast Mainline;
- East Midlands;
- London Midland;
- Cross Country; and
- Crossrail.

7.2.2 The reviews were undertaken because, unlike the DS, the DM transit lines have not been through a full checking process. This review sought to address this situation and also look into some known issues with the DM networks. The outcome of these reviews was a series of recommended corrections, improvements and simplifications which could be made to the DM network. Some of these have already been addressed in PFMv4.6 (specifically PFMv4.5.4) as described earlier in this document.

7.2.3 PFMv5.0 picks up more of these recommendations , as shown in the table below:

Table 25 - Network Review corrections included in PFMv5.0

Change	Description of Change
East Midlands	Updated frequencies, capacities and journey times for services in the areas of Lincoln, Nottingham, Newark, Peterborough, Grimsby, and Skegness. The remainder of this chapter gives further details of the partial update to East Midlands train services.
Cross Country	Frequency, capacity and the inclusion of new services for multiple routes within the network. This included 3 extra trains and more frequent services between Southampton and Manchester, combined with reduction of service provision between Bristol and Manchester. Appendix A5.1 gives further details of the updates to Cross-Country services.

7.2.4 Further to the network reviews that were undertaken a series of updates to the DM specification were discussed with the DfT. The DfT subsequently supplied information for updating the DM specification of nine TOCs. This is known as the 2014 DM specification, and provides a more recent view of future-year rail provision.

7.2.5 Due to time constraints, not all of the specified 2014 DM updates were included in the release of PFMv5.0. PFMv5.0 includes the following revisions to the DM specification, which are further discussed in the table below:

- **West Coast Mainline** – Full 2014 DM specification incorporated;
- **TransPennine Express** – Partial update to the 2014 DM specification by updating Scotland services benefitting from the same Carstairs acceleration as included on West Coast Mainline;
- **East Midlands** – Partial specification update focussing on the electrification of Leicester to Sheffield; and
- **Crossrail** – Partial specification update focusing on the service extension to Reading.

Table 26 - Updated DfT specifications included in PFMv5.0

Change	Description of change
East Midlands	Using data supplied by the DfT, services were updated to and from London to Leicester, Nottingham, Sheffield and Corby due to the electrification upgrade on Midland Mainline. The main change was a reduction of the East Midlands Corby services, from 2 trains per hour (tph) to 1 tph in favour of introducing a 1 tph service to Leicester. The Corby-St Pancras trains serving Luton Airport Parkway were re-coded to start/terminate at Leicester. Further details of the partial update to East Midlands train services are given later in this chapter.
West Coast Mainline	Extension of 2tpd Euston-Wolverhampton service to Shrewsbury. Speeding up of services to/from the North West (2 mins JT savings between Crewe-Stafford at Norton Bridge). Speeding up of services to/from Scotland (1.5-3.5 mins journey time savings at Carlisle/Carstairs). Higher frequency of services Euston-Scotland (mainly due to most Birmingham-Scotland services extended to London). Lower frequency of services Euston-Preston/Blackpool. More detail of the updates made to services on the WCML is given later in this chapter. For further details including service specification diagrams refer to the 'Assumptions Report: PLANET Framework Model version 5.2'.
Trans Pennine Express	Re-routing of all TPE Manchester Airport-Scotland services via Bolton instead of Wigan.
Crossrail	Extension of Maidenhead services to Reading. As details were not fully specified, the coding gives a more realistic illustration of Crossrail and the connection to Old Oak Common. For a specification of the changes see appendix A5.2.

7.2.7 Any changes made to the DM network have also been coded into the DS networks as follows:

- For those areas of the network where the DM and the DS are the same, then PFM5.0 DS was updated to be exactly consistent with the DM; and
- For those areas of the network where the DM and the DS are different (either due to HS2 or released capacity changes), then only the journey time and rolling stocks were updated in the PFMv5.0 DS. Furthermore the frequencies and stopping patterns were left as specified from the previous DS.

Updates to the Do Minimum classic line coding

7.2.8 The updates for the DM classic line coding for West Coast Mainline and East Midlands is discussed further within this section. For full details of the service specifications for all TOCs including service specification diagrams refer to the 'Assumptions Report: PLANET Framework Model version 5.2'.

West Coast Mainline

7.2.9 The network updates to the WCML involved a significant number of changes to the timetable, including the frequency and stopping patterns on individual trains.

7.2.10 The resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network has been analysed and is presented in Appendix A5.3.

7.2.11 The key findings are described below:

- There is an increase in frequency of direct services between London and Scotland. However, the additional services are via Birmingham so have significantly slower journey times.
- Euston - Manchester services are unchanged. Euston - Birmingham services has a slight reduction in frequency. While Euston – Liverpool has about a 12% reduction in frequency with no change in average journey time.
- For Euston to Preston the frequency has increased marginally. However, the average journey time has increased more significantly as a number of these services are now via Birmingham whereas previously there were more direct.
- The main change in the number of trains per day on the WCML network is a reduction of approximately 1tph between the North West (Preston) and London. There is a further small reduction in the number of trains per day between the West Midlands and London.
- The change in number of seats per day reflects the change in number of trains per day. The capacity change between London and the West Midlands is much greater than the change north of the West Midlands.

East Midlands

7.2.12 The network updates for the East Midlands services involved a number of changes to the frequency and stopping patterns on individual trains. A summary of the changes can be seen in Appendix A5.4.

7.2.13 The resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network has been analysed and is presented in Appendix A5.4.

7.2.14 The key findings are described below:

- There are increases in service frequency for services to Sheffield, Derby and Leicester, together with reductions in journey times in the main.
- The change in trains per day shows the change to hourly service to serve Leicester rather than Corby. Elsewhere on the network there are small changes in the level of trains per day as part of the transit line updates.
- There is a reduction in capacity on Midland Mainline as part of the DM update with a change to the vehicle type to represent the Intercity Express Programme (IEP) trains in the future year. These trains are used for all London-bound services within the East Midlands timetable and the plot shows a reduction in capacity on the network between London and Leicester, Nottingham, Derby and Sheffield, except between Kettering and Leicester

which sees capacity improvements due to the change in service described above. Elsewhere on the network the capacity changes are small.

Updates to the Do Something classic line coding

7.2.15 PFMv5.0 incorporates updates to the coding for the West Coast Main Line and East Midlands services in the DS. Changes to the DS reflect updates to the DM and a re-specification of the released capacity coding to reflect the DM changes. The table below details the coding changes included in PFMv5.0.

Table 27 - Coding Updates Implemented in PFMv5.0 - Do Something classic services

TOC	Description of change
WCML Phase 1	1tph Euston to Wolverhampton services have been combined with 1tph Birmingham-Scotland services in order to provide a 1tph service between Euston and Scotland (14tpd) to match the DM. The remaining Euston to Wolverhampton service has then been extended to Shrewsbury at a frequency of 2tpd The Euston to Blackpool (1 tpd) Euston to Lancaster (1 tpd) and Euston to Preston (1 tpd) services have been removed. A 3tpd service between Euston and Manchester has been coded. A 1 tpd shuttle between Preston and Blackpool has been coded. Services have been speeded up to/from North West (2 mins journey time saving between Crewe-Stafford at Norton Bridge). Services have been speeded up to/from Scotland (1.5-3.5 mins journey time saving at Carlisle/Carstairs).
WCML Phase 2	1tph Euston to Wolverhampton WC services have been combined with 1tph Birmingham-to Preston (LM) in order to provide a 1tph service between Euston and Preston. The remaining Euston to Wolverhampton service has then been extended to Shrewsbury at a frequency of 2tpd. Services have been speeded up to/from North West (2 mins journey time saving between Crewe-Stafford at Norton Bridge). Services have been speeded up to/from Scotland (1.5-3.5 mins journey time saving at Carlisle/Carstairs).
EM Phase 1	All services are replaced with the updated DM (in Phase 1 the East Midlands specification is identical to the DM).
EM Phase 2	DM changes reflected in DS, namely: EW001W journey times amended between Toton and Loughborough to match EW002E (increase journey time). Corby and Leicester services replaced with those in the DM coding (this increases London - Leicester services by 1tph). Derby services amended to remove the dummy loop at Leicester and distribute the long dwell time on adjacent links (essentially slows the service down for most ODs).

West Coast Mainline

7.2.16 As a result of the network changes described in Table 27 the resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network for Phase 1 has been analysed and is presented in Appendix A5.3.

7.2.17 The key findings are described below:

- Phase 1 changes in frequency largely replicate those in the DM and primarily relate to the additional Euston to Scotland services. Changes to journey times reflect the changes of service patterns and the speeding up of services due to infrastructure improvements.
- In terms of number of trains per day the key changes are:
  - Increase of 2tpd to Shrewsbury as a result of extension of a number of Euston to Wolverhampton services;
  - A reduction of 2 tpd between Birmingham and the West Midlands;
  - Reduction of 16 tpd between Wolverhampton and Birmingham as a result of the merger of Euston to Wolverhampton and Birmingham to Scotland services; and
  - In the North West the number of trains per day changes as a result of rerouting northbound services out of Manchester via Bolton instead of Wigan.
- The change in number of seats per day reflects the change in number of trains per day.

7.2.18 A summary of the changes in level of service on WCML for Phase 2 is also presented in Appendix A5.3. The key findings are described below:

- Phase 2 changes in frequency largely replicate those in the DM and primarily relate to the additional Euston to Preston services. Changes to journey times reflect the changes of service patterns and the speeding up of services due to infrastructure improvements.
- The following changes in the number of WCML trains per day are observed in Phase 2:
  - An increase of 16 tpd between Wolverhampton and the North West as a result of combining the 1tph Euston to Wolverhampton WC services with the 1tph Birmingham-to Preston (LM) service. Note in reality this is not an increase in the total number of trains per day, but a transfer from one TOC to another;
  - Increase of 2 tpd to Shrewsbury as a result of extension of Euston to Wolverhampton services; and
  - In the North West change as a result of rerouting northbound services out of Manchester via Bolton instead of Wigan.
- The change in number of seats per day reflects the change in number of trains

per day.

East Midlands

7.2.19 The Phase 1 changes for East Midlands services are the same as those changes for the DM scenario, and hence the change in the level of service is the same.

7.2.20 In Phase 2, there are minimal changes to service frequency; this is because the East Midlands TOC is re-specified as part of Phase 2. The resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network has been analysed and is presented in Appendix A5.4.

7.2.21 The key findings are described below:

- There are some minor changes to frequency over the course of the day, but no significant changes.
- Reductions in journey time for routes using the MML, elsewhere some small changes to journey times between Derby and Sheffield.
- There are no changes to the number of trains per day on the Midland Mainline between London and Leicester, Derby, Nottingham and Sheffield in Phase 2. The changes elsewhere on the network are the same as those changes in the DM scenario.
- In Phase 2 there is a similar reduction in the seat capacity on Midland Mainline as for the DM scenario due to the change in vehicle type to IEP trains.

Minor corrections to model and appraisal process

7.2.22 A series of relatively minor updates addressing issues previously identified by the audit have been incorporated into the model. These updates are presented in the following table.

Table 28 - Corrections implemented in PFMv5.0

Item	Description of change
Winner and Loser database output automation	Updates made to previous automation: - Empty cell marked with non-zero constant; and - Data by column aligned correctly with the header and identical number of entries across rows.
Convergence Statistics	The importing of convergence statistics has been updated to return a blank when there is no data. It has also been further updated to deal with the situation where multiple phases were included.
Updated Labels	The labelling of the results in the appraisal spreadsheet changed from £bn to £m.
2026 Phase 2 Model Update	The python scripts to control the GAP calculation in the model were copied into the 2026 Phase 2 model as they were missing from that model.
COLOURS	The colours in "Run_All.Bat" to represent "okay" (green), "lack of disk space" (amber) and "error" (red) have been updated" so that the text is more easily readable on screen. The Run_all.bat has also been updated to look for 30GB of free disk space, in particular for the Numerical Integration process.

7.3 Quality assurance

7.3.1 For PFM5.0 the following checks have been undertaken on the input coding:

- Internal checks have been undertaken on the coding changes for each of the TOC's. This has been undertaken for both the DM changes and the subsequent DS changes; and
- The independent model auditor has also thoroughly checked the coding undertaken. Whilst they have picked up some minor issues the updates have been signed off.

7.3.2 The following table shows a full list of the checks that have been undertaken.

Table 29 - Orange checks undertaken for PFMv5.0

PFM Update	Level of check	Description of check
WCML lines and network coding	Orange	Internal checks and independent audit checks have been undertaken on these changes.
East Midlands lines coding	Orange	A spreadsheet was set up to check the coding. The service updates were also reviewed in the model and finally they were checked by the independent auditor.
Cross Country Network Review Corrections	Orange	A spreadsheet was set up to check the coding. The service updates were also reviewed in the model and finally they were checked by the independent auditor.
TransPennine Acceleration	Orange	Internal checks and independent audit checks have been undertaken on these changes.
Crossrail services to Reading	Orange	A spreadsheet was set up to check the coding. The service updates were also reviewed in the model and finally they were checked by the independent auditor.

7.3.4 Further to the above checks, the model results have been through a full Orange Check procedure. This orange check consisted of a rigorous check of model outputs including summary network and demand statistics, Economics, Sectorial Economics and OD Benefits. To support this, comparisons have been made to the previous version of the PFM to ensure changes in the outputs are occurring in the areas of the model that have been updated.

8 PFMv5.1

8.1 Summary of changes

8.1.1 PFMv5.1 incorporates a series of changes to the PFM. In practise these have been incorporated in a series of step-through tests in order to ensure correct implementation of each individual change. PFMv5.1 is the model release which combines the following updates:

- Revised HS2 timetable for high speed services in Phase 1 and Phase 2;
- Further updates to the DM transit line coding, in particular focusing on East Coast Mainline (ECML), East Midlands (EM), London Midland (LM) and Chiltern TOCs;
- Revised rail demand forecasts through an amendment to the employment growth driver applied within the forecasting process; and
- Update to the generalised journey time (GJT) elasticity applied in the regional models to be consistent with PDFHv5.1 rather than PDFHv4.1.

8.2 Model development

8.2.1 PFMv5.1 incorporates a revised HS2 timetable specification received from HS2 Ltd in January 2015. This timetable takes into account updates to journey times as a result of refinement of the route alignment.

8.2.2 Revised DM specifications have been provided by the DfT which reflect a more recent view of how a future timetable will operate. PFMv5.1 has fully incorporated these revised assumptions on the Intercity East Coast, East Midlands, Chiltern and London Midland franchises. As a result of changes to the DM, PFMv5.1 also incorporates changes to the DS so that it maintains consistency with the DM.

8.2.3 The demand matrices for PLD and each of the PLANET regional models have been updated to take into account a correction to the employment growth driver supplied by the DfT, which was used to derive the rail demand forecasts for PFMv5.0. This impacts the input rail demand matrices for both 2026 and the cap year.

8.2.4 The regional PLANET models use a generalised journey time (GJT) elasticity to estimate changes in demand. In model versions up to PFMv5.0, these values were based on the PDFH version 4.1 (June 2005). These have been updated to be consistent with PDFH version 5.1.

Updates to the HS2 coding

8.2.5 HS2 Ltd issued a revised HS2 timetable specification in January 2015. This primarily consists of updates to journey times as a result of further development and more detailed design of the route alignment. This resulted in a full set of new journey times to be applied to Phase 1 and Phase 2. A summary of the changes to journey times is

included in the following table; a more detailed summary of the revised timetable specification is included in Appendix A6.1.

Table 30 - Changes to the HS2 Timetable included in PFMv5.1

Phase	Service	Description of change
Phase 1	HS01, HS02, HS03	• No change in the Birmingham services
	HS04, HS05, HS06	• No change in the Manchester services
	HS07, HS08	• The journey times of the Liverpool services have been amended at link level such that HS07 via Crewe is faster to Crewe by 1 min with no change to the overall journey time. Hs08 via Stafford is faster overall by 1 minute and to Stafford it is faster by 2 minutes
	HS09	• No change in Preston services (HS09)
	HS10	• Scotland services are slower by 1.5 minutes (HS10)
Phase 2	HS01, HS02, HS03	• No change for Birmingham services
	HS04, HS05, HS06	• Manchester services are faster by 1 minute each
	HS07, HS08	• Liverpool services via Crewe (HS07) are faster by 1 minute and via Stafford (HS08) are also faster by 1 minute
	HS09	• Preston services are slower by 1 minute
	HS10, HS11	• Scotland services are slower - to Glasgow slower by 2 minutes and to Edinburgh slower by 3 minutes (HS10, HS11)
	HS12, HS13, HS14	• Leeds services are faster by 1min (HS12, HS13) and by 2 minutes (HS14a)
	HS15, HS16	• York (HS014b)and Newcastle (HS15, HS16) services are faster by 2 and 1 minutes respectively
	HS21, HS22	• Birmingham – Manchester services are faster by 1 minute (HS21,HS22)
	HS23	• Birmingham - Scotland services are faster by 6 minutes (Glasgow) and 10 minutes (Edinburgh) (HS23a and HS23b respectively)
	HS24, HS25	• Birmingham -Leeds services are faster by 2 min (HS24,HS25)
	HS26	• Birmingham -Newcastle services are faster by 5 minutes (HS26)

Updates to Do Minimum classic line coding

8.2.6 PFMv5.1 includes a further update of the DM specification within the PFM in line with the 2014 DM specification supplied by the DfT. These updates follow on from the DM updates included in PFMv5.0. PFMv5.1 includes updates to the following TOCs:

- **East Coast Main Line (ECML)** – Full 2014 DM specification incorporated. The new ECML DM timetable is based on the Intercity East Coast (ICEC) May 2020 timetable extracted from MOIRA[7] developed by the new Virgin Trains East Coast franchisee. Accompanying stock type information was supplied by the DfT;
- **East Midlands (EM)** – Full 2014 DM specification. The EM DM timetable is based on the latest East Midlands Trains timetable;
- **London Midlands (LM)** – Full update to reflect the December 2014 weekday timetable; and
- **Chiltern (CH)** – Full update based on the September 2015 Weekday timetable.

8.2.7 The changes that have been made to the service specifications under each of these TOCs in the DM scenario is discussed in more detail in the remainder of this chapter. For full details of the service specifications for all TOCs including service specification diagrams refer to the 'Assumptions Report: PLANET Framework Model version 5.2'.

East Coast

8.2.8 The network updates for ECML have involved the modification of all services under the ECML timetable occurring with the recent change in franchisee. The timetable has been completely recoded based on the May 2020 timetable extracted from MOIRA. A standard weekday Wednesday timetable has been used, and stock type changes as advised by the DfT have also been made.

8.2.9 An overview of high level changes that have occurred to the ECML timetable is presented in the list below:

- Updates assume 6.5 trains per hour into and out of London, the same as previous assumptions; however there is significant variation in the destinations served. New destinations are:
  - 2 trains per day to Sunderland
  - 6 trains per day to Middlesbrough
  - 1 train per day to Huddersfield
  - 1 train per day to Hull
  - 1 train per day to Stirling

[7] A desktop software application designed to forecast the impact of timetables on passenger revenue. Developed by DeltaRail.

- There is a reduction of 9 trains per day serving Leeds.
- There are an increased number of services on the following routes:
  - 6 trains per day to Harrogate (previously 1 train per day)
  - 6 trains per day to Bradford (previously 1 train per day)
  - 7 trains per day to Lincoln (previously 1 train per day)
- 3 trains per day in both directions starting/terminating short at Doncaster/York/Newark. This is balanced by small reductions in trains per day to Newcastle/Edinburgh

8.2.10 The resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network has been analysed and is presented in Appendix A6.2.

8.2.11 The key findings are described below:

- There is a reduction in the number of services serving Leeds (20%) in the DM scenario. There are large increases in service provision for West Yorkshire and the North East as the updated timetable serves a greater number of destinations in these areas. Elsewhere there are minimal changes to the level of service provision in particular to key destinations such as Edinburgh, Newcastle and York.
- There are generally small reductions in journey times to key destinations in Scotland, Newcastle and West Yorkshire.
- An increase in service provision to Lincoln dominates the increase in the number of trains per day on the southern section of the network.
- There is little change to the number of trains per day in the middle of the network, indicating no significant increase in the overall number of ECML services; however the variation in the network north of Doncaster indicates how the timetable has changed to serve a wider network of destinations.
- There are fewer trains per day to Leeds, off-set partially with more services to other destinations in West Yorkshire.
- There are no significant changes in the number of trains per day north of Newcastle.
- The change to the number of seats per day on the ECML network is similar in pattern to the change in the number of trains on the network. On sections of the network with little change in the number of trains per day there are small decreases in the number of seats per day as the 9-car IEP trains which are now used on much of the ECML network have 611 seats, whereas the previous stock type used had 626 seats.

East Midlands

8.2.12 The network updates for EM have included a full update of the services coded into the PFM to represent the latest East Midlands Trains timetable. The timetable assumes electrification of the Midland Mainline. However journey time savings associated with this have previously been incorporated into PFMv5.0, and therefore the updates for PFMv5.1 primarily focus on changes to services, destinations and stopping patterns.

8.2.13 An overview of the changes to the EM timetable is presented in the list below:

- London Services:
  - The Derby terminating services have been removed from the Phase 2 timetable.
  - All other services have the same number of trains per day as previous.
  - No changes to end-to-end journey times for the London services.
- Non-London Services:
  - The Leicester – Liverpool services have been curtailed at Manchester, and there have been small changes to the headway of this service.
  - The services between Nottingham and Worksop have been reduced to 16 trains per day from 24.
  - Elsewhere on the network there are small fluctuations in service headways and journey times.

8.2.14 The resulting change to the East Midlands services in terms of number of trains, journey times, and seats per day is presented in Appendix A6.3, the key findings are reported below:

- There is very little change in the service provision for EM London services; the only change is that the Derby terminating services (which also serve Leicester) are no longer featured in the EM timetable.
- There is a reduction in the number of services between London and Derby, two trains per day in the up direction and four trains per day in the down direction.
- Service provision between Manchester and Liverpool has been reduced due to the Leicester to Liverpool services being cut short at Manchester. This service has also been re-routed to serve Derby, as opposed to Nottingham.
- There are small changes in frequency between Nottingham and Skegness, and for other routes on the EM timetable.
- The change in seats per day on the EM network broadly follows the pattern for the change in the number of trains per day on the network. There are increases in capacity on routes between Norwich and Grantham, Norwich and Grimsby, Derby and Crewe and Grantham and Lincoln due to updates to the stock type updates.

Chiltern

8.2.15 The Chiltern timetable has been completely recoded based on the September 2015 Weekday timetable. The updates to Chiltern involved a significant number of changes to the timetable, including the frequency and stopping patterns on individual trains. It also includes changes to stock allocation as part of the revised timetable and journey time improvements reflecting Evergreen 3[8].

8.2.16 A list of the changes made to the Chiltern services is as follows:

- An additional 4 tpd in the peak between Aylesbury and Marylebone have been included in the network;
- The Marylebone to High Wycombe frequency has been reduced from 1.5tph to 1 tph;
- A new hourly service Marylebone to Gerrard's Cross has been added;
- New peak services between West Ruislip and Marylebone have been added;
- Marylebone to Birmingham services have been increased from 1.5tph to 2 tph;
- An extra 1 tph Marylebone to Banbury has been added;
- Additional peak services between Marylebone to Leamington Spa were removed;
- An extra 5 tpd Oxford to Marylebone have been added;
- Journey time improvements resulting from the Main Line upgrade (Evergreen 3) have been implemented; and
- Reduced capacity for Oxford services –previously variety of stock types assumed, now 2x2 car 170s assumed in peak, 2 car 170s off peak.

8.2.17 The resultant change in level of service for key movements and the total number of trains and seats on various parts of the network are presented in Appendix A6.4, the key findings are described below:

- For most movements the service frequency either remains similar to before or there are small increases. Key movements that see an increase in service frequency are between Marylebone and Banbury and Marylebone and Oxford. The service frequency between Marylebone and Princes Risborough shows a significant reduction.
- In relation to journey time, overall there are mainly reductions in journey time reflecting upgrades to the main line. Key reductions in journey time are between Marylebone and Birmingham and Marylebone and Oxford.
- The change in the number of trains per day highlights the key differences

[8] Evergreen 3 includes a new section of line to allow Chiltern trains to serve Oxford; along with line improvements to reduce journey times on the Chiltern Mainline.

compared to PFMv5.0. The main change is a general increase in the number of services along much of the main line from Marylebone to Banbury, together with an increase in services to Oxford.

- There is a significant increase in the number of seats per day along much of the main line corridor. The change in number of seats per day reflects the change in number of trains per day and the change in stock type on some of the services.

London Midland

8.2.18 The LM timetable has been updated to reflect the December 2014 weekday timetable. The network updates to LM involved a significant number of changes to the timetable, including the frequency and stopping patterns on individual trains and stock allocation.

8.2.19 A summary of the changes to London Midland services is listed below:

- Additional services in the peak (1tph) between Euston and Milton Keynes;
- There is a reduction in Euston-Northampton services from 2tph to 1tph in the peak only, and an increase in Euston-Birmingham services from 2.5tph to 3tph;
- Additional services in the peak (1 tph) between Birmingham New Street and Wolverhampton, and Birmingham New Street and Coventry;
- Extra 1tph service between Birmingham International and Birmingham New Street;
- Services have been speeded up to/from the North West (2 minutes journey times saving at Norton Bridge works); and
- Trains have been lengthened to 12-cars on peak hour Euston services (remains 8-cars in off peak)

8.2.20 The resultant change in level of service for key movements; and total number of trains and seats on various parts of the network is presented in Appendix A6.5, the key findings are discussed below:

- Key changes are a reduction in the number of services between Euston and Northampton and Euston and Milton Keynes. The frequency of services for most other movements remains largely unchanged. Where there are reductions in service frequency, these services are subject to capacity increases through train lengthening.
- Journey times for selected movements are largely unchanged.
- The main change in trains per day is a reduction of up to 22 tpd between London and Northampton.
- The change in number of seats per day reflects the change in number of trains per day and the change in train types, which includes train lengthening on

services to/from London in the peaks. The net impact is a significant increase in seats along the whole of the corridor served by London Midland.

Updates to Do Something classic line coding

8.2.21 PFMv5.1 incorporates updates to the coding for the ECML, EM, LM and CH in the DS. Changes to the DS reflect updates to the DM and a re-specification of the released capacity coding to reflect the DM changes.

8.2.22 The changes that have been made to the service specifications under each of these TOCs in the DS scenario is discussed in more detail below. For full details of the service specifications for all TOCs including service specification diagrams refer to the 'Assumptions Report: PLANET Framework Model version 5.2'.

East Coast

8.2.23 The ECML timetable only includes released capacity in the Phase 2 scenario, therefore for Phase 1 the ECML timetable is as in the DM, and hence the change in the level of services is as previously reported.

8.2.24 The Phase 2 ECML timetable is based on the previous Phase 2 timetable but also incorporates the main changes from the DM update in terms of wider destinations served, and journey time savings associated with the introduction of IEP trains.

8.2.25 The Phase 2 timetable changes for ECML are summarised in the list below:

- Harrogate and Bradford services are represented in the full network ECML timetable at the increased frequency included in the DM
- The Hull, and Middlesbrough services are retained when HS2 is introduced
- Leeds is served by the same number of services in the full network as were previously coded, however a greater proportion of these travel onwards to wider destinations in West Yorkshire
- Average journey times to Leeds are reduced by 4%
- Newcastle has 1 more train per day in the full network scenario
- Small reductions in journey times for Edinburgh, Newcastle, Skipton, Harrogate and Bradford
- ECML feeder services north of Edinburgh have been recoded as Scotland services in the full network

8.2.26 The resulting change to the London services in terms of number of trains, journey times, and seats per day is presented in Appendix A6.2, the key observations are described below:

- Compared to the DM, journey times are slower on several routes in the Phase 2 scenario. This is because on average stopping patterns in Phase 2 contain more intermediate calls than in the DM. London to Edinburgh services can be used as an example to highlight this. There are nine variants of stopping

patterns in the up direction and eight variants in the down direction in the DM scenario; however in the Phase 2 scenario all services have the same intermediate stopping pattern. When you compare these stopping patterns, the DM scenario has some services with more intermediate calls than in the Phase 2 scenario but most services are quicker and have fewer intermediate calls; therefore on average journey times are faster. This occurs for most London services on ECML when comparing the DM and Phase 2 services.

- For Middlesbrough services which are new to the Phase 2 scenario the specification requested an additional call at Doncaster which accounts for the additional journey time in Phase 2 compared to the DM.
- The changes to service provision to Harrogate, Bradford, Middlesbrough and Hull reflect changes in the DM scenario.
- The change in trains per day on the ECML network for the Phase 2 scenario follows a very similar pattern as for the DM scenario, though there is no significant increase in the service provision to Lincoln as Lincoln services were previously included in the Phase 2 scenario at one train per hour.
- The change in the number of seats per day follows the same pattern as for the number of trains per day north of Lincoln. There is a reduction in seat capacity on the London to Lincoln route due to the coding of 5 car IEP trains on this section of the network.

East Midlands

8.2.27 The EM timetable only includes released capacity in the Phase 2 scenario, therefore for Phase 1 the EM timetable is as in the DM and as described above.

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

- One train per hour between Nottingham and London St Pancras;
- One train per hour between Sheffield and London St Pancras;
- One train per hour between Derby and London St Pancras;
- One train per hour between Corby and London St Pancras; and
- One train per hour between Leicester and London St Pancras.

8.2.29 No alteration is made to the non-London services operated by East Midland Trains.

8.2.30 The resulting change to the London services in terms of number of trains, journey times, and seats per day is presented in Appendix A6.2.

8.2.31 The key findings are:

- There is a reduction in the number of Derby – London services per day to 16 which affects the overall level of service at Derby and Leicester. Otherwise minor changes in service headway.

- Reductions in journey time are caused by changes to stopping patterns on the Sheffield and Derby services, with a reduction to the number of intermediate stations served on both services; this also results in journey time reductions to Leicester.
- The number of trains per day has been slightly reduced in the Phase 2 scenario between London and the East Midlands. All other changes in trains per day are as seen in the DM scenario.
- There is a small reduction in seat capacity between London and the East Midlands in line with the changes in train headways that have been made. Elsewhere on the network the same changes in seat capacity occur as in the DM as the non-London EM services are unaffected by the Phase 2 released capacity specification.

Chiltern

8.2.32 There is no released capacity specification for Chiltern in either Phase 1 or Phase 2, therefore in the DS, the Chiltern specification is exactly the same as in the DM. In PFMv5.1 the DS has been updated to correspond with the PFMv5.1 DM.

London Midland

8.2.33 The DS scenarios include released capacity for London Midland in both Phase 1 and Phase 2. Within PFMv5.1 the released capacity specification is identical for Phase 1 and Phase 2. The released capacity timetable (service patterns and frequencies) included in PFMv5.0 has been retained in PFMv5.1 as the changes included in the updated DM were already included in the previous (PFMv5.0) released capacity specification. Vehicle types have been updated to be consistent with the changes included in the DM.

8.2.34 A summary of the changes included in the DS scenario are included in the table below.

Table 31 - London Midland Updates Implemented in PFMv5.0 - Do Something classic services

Phase	Description of change
Phase 1 and Phase 2	Journey times have been speeded up to/from the North West (2 minutes JT saving at Norton Bridge works), which is in line with changes in the DM. Identical vehicle type changes applied as in DM (train lengthening to 12-cars on peak hour Euston services, remaining as 8-car services in the off peak).

8.2.35 The resultant change in the level of service for key movements, and total number of trains and seats on various parts of the network has been analysed and is presented in Appendix A6.5.

8.2.36 The key findings are described below:

- In terms of level of service there is no change in trains per day compared to PFMv5.0 and the only services that experience a change in journey time are services to Crewe and Liverpool travelling through Norton Bridge.

- There is a significant increase in the number of seats per day. This reflects the change in stock allocation and primarily relates to the lengthening of all London trains to 12 cars in the peak periods.

Updates to demand matrices

8.2.37 An error was identified in one of the employment growth drivers supplied by the DfT, which was used to derive the rail demand forecasts for PFMv4.7 – PFMv5.0. These forecasts were based on the OBR GDP growth rate rather than the OBR employment growth rate. Subsequently the demand forecasting process has been rerun using the corrected employment driver and revised rail demand matrices produced for 2026 and the cap year for each of the four PLANET models.

8.2.38 For documentation of the forecasting procedure and resulting future-year rail forecasts refer to '5130012 Atkins Final Report v4'.

Updates to demand elasticities in PLANET regional models

8.2.39 The regional PLANET models use a generalised journey time (GJT) elasticity to estimate changes in demand. In model versions up to PFM v5.0, these values were based on the PDFH version 4.1 of June 2005. These have been updated to be in line with advice in DfT's TAG Unit M4 (November 2014), to use parameters from PDFH 5.1, issued in April 2013.

8.2.40 The change affects all three regional models – PS, PM, PN - (PLD has a bespoke demand model). A comparison of the elasticities included in PFMv5.0 and PFMv5.1 are included in the tables below for the various journey purposes. The comparison indicates that in all cases the updated GJT elasticities are higher than before and this is expected to cause a greater change in demand as a result of changes in GJT.

Table 32 - Comparison of GJT Elasticities in Regional Models (Business / Leisure)

	PFMv5.0 (based on PDFH 4.1)				**PFMv5.1 (based on PDFH 5.1)**			
From/To	Central London	Greater London	South East	Rest of Country	Central London	Greater London	South East	Rest of Country
Central London	-0.60	-0.60	-0.90	-0.90	-0.90	-0.90	-1.25	-1.35
Greater London	-0.60	-0.60	-0.90	-0.90	-0.90	-0.90	-1.25	-1.35
South East	-0.80	-0.80	-1.00	-1.00	-1.25	-1.25	-1.25	-1.20
Rest of Country	-0.90	-0.90	-1.00	-1.00	-1.35	-1.35	-1.20	-1.20

Table 33 - Comparison of GJT Elasticities in Regional Models (Commute)

	PFMv5.0 (based on PDFH 4.1)				PFMv5.1 (based on PDFH 5.1)			
From/To	Central London	Greater London	South East	Rest of Country	Central London	Greater London	South East	Rest of Country
Central London	-0.5	-0.5	-0.8	-0.9	-0.63	-0.63	-0.88	-1.35
Greater London	-0.5	-0.5	-0.8	-0.9	-0.63	-0.63	-0.88	-1.35
South East	-0.7	-0.7	-0.9	-0.9	-0.88	-0.88	-0.88	-1.20
Rest of Country	-0.9	-0.9	-0.9	-0.9	-1.35	-1.35	-1.20	-1.20

8.3 Quality assurance

8.3.1 The following checks were undertaken on the coding inputs for PFMv5.1:

- Internal checks on the coding for each of the TOCs. This was done for both the DM changes and the subsequent DS changes; and
- The independent model auditor also thoroughly checked the coding undertaken.

8.3.2 The table below shows a full list of the checks undertaken for PFMv5.1.

Table 34 - Orange checks of the updates for PFMv5.1

Component	Level of check	Description of check
Updated HS2 lines coding	Orange	HS2 timetables were provided by HS2 Ltd for Phase 1 & 2. Reliability and dwell time calculations have been applied to create the final timetable specification to inform the coding. These calculations have been fully checked. Transit lines files checked by text comparison software confirmed that the classic coding updates and HS2 coding have been implemented as per the specifications. Coding files independently checked and signed off by model auditors. Coding has been sense checked to ensure the service patterns match with the model specification.
WCML lines coding corrections	Orange	Internal processes were set up to check the transit line coding via step through methodology spreadsheets, and these processes have been through QA procedures. The checking procedures have included the checking of the preload process. Networks, vehicle lists and corrections to coding checked using comparison with previous versions to ensure the changes were appropriate.

Component	Level of check	Description of check
		Coding has been sense checked to ensure the service patterns match with the model specification. Analysis also carried out using high level plots and standard outputs. Independent audit of entire process carried out in two stages; coding against a specification, and the implementation against DfT sources.
ECML line coding and network changes	Orange	Transit line inputs have been reviewed in spreadsheets for PLD and regional sub-models, and independent checks of trains per modelled time period and journey times have been carried out against the original data file. Economic, demand, OD benefits, sectoral benefits, train loadings and network statistics outputs have been sense-checked against the changes that have been made to the transit line coding. Transit line flow changes, trains per day and seats per day plots have been produced and analysed.
EM line coding and network changes	Orange	Transit line inputs have been reviewed in spreadsheets for PLD and regional sub-models, and independent checks of trains per modelled time period and journey times have been carried out against the original data file. Economic, demand, OD benefits, sectoral benefits, train loadings and network statistics outputs have been sense-checked against the changes that have been made to the transit line coding. Transit line flow changes, trains per day and seats per day plots have been produced and analysed.
Chiltern line coding and network changes	Orange	Internal processes were set up to check the transit line coding via step through methodology spreadsheets, and these processes have been through QA procedures. The checking procedures have included the checking of the preload process. Networks, vehicle lists and corrections to coding checked using comparison with previous versions to ensure the changes were appropriate. Automated error checking set up prior to model runs in order to reduce the number of corrections to be made. Coding has been sense checked to ensure the service patterns match with the model specification. Analysis also carried out using high level plots and standard outputs. Independent audit of entire process carried out in two stages; coding against a specification, and the implementation against DfT sources.
London Midland coding and network changes	Orange	Internal processes were set up to check the transit line coding via step through methodology spreadsheets, and these processes have been through QA procedures. The checking procedures have included the checking of the preload process. Networks, vehicle lists and corrections to coding checked using comparison with previous versions to ensure the changes were appropriate. Automated error checking set up prior to model runs in order to reduce the number of corrections to be made. Coding has been sense checked to ensure the service patterns match with the model specification. Analysis also carried out using high level plots and standard outputs.

Component	Level of check	Description of check
		Independent audit of entire process carried out in two stages; coding against a specification, and the implementation against DfT sources.
Preload Process	Orange	Preload process changes for each TOC update checked internally via manual checking spreadsheets at each stage. Each of the updates were tested offline to check the functionality of the preload process.
Updated demand matrices as a result to correction to employment growth driver	Orange	Demand matrices internally checked for correct updates in comparison to source data. Results analysed using standard outputs produced.
Macros changes as a result of update to PDFH5.1 GJT elasticities in regional models	Orange	Macros internally checked using comparison with old versions to ensure that the new GJT elasticity values had been implemented correctly. The elasticity values were also separately checked against original PDFH5.1 source. Results analysed using standard outputs produced.

8.3.3 Further to this the model has been through a full Orange check procedure. As part of this process comparisons were made with intermediate model runs used to test individual updates. This ensured that the overall impacts observed as part of the final model run broadly reflected the impacts observed when updates were implemented in isolation.

8.3.4 The model results were compared back to PFMv5.0 to allow comparisons of the standard outputs which are created during the model, including summary demand and network statistics, Economics, Sectorial Economics and OD Benefits. To support this, a series of comparison plots of the network were produced to identify where the major changes occurred, and to ensure the changes identified in the orange checks were occurring on the expected routes.

8.3.5 The above checks give confidence that the methodology used in this version of the model is appropriate, its implementation has been undertaken correctly and that the final model run has been undertaken correctly.

9 PFMv5.2

9.1 Summary of changes

9.1.1 PFMv5.2 implements changes to the rail and underground fares growth assumptions contained within the model, which affects the demand cap year. This change aligns with the new government's election manifesto commitment that rail fares will not grow faster than RPI during the 5-year term that they are in power.

9.2 Model development

9.2.1 The primary change that has been implemented within PFMv5.2 is an update to the rail fares growth assumptions. The new assumption is:

> *Regulated and unregulated rail and underground fares increase at RPI+0% up to 2020/21 and at RPI+1% from 2021/22 (until the demand cap year is reached).*

9.2.2 The above change in rail fares growth assumptions affects how the PFM forecasts rail demand in future years, and crucially, affects the PFM cap year (the second forecast year that is modelled within the PFM) which is defined as the year in which long-distance rail demand within the PLD rail matrix reaches 290,146. The cap year under the above rail fares growth assumptions has been calculated to be 2037.

9.2.3 The change in cap year requires the following further updates to the PFM:

- Future-year rail demand matrices for 2026 and the new cap year for all journey purposes within the PLD, PS, PM and PN sub-models;
- Future-year highway demand matrices for the new cap year for all journey purposes in the PLD sub-model;
- Future-year air demand matrices for the new cap year for all journey purposes in the PLD sub-model;
- Recalculation of Vehicle Operating Costs (VOC) for the new cap year;
- Network changes; and
- Heathrow Access Model (HAM) forecast updates.

9.2.4 The specific changes that have been made to the PFM for each of these is discussed in the following sections.

Future-year rail demand

9.2.5 Future-year rail demand for PFMv5.2 has been forecast in the same way as for previous models. This forecasting approach is summarised in the document 'Atkins Model Development Report – PFM V4.3 to PFM V5.2 updating the exogenous forecasts'. The demand change for rail mode is presented in the document 'Assumptions Report: PLANET Framework Model version 5.2'.

Future-year highway demand matrices

9.2.6 Future-year highway demand has been forecast for the demand cap year of 2037. This has been derived from the highway demand forecasts in PFMv5.1.

9.2.7 The highway demand forecasts in PFMv5.2 for 2026 are the same as those in PFMv5.1.

9.2.8 The 2037 highway demand forecasts have been derived by assuming linear growth between the highway demand forecasts for 2026 and 2040 from PFMv5.1.

9.2.9 This interpolation method to calculate highway demand for 2037 results in the level of highway demand by journey purpose as shown in the following table. This is compared to the cap year highway demand in PFMv5.1 for 2040. Overall there is a 1.5% decrease in highway demand in the cap year between PFMv5.2 and PFMv5.1

Table 35 - 16 Hour PLD Future Year Future-year Highway Demand Totals in the cap year for PFMv5.2 compared to PFMv5.1

Journey Purpose	Cap Year Highway Demand			
	PFMv5.1 (2040/41)	PFMv5.2 (2037/38)	Change	%
Commute	164,137	162,322	-1,815	-1.1%
Business	343,452	338,471	-4,982	-1.5%
Leisure	957,464	941,935	-15,529	-1.6%
Total	1,465,053	1,442,727	-22,326	-1.5%

Future-year air demand matrices

9.2.10 Future-year air demand has been forecast for the demand cap year of 2037. This has been derived from the air demand forecasts in PFMv5.1.

9.2.11 The air demand forecasts in PFMv5.2 for 2026 are the same as those in PFMv5.1.

9.2.12 The 2037 air demand forecasts have been derived by using a linear interpolation method to calculate the level of air demand in 2037 based on the level of demand in 2026 and 2040 within PFMv5.1.

9.2.13 The resulting air demand totals are presented by journey purpose in the table below and compared to the air demand totals in the 2040 cap year from PFMv5.1. There is a 5.5% reduction in air demand in the cap year in PFMv5.2 compared to PFMv5.1.

Table 36 - 16 Hour PLD Future Year Future-year Air Demand Totals in PFMv5.2 compared to PFMv5.1

Journey Purpose	Cap Year Air Demand			
	PFMv5.1 (2040/41)	PFMv5.2 (2037/38)	Change	%
Business	26,748	25,253	-1,496	-5.6%
Leisure	20,234	19,130	-1,104	-5.5%
Total	46,982	44,383	-2,600	-5.5%

Vehicle operating costs

9.2.14 The vehicle operating costs (VOC) associated with highway travel in the PLD assignment are derived for the future modelled year using WebTAG projections. The VOC for PFMv5.2 have been calculated using the same methodology as for PFMv5.1; these can be seen in the table below.

Table 37 - PLD Highway Vehicle Operating Costs in the cap year in PFMv5.2

Component	Commute	Business	Leisure
Fuel (pence/km/vehicle)	5.624	4.733	5.632
Non-Fuel (pence/km/vehicle)	3.745	6.447	3.745

Network changes

9.2.15 The structure of the rail, highway and air networks within PFMv5.2 is unchanged from PFMv5.1; in particular the network assumptions for the cap year 2037 are the same as those assumed in PFMv5.1 for the cap year of 2040.

9.2.16 However the networks contain a series of attributes, assigned to links and nodes, some of which affect the generalised cost of a journey in the PFM. There are two particular attributes which are required to be updated when the demand cap year changes, namely the highway preloads and air fares.

Highway preloads

9.2.17 Modelling of the highway mode is only considered at PLD level within the PFM, and therefore only models long-distance car trips. Highway preloads are assigned to the PLD network links to adequately reflect more local traffic. They are created at base year level and denote the difference between the long-distance PLD trips and observed count data. The base preloads are then grown to the required forecast year.

9.2.18 The highway preloads for the second forecast year of 2037 have been forecast by using liner interpolation of the preload flow volumes in PFMv5.1 for the 2026 and 2040 forecast years for each highway link to which a preload volume is assigned.

Air fares

9.2.19 The air networks in the PFM require the input of air fares for each air service represented within the PFM. This is in order to calculate an accurate representation of the generalised cost for the air journey to compare against alternative routes.

9.2.20 The air fares that are input to the PFM within the network files are grown from base year values using a set of projections for domestic air fare growth in the UK by journey purpose. This same projection has been used to recalculate the air fares for the revised cap year of 2037.

Heathrow Access Model updates

9.2.21 The Heathrow access model (HAM) within the PFM is a spreadsheet mode choice model representing surface access trips to/from Heathrow airport. The model includes DfT demand forecasts for air passenger demand accessing Heathrow airport along with a catalogue of costs associated with accessing the airport by varying modes.

9.2.22 The DfT demand forecasts within the HAM have been updated in PFMv5.2 by deriving the average yearly growth rate 2026-2040 for demand in the HAM from PFMv5.1 and interpolating to calculate the demand forecasts for 2037.

9.2.23 The cost assumptions and demand forecasts have been updated in PFMv5.2 to reflect the change in demand cap year. The cost assumptions that have been updated are listed below:

- Values of time for business and leisure purposes;
- Vehicle operating costs;
- Rail fares;
- Airport parking charges; and
- Taxi/minicab fares

9.2.24 The revised values have been calculated using the existing range of values within the HAM. Where values were not already existing for 2037 specifically these have been calculated by assuming the average yearly growth rates over the range of years, and interpolating to get intermediate years.

9.3 Quality assurance

9.3.1 The model development changes between PFMv5.1 and PFMv5.2 have been through a QA process; these are detailed in the table below.

9.3.2 The updates to the rail fares growth, and resulting demand forecast and cap year changes involve the following types of checks:

- checks to the source of the rail demand input files;
- checks on the methodology and outputs of forecasting future-year highway and air demand;
- line-by-line checks of the updates to macros; and
- ensuring all new inputs are correctly located within the model run structure.

Table 38 - PFMv5.2 QA Checks

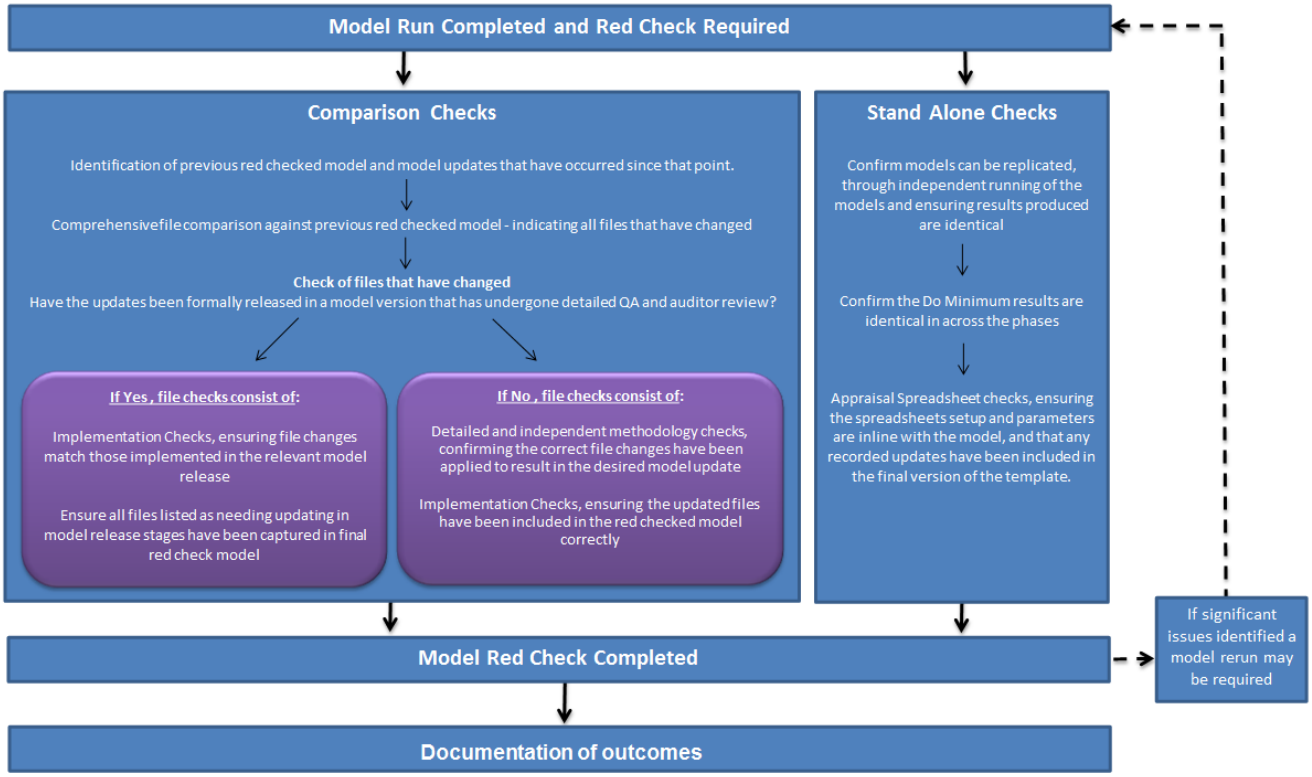
Type of QA Check	Level of check	Description of check
Model Methodology	Orange	Future-year Highway and Air Demand Forecasts – the spreadsheet process was set up to calculate the interpolation of highway and air demand from input 2026 and 2040 PFMv5.1 matrices. This has been orange checked to ensure the correct methodology has been applied and the results are correct.
Model Implementation	Orange	PLD matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match and the use of text file comparison program.
Model Implementation	Orange	PM matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	PN matrices - The correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	PS matrices - Check that the correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	Highway Matrices - Check that the correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	Air Matrices - Check that the correct matrices have been included within the appropriate location in the model run structure and are correctly labelled, including an extensive check that file names and date stamps match.
Model Implementation	Orange	VOCs - Check calculation of VOC values. Check the values have been correctly exported to voc.mac.
Model Implementation	Orange	HAM VOCs - Worked through check of calculation of vehicle operating costs specified above and a check of the demand weighting process used to calculate the combined value for VOC figures. Comparison of old and new values.
Model Implementation	Orange	PLD demand networks - Check that highway preloads have been interpolated correctly using the correct 2026 and 2040 preload values from PFMv5.1. Check that these values have been included within the PLD demand networks and that these are located in the correct place within the PFM structure.
Model Implementation	Orange	PLD demand transit lines – Check that the air fares have been calculated correctly using the PFM projections and check that these have been correctly included within the PLD demand transit lines for air mode. Checks have also been made to ensure that the correct version of the PLD demand transit lines have been included in the appropriate place within the PFM model structure.
Model Implementation	Orange	Heathrow Demand and Cost Values – checks have been carried out to ensure that these have been correctly calculated for the cap year and that the values exist in the correct range within the spreadsheet model. Finally checks that the correct version of the spreadsheet model has been used within the model run.

9.3.5 Further to the checks detailed above the final model run for PFMv5.2 has been subjected first to an orange check which checks that the responses in the model are reasonable given the changes that have been made. Then the model has been subjected to the red checking procedures which ensure that all aspects of the model implementation has been carried out correctly. Finally the model inputs and outputs have been independently verified by an external audit team.

9.3.6 The orange check compared the model results to PFMv5.1 where a comparison of the standard outputs is completed, including demand and network statistics, Economics, Sectorial Economics and OD Benefits.

9.3.7 The red checking procedures verified all model changes since the previous red checked version of the PFM, in this case PFMv4.3. The processes are summarised in the diagram below.

Figure 24 – PFMv5.2 Red Checking Procedures



9.3.8 Finally the independent audit team replicated and verified the model inputs and results and independently verified the model implementation by sense checking and inspecting the updates that have occurred.

Glossary

CPI	Consumer Prices Index
DfT	Department for Transport
DM	Do Minimum - Future-year Scenario without HS2
DOS	(Microsoft) Disk Operating System
DS	Do Something - Future-year Scenario including HS2
ECML	East Coast Mainline and associated train services (also abbreviated to WC in transit line coding)
EDGE	Endogenous Demand Growth Estimator – forecasting framework for rail demand growth in Great Britain (DfT)
EM	East Midlands Trains and associated train services
EMME	Modelling software used by the PFM
GAP	GAP Statistic - measure of convergence of the model (PFM)
GDP	Gross Domestic Product
GJT	Generalised Journey Time - total journey time considering all factors
HAM	Heathrow Access Model - a component of the PFM
HS	High Speed (as in HS rail services)
HS2	High Speed Two (the project)
HS2 Ltd	HS2 project promoter
HWY	Highway
hybrid Bill	Consents process for major projects deemed to be in the national interest that also affect a large number of private interests
ICEC	Intercity East Coast - Franchise operating on ECML
IVT	In Vehicle Time - a component of GJT
LM	London Midland and associated train services
LU	London Underground (Limited)
MDR	Model Development Report (this document)
MECC	Marginal External Cost of Car - benefits associated with decongestion on the road network, part of the appraisal process
MML	Midland Mainline (East Midlands is the associated TOC)

Mzone	Detailed zone used within the station choice model
NI	Numerical Integration - the process used to evaluate the benefits of the HS2 scheme during appraisal
NTEM	National Trip End Model (DfT)
NTM	National Transport Model (DfT)
OBR	Office for Budget Responsibility
OD	Origin-Destination
ONS	Office for National Statistics
OOC	Old Oak Common - proposed station in West London, part of the HS2 scheme
PDFH	Passenger Demand Forecasting Handbook
PFM	PLANET Framework Model: The primary tool for assessing the HS2 scheme
PLD	PLANET Long Distance: Nationwide assignment model within the PFM
PM	PLANET Midlands: Regional assignment model of the Midlands within the PFM
PN	PLANET North: Regional assignment model of the North of England within the PFM
PS	PLANET South: Regional assignment model of the South of England within the PFM
PT	Public Transport
QA	Quality Assurance - refers to the processes used for checking PFM implementation and results
RPI	Retail Price Index
SCM	Station Choice Model
TEMPRO	Trip End Model presentation PROgram (DfT)
TfL	Transport for London
TLC	Three Letter Code - identifies UK train stations
TOC	Train Operating Company
Toton	The name given to the HS station in the East Midlands as part of the HS2 scheme
tpd	Trains per day
TPE	Trans-Pennine Express and associated train services (also abbreviated to TP in transit coding)
tph	Trains per hour

VOC	Vehicle Operating Costs
VOT	Value of Time
WCML	West Coast Mainline and associated train services (also abbreviated to WC in transit line coding)
WebTAG	DfT's web-based Transport Appraisal Guidance
WITA	Wider Impacts in Transport Appraisal - DfT appraisal process
XC	Cross-Country and associated train services

Appendix A – Model Development Updates: Further Information

A1 PFMv4.4 Model Development Updates

A1.1 Transit Line Coding Updates

Issue Details	Specific PLD Coding Changes Implemented		
PLANET Long Distance Phase 2 Coding Updates			
Add Burton and Tamworth stops to northbound XC services that use this route	XC118-	PLYMTH-LEEDS 1E63	Added call to Tamworth (91322) and Burton (91658)
	XC120-	PLYMTH-LEEDS 1E67	Added call to Tamworth (91322) and Burton (91658)
	XC200-	PLYMTH-GLGC 1S33	Added call to Tamworth (91322) and Burton (91658)
	XC201-	PENZNCE-GLGC 1S35	Added call to Tamworth (91322) and Burton (91658)
	XC202-	PLYMTH-ABRDEEN 1S39	Added call to Tamworth (91322) and Burton (91658)
	XC203-	PENZNCE-GLGC 1S43	Added call to Tamworth (91322) and Burton (91658)
	XC204-	PLYMTH-DUNDETB 1S47	Added call to Tamworth (91322) and Burton (91658)
	XC205-	PLYMTH-GLGC 1S51	Added call to Tamworth (91322) and Burton (91658)
	XC207-	PLYMTH-EDINBUR 1S55	Added call to Tamworth (91322) and Burton (91658)
	XC208-	PLYMTH-EDINBUR 1S59	Added call to Tamworth (91322) and Burton (91658)
	XC209-	BHAMNWS-EDINBUR 1S61	Added call to Tamworth (91322) and Burton (91658)
	XC210-	BATHSPA-GLGC 1S71	Added call to Tamworth (91322) and Burton (91658)
	XC211-	PLYMTH-EDINBUR 1S98	Added call to Tamworth (91322) and Burton (91658)

Issue Details	Specific PLD Coding Changes Implemented		
In Phase 2, Trans-Pennine services, Liverpool - Edinburgh services should be reduced such that there are 6 in peak hour each way	TP132-	LVRPLSH-EDINBUR 1N08	Reduce headway by one train
	TP168-	EDINBUR-LVRPLSH 1N51	Reduce headway by one train
Phase 1 and Phase 2 network, LM Euston-Lichfield TV, LM421/422 are actually running between Northampton and Euston	LM421U	LCHFDTV-EUSTON PEAK	Extended to start at Lichfield (91291)
	LM422D	EUSTON-LCHFDTV PEAK	Extended to start at Lichfield (91291)
In Phase 2 network, WC, there are no services going through Lancaster except for Euston -GLGC/EDINBUR services. In DM network, service Euston to Lancaster is missing. In Phase 1, there are a lot of WC services going through Lancaster, which is very different from the Phase 2 network	WC305	EUSTON-MAN-GLGC	Added call at Oxenholme (92090), Removed call at Penrith (92102)
	WC306	GLGC-MAN-EUSTON	Added call at Oxenholme (92090), Removed call at Penrith (92102)
	WC307	EUSTON-MAN-EDINBUR	Added call at Lancaster (92685), removed call at Oxenholme (92090), added call at Penrith (92102)
	WC308	EDINBUR-MAN-EUSTON	Added call at Lancaster (92685), removed call at Oxenholme (92090), added call at Penrith (92102)
Phase 2 network, XC - Newcastle - Glasgow (XC212) should stop at Alnmouth	XC212-	NWCSTLE-GLGC 1S99	Added call at Alnmouth and Dunbar (6821 and 6851)
Other Phase 2 network corrections made during the coding process which were not previously identified on the issues log	LM413U	BHMNS-EUSTON 0000	Added call at Wolverton (2364)
	LM414D	EUSTON-BHMNS 0000	Added call at Wolverton (2364)
	EM252-	NTNG-SKEGNES 2S23	Deleted Nottingham-Leicester section
	TP901-	LVRPLSH-NWCSTLE 1N08	Increased headway by one train
	TP902-	NWCSTLE-LVRPLSH 1N51	Increased headway by one train
PLANET South Phase 2 Coding Updates			
Other Phase 2 network corrections made during the coding process which were not previously identified on the issues log	LM407U	MKNSCEN-EUSTON	Call at Bushey (560) removed
	LM410D	EUSTON-BLTCHLY	Call at Bushey (560) removed
	LM413U	BHMNS-EUSTON	Call added at Wolverton (2364), call removed at Berkhamsted (2367)
	LM414D	EUSTON-BHMNS	Call added at Wolverton (2364), call removed at Berkhamsted (2367)

Issue Details	Specific PLD Coding Changes Implemented		
	LM430U	BLTCHLY-EUSTON	Call at Bushey (560) removed
PLANET Midlands Phase 2 Coding Updates			
Other Phase 2 network corrections made during the coding process which were not previously identified on the issues log	WC109U	HLYH-EUSTON	Removed call at Rugely (91084), Lichfield (91291) and Tamworth (91322)
	WC110U	HLYH-EUSTON	Removed call at Lichfield (91291) and Tamworth (91322)
	WC310U	CHSTR-EUSTON	Removed call at Rugely (91084) and Tamworth (91322)
	WC311U	CRWE-EUSTON	Removed call at Rugely (91084) and Tamworth (91322)
PLANET North Phase 2 Coding Updates			
Phase 2 network, Trans-Pennine services, Manchester Airport - Scotland services should be curtailed at Manchester Piccadilly to be in line with PLD.	TP110-	EDINBUR-MNCRIAP	Curtailed at Piccadilly - retain Airport-Piccadilly section only
	TP116-	MNCRIAP-GLGC	Curtailed at Piccadilly - retain Airport-Piccadilly section only
	TP117-	MNCRIAP-EDINBUR	Curtailed at Piccadilly - retain Airport-Piccadilly section only
PLANET Long Distance Phase 1 Coding Updates			
Phase 1 and Phase 2 network, LM Euston-Lichfield TV, LM421/422 are actually running between Northampton and Euston	LM421U	LCHFDTV-EUSTON PEAK	Extended to start at Lichfield (91291). Also removed Milton Keynes (768) and Bletchley (2365). Added in Berkhamsted (2367), Hemel Hempstead (704), Apsley (2368) and Kings Langley (739)
	LM422D	EUSTON-LCHFDTV PEAK	Extended to start at Lichfield (91291)
In Phase 2 network, WC, there are no services going through Lancaster except for Euston -GLGC/EDINBUR services. In DM network, service Euston to Lancaster is missing. In Phase 1, there are a lot of WC services going through Lancaster, which is very different from the Phase 2 network	WC305	EUSTON-MAN-GLGC	Added call at Oxenholme (92090)
	WC306	GLGC-MAN-EUSTON	Added call at Oxenholme (92090)
	WC307	EUSTON-MAN-EDINBUR	Added call at Lancaster (92685), removed call at Oxenholme (92090), added call at Penrith (92102)
	WC308	EDINBUR-MAN-EUSTON	Added call at Lancaster (92685), removed call at Oxenholme (92090), added call at Penrith (92102)
	LM413U	BHMNS-EUSTON	Added call at Wolverton (2364)
	LM414D	EUSTON-BHMNS	Added call at Wolverton (2364)

Issue Details	Specific PLD Coding Changes Implemented		
Other Phase 1 corrections made during the coding process which were not previously identified on the issues log	LM430U	BLTCHLY-EUSTON	Service edited to call at Northampton (914) and then run fast to Euston (655)
	LM431D	EUSTON-BLTCHLY	Added call at Bletchley (2365)
PLANET South Phase 1 Coding Updates			
Other Phase 1 corrections made during the coding process which were not previously identified on the issues log	LM407U	MKNSCEN-EUSTON	Call at Bushey (560) removed
	LM410D	EUSTON-BLTCHLY	Call at Bushey (560) removed
	LM411U	NMPTN-EUSTON	Call at Watford Junction (914) added
	LM413U	BHMNS-EUSTON	Call added at Wolverton (2364), call removed at Berkhamsted (2367)
	LM414D	EUSTON-BHMNS	Call added at Wolverton (2364), call removed at Berkhamsted (2367)
	LM430U	BLTCHLY-EUSTON	Call at Bushey (560) removed
PLANET Midlands Phase 1 Coding Updates			
Other Phase 1 network corrections made during the coding process which have not previously been identified	WC109U	HLYH-EUSTON	Removed call at Rugeley Trent Valley (91087)
	WC110U	HLYH-EUSTON	Removed call at Rugeley Trent Valley (91087)
	WC310U	CHSTR-EUSTON	Removed call at Rugeley Trent Valley (91087)
	WC311U	CRWE-EUSTON	Removed call at Rugeley Trent Valley (91087)
PLANET North Phase 1 Coding Updates			
Phase 1, Trans-Pennine services, Manchester Airport - Scotland services should be curtailed at Manchester Piccadilly to be in line with PLD.	TP110-	EDINBUR-MNCRIAP	Curtailed at Piccadilly - retain Airport-Piccadilly section only
	TP116-	MNCRIAP-GLGC	Curtailed at Piccadilly - retain Airport-Piccadilly section only
	TP117-	MNCRIAP-EDINBUR	Curtailed at Piccadilly - retain Airport-Piccadilly section only

A1.2 Preload Process Corrections

Item	Original Concern	Action taken
1	Nodes and network structure within the preload process have been found to be missing. In particular network structure around Meadowhall, East Midlands Hub (Toton) and the Stoke to Crewe line. This affects the services that use these links.	The missing networks have been added to the preload process, in particular: • Network around Meadowhall has been added to the PLD-PN process in all model scenarios, along with the Ordsall Chord/Northern Hub links. • The Stoke – Crewe links have been added in the PLD-PM process for the DM scenario. • Toton node and surrounding links have been added to the PLD-PM preload process in the Full Network scenario.
2	EM337D and EM176 should not be included in the preload process as not in the transit lines.	EM337D removed from preload process; and EM176- replaced with EM212-..
3	Services LM126U, LM148D, LM149D, LM167U, and LM169U are not included in the preload process but are included in the transit lines.	These services have been added.
4	WCML services WC183D, WC185D, WC192D, WC231 and W236U should be included within the PM preload process.	These services have been added.
5	Nodes 96358 in Ancaster and 91727, 91728 in Mansfield are missing from the node list within the preload process.	These have been added and mapped to the relevant regional area.
6	Services EC213, EC214, EC300 and EC301 between Scotland and Kings Cross should be included within the preload process.	These have been added.
7	Service LM114 between Bletchley and Crewe is missing from preload process.	This has been added
8	A series of WCML services exist in the preload process between PLD and PN in the Phase 2 scenario that don't feature in the set of transit lines.	These services have been deleted from the preload process.
9	East Midlands service EM115U features in the preload process between PLD and PN but not in the set of transit lines.	This service has been deleted from the preload process.
10	WCML services WC419 and WC420 (Crewe-Euston) should be included in the preload process between PLD and PN sub-models.	These have been added.

Item	Original Concern	Action taken
11	The node list in the preload process requires updating to match the nodes in the PLD network around Meadowhall.	Nodes 4001 and 4002 have been added to the preload process.
12	The following links exist in the preload process: 96663-96664, 96663-96676, 96664-96663 and 96676-96663 but not in the PLD network. The set of links in the preload process need updating to better represent the network around Meadowhall now that nodes 4001 and 4002 have been added to the node list.	These links have been deleted and replaced with the set of links connecting nodes 4001 and 4002 and representing the network structure around Meadowhall.
13	Service EM131 is missing from the preload process for PM.	This has been added and matched with all other Corby – St Pancras services.
14	Service XC228 (DUNDEEE-PLYMOUTH) should be included in the preload process for PM.	This has been added to the process.
15	Chiltern services between Marylebone and Aylesbury within the preload process for PS require updating to reflect the differentiation between the two routes via Amersham and Princes Risborough mainline. -,	'CH105D', 'CH106D', 'CH107D', 'CH108D', 'CH168D', 'CH169D', 'CH170D', & 'CH171D' PLD services within the preload process have been updated to be matched with services using the Princes Risborough route.
16	Chiltern services between Aylesbury and Marylebone require updating as per the point in item 15 above.	'CH125U', 'CH128U', 'CH176U', 'CH178U', 'CH190U', 'CH194U', 'CH197U', & 'CH200U' PLD services within the preload process have been updated to be matched with services using the Princes Risborough route.
17	Chiltern PLD transit line 'CH115-' High Wycombe to Birmingham Snow Hill incorrectly matched to the wrong group of services – this requires updating.	Service has been better matched to the Marylebone to Birmingham set of services.
18	Missing PS services within the PS preload process for the Great Western Berks & Hants service group.	Added the following PS transit lines to the preload process and matched with relevant PLD services. 'GW182-' Newbury-Bedwyn, 'GW207-' Rdngstn-Newbury, 'GW183-' Newbury-Rdngstn, 'GW105-' Bedwyn-Newbury'
19	Great Western Paddington-Birmingham New Street services 'GW385D', 'GW394D', and 'GW414D' in PLD, there are no matching services in PS as services in PS only go as far as Oxford due to network remit.	Updated the matching such that the corresponding PS services are matched to other Paddington to Oxford services rather than the PLD services identified to the left.
20	As above for the reverse direction Birmingham New Street to Paddington.	Updated the matching such that the corresponding PS services are matched to other Paddington to Oxford services rather than the PLD services identified to the left.

Item	Original Concern	Action taken
21	The PS node representing the St Pancras International station within the PS preload process is incorrectly matched to the PLD node representing Kings Cross Station, rather than the node for St Pancras Thameslink station. This affects the following services: Thameslink northbound flow between Farringdon (6060), St. Pancras International (6100) and Kentish Town (732) for PLD transit lines - 'TH101N', 'TH104N', 'TH108N', 'TH116N', 'TH124N', 'TH126N', 'TH128N', 'TH129N', 'TH132N', 'TH144N', and 'TH149N'. This also affects the processing of flows in the reverse direction for southbound PLD services ('TH114S', 'TH117S', 'TH119S', 'TH122S', 'TH123S', 'TH125S', 'TH127S', 'TH130S', and 'TH131S').	Amended node correspondence list for PS node 738 (St. Pancras International) to PLD node 6100 (St. Pancras Thameslink) within the PS preload process.
22	Thameslink northbound transit lines from East Croydon in PLD ('TH107N', 'TH134N', 'TH135N', and 'TH142N') have no matching PS transit lines. Also there is no flow between Farringdon and Kentish Town.	PS transit lines 'TH121N' and 'TH122N' Seven Oaks-Luton have been updated to match these PLD services as they follow the same route from East Croydon. The no flow between Farringdon and Kentish Town issue has been corrected by the above alterations to the node correspondence list for the PS St Pancras International node.
23	Thameslink southbound PLD transit lines to East Croydon ('TH133S', 'TH136S', and 'TH145S'), have no matching PS transit lines.	PS transit line 'TH170S' has been updated to match these PLD services.
24	Thameslink northbound PLD transit lines 'TH111-', 'TH112-' (Horsham-Cambridge) and 'TH113-' (Three Bridges-Peterborough), have no flow between Farringdon and Finsbury Park. This also effects reverse processing flows for southbound PLD services ('TH151-', 'TH153-' and 'TH154-' Cambridge-Horsham, and 'TH152-' Peterborough-Three Bridges) along the same route.	This issue has also been rectified by the node correspondence updates at St Pancras International.
25	In PLD, the Southern transit line 'SN464-' Clapham Junction - Watford Junction is incorrectly grouped with the southbound services.	The service matching between PLD and PS for this service has been updated.
26	No matching flow between PLD and PS on Bletchley-Tring section of London Midland network in both directions. This is caused by incorrect matching of services by direction.	The matching of services between PLD and PS has been updated to reflect the directionality of services.

A2 PFMv4.5 Model Development Updates

A2.1 Wormhole and ensemble processes updates

Original Concern	Action taken
Zone partition for wormhole (gs) should be considered as an integral part of network changes, just like the station choice model. At the moment one gs partition is used for DM, Phase 1 and Phase 2 models which is causing problems. Either different version of gs should be used for different models or the network change should take account of the ONLY gs partition. This is causing problems for the wormhole process, as a result zone/station 212 is not correctly defined in all scenarios in gs.	A single gs ensemble has been developed to cover all models (DM and DS, Phase 1 and Phase 2). This new gs ensemble was developed from first principles by reallocating all active SCM stations to PLD zones (with a cross-check against existing allocations) and separately identifying inactive stations which are all allocated to a specific group within the ensemble. Meadowhall classic station (212) and HS (207) zones have been coded as active in all models, and allocated to the correct ensemble group. An offline process is now established to enable updating of the gs ensemble when SCM stations are changed.
In the Phase 2 network, zones 195(HS Leeds), 198(HS Toton) and 200(HS Manchester) come out of dormancy, but in the gs ensemble they are still allocated to Cornwall as all dummy zones are.	In the revised gs ensemble applied to all models, zones 195, 198 and 200 are set to active and allocated to gs105, gs139 and gs125 respectively.
In PFMv4.2 model update, zones 220 (was Waterloo East) and 221 (was London Bridge) are moved to the North. However in the gs ensemble they are still allocated to Central London.	In the revised gs ensemble applied to all models, zones 220 (now Barnsley) is allocated to gs03 and zone 221 (now Rotherham) is allocated to gs171.
Zone 220 was for Waterloo East, 221 was London Bridge, it is recommended to use other un-used zones for the new nodes.	The new process for revising gs ensemble maintains a discrete list of inactive stations, which are allocated to gs00. This provides an audit trail to enable reuse of station numbers to be documented.
Free flow journey time skims are to be produced for each model run to reflect the journey time between OD pairs in response to the network/services. Depending on how significantly the network/services have changed, the responded journey tine skims may have an impact on the AM peak factors selected to transfer selected PLD demand into PS.	The functionality for implementing journey time skims was present in PFMv4.3 but was not active. This has now been activated to enable the skims to be produced and this process to be monitored.
The additional calculation to include outward-return trip split factors in order to incorporate revised assumptions on home/non home based demand is missing.	The functionality for this had been previously developed but was not implemented in PFMv4.3. This has now been activated, and the matrix calculations which apply the peak factors in were revised.

A2.2 Preload Process Updates

Interpretation of issue	Investigation undertaken	Action Taken	Action Completed?	Further action needed?
There are many transit lines in the preload process that no longer exist within the assignment sub-models.	A comparison of the services has been made to ascertain which services in the preload process are no longer required.	Lines that didn't match a services within the model were removed.	Yes.	No.
Concern that London Overground TOC ("OV") has not been included in the conversion factors for the PLD - PS preload process.	Checked for the presence of OV services within the preload process. OV services found within the conversion factors, and preloads assigned to OV services in the PLD, as shown in the outputs.	No action.	Yes.	No.
Concern that there are no transit lines in the down direction between Paddington and Reading are matched between PLD and PS in the corresponding preload process.	Investigated matching of services on this route between PLD and PS – found to be in order.	No action.	Yes.	No.
Concern that there are no transit lines in the down direction between Weston-Super-Mare and Taunton, in the PLD-PS preload process.	Investigations found that services on this route do exist in both PLD and PS	Services identified have been matched between the two models, and checks have been carried out that this has been correctly carried out.	Yes.	No.
Concern that there are no transit lines in the down direction between Henley-on-Thames and Marlow/Bourne End branch, in the PLD-PS preload process.	Investigations within the process and on National Rail show that these services are not defined in the morning peak, and therefore cannot be matched between PLD and PS.	No action	Yes.	No.
Concern that there are no transit lines in the down direction between Milton Keynes Central and Wolverton for London Midland services in the PLD-PS preload process.	Investigations identified a service that served Wolverton from Euston (LM414D) in PS, this can be matched with relevant services in PLD and allocated to this section of the network.	LM414U matched as suggested.	Yes.	No.
Concern that there are no transit lines in the down direction between Milton Keynes Central and Wolverton for West Coast services in the PLD-PS preload process.	Investigations showed that there are no relevant services that can be matched between PLD and PS.	No action taken.	Yes.	No.

Interpretation of issue	Investigation undertaken	Action Taken	Action Completed?	Further action needed?
Concern that there are no PS transit lines in the northbound direction south of Reading (i.e. Southampton-Basingstoke-Reading) for any TOC.	Two services in PS (XC315- and XC318-) serve the Southampton-Basingstoke-Reading, and are correctly matched to services in PLD, but there are no services in the reverse direction to be matched. There are no northbound services from South Coast to Yorkshire/North East compared to the opposite direction which is correct – these could be combined to provide line matching in both directions.	XC services between Southampton-Reading combined with South Coast-Yorkshire and South Coast-Manchester for the purpose of line matching in both directions	Yes.	No.
Concern that there are no PS transit lines in the southbound direction south of Bristol Temple Meads (i.e. Bristol Temple Meads - Weston-Super-Mare - Taunton - Exeter St. Davids) in the PS preload process.	Investigated and found XC138- (Manchester Piccadilly to Paignton) - which fulfils the desired service stopping pattern. This has been found to be correctly mapped.	No action.	Yes.	No.
Concern that there are no PS transit lines to/from Scotland on WCML.	2010 timetable indicates that there are services from the PS area to Scotland, but not ones that stop twice within the PS area in order to be included in the preload process, and this is observed in the transit line database.	No action.	Yes.	No.
Concern that there are no HT down services in PS, where there are corresponding down services in PLD for them to match to.	Investigations found that there is no return London Kings Cross-Hull service to facilitate the matching.	No action.	Yes.	No.
Preloads are missing for PLD services between Harringay and King's Cross.	Investigations found no transit lines in PLD that provide a direct service between Harringay and King's Cross. The 2009 timetable indicates that services pass through Harringay without stopping during the day, and this is reflected in the current timetable on National Rail. There are PS Thameslink services that pass through Harringay from King's Cross that are assigned to PLD services. There are additionally three similar PLD services (TH102- TH110- TH118-) that have not currently been assigned.	Added TH102- TH110- and TH118 to the preload matching process and TH105- TH120- and TH150- in alignment with corresponding Welwyn Garden City and Alexander Park services that operate in the opposite direction.	Yes.	No.
PS contains no matched ECML Scottish services in the down direction.	Investigations show that they are correctly matched.	No action.	Yes.	No.

Interpretation of issue	Investigation undertaken	Action Taken	Action Completed?	Further action needed?
PS contains no matched services between Peterborough and Kings Cross.	Investigations found an erroneous services EC200U in the northbound direction which is mapped between PLD and PS, however there is no corresponding service in the opposite direction. All other Kings Cross-Peterborough services that stop at Peterborough are correctly assigned in both directions.	Removed EC200U services from preload process.	Yes.	No.
Services XC156- and XC235-, Cardiff-Manchester and Manchester-Cardiff respectively in PLD are services that reverse out of Bristol Temple Meads and therefore travel the Filton-Bristol Temple Meads section twice as part of the route. These are matched inconsistently with other services between Manchester and Bristol/South West.	This has been investigated and found to be true. Removal of these services from the matching has been considered but since there is no corresponding PS service the PLD service would have to be removed entirely from the preload process. Decision made to keep the service in the packet.	No action taken.	Yes.	No.
Nodes 6435-6675 and the two new nodes 4001 and 4002 do not match PLD nodes.	4001 and 4002 have already been added. 6435 and 6675 (Seamer and Etruria) have previously been identified as insignificant in the analysis, so no need to add them.	No action.	Yes.	No.
PS XC services between the South Coast-and Birmingham/North - such as XC169 Bournemouth-Birmingham – are routed via Oxford, Bletchley, Northampton and Trent Valley to Crewe, whilst PLD services that are matched to these route via Oxford and Leamington Spa.	Investigations found this to be the case. All other services along this route are mapped correctly.	XC169- better matched to correct PLD services.	Yes.	No.
Review of services XC380-384 (MNCRPIC-BOMO) inclusion in the PM preload process required due to questions surrounding stopping patterns. Same point for XC354 and 357.	XC380-384 in PLD are currently mapped to XC322 and XC324 in PM. However since the services in PLD only stop at Crew and Milton Keynes, and Milton Keynes is not represented in PM no mapping should occur. Mapping for XC354 and XC357 PLD transit lines to the corresponding PM line XC316 is correct.	Removed the line matching as suggested.	Yes.	No.
GC101, GC104 and GC105 were found missing from the preload process.	These services are King's Cross to Bradford Interchange. GC has both directions in PLD and a single direction in regional;	No action.	Yes.	No.

Interpretation of issue	Investigation undertaken	Action Taken	Action Completed?	Further action needed?
	not viable for matching if there is no corresponding reverse direction train.			
Many local services, completely within the core local regions, were found included within the preload process which requires clarification.	These internal preload loadings provide a mechanism for feeding the long distance services and helping in the representation of crowding.	No action.	Yes.	No.
To be consistent with other preload links, 98257-98359 and 98359-98257, 98548-96417 and 96417-98548 should be included in the preload link list.	Checked to see that the links did not exist within the PLD links list.	Added the listed links to the PLD links list for consistency.	Yes.	No.
Node 92573 not included within the preload process while other nodes along the line are all included in the list. Services on this route are also included.	Investigations have found this to be true, they have also found that node 92573 (Cherry Tree) is included in the Manchester grouping, whilst 92574 (Clitheroe) and 92576 (Darwen) are not. Other nodes around Preston - Blackburn are included in this category, hinting that a consistent approach would be to include the other stations.	Node 92573 added to node list. Markers on nodes 92574 and 92576 changed to include them in the Manchester TTW area.	Yes.	No.
LM services between Liverpool/Crewe and Birmingham defined in preload process (LM188, 202 etc.)? They are services within the PN model and there are similar services running in the PM model. Requires clarification	Services found in PN (LM110-LM113-, LM109-) and in PM (LM149-LM150-, LM146-LM147-) are correctly matched to PLD packet codes PNLM01B and PMLM12B respectively. However, the stopping patterns of the PM services continue to Liverpool whilst those of the PN services do not continue to Birmingham but are cut off at Wolverhampton. Furthermore, it is only in DM that these PM services extend to Liverpool and only in the Liverpool-Birmingham direction, as they do not exist in the DS. As few services affected and no services in opposite direction then demand should not be transferred at Birmingham within PN - worth noting but no action needed.	No action.	Yes.	No.
HT matched with EC transit lines in DS Phase 2 preload process.	No HT service exists within PS Phase 2 DS.	Removed HT services from line matching for consistency, no other action needed.	Yes.	No.
Finsbury Park assigned two different node numbers in station look up within PLD-PS preload process -	In PLD and PS, Finsbury Park has two station identifiers - 663 (FBKs) and 1007 (FBKn). Both are used within the latest	No action.	Yes.	No.

Interpretation of issue	Investigation undertaken	Action Taken	Action Completed?	Further action needed?
requires investigation as to the effect on line matching.	models. However, the PS preload process contains a function which assigns all 663 node tags to the 1007 tag within the 'node matching'. This avoids any confusion in line matching for Finsbury Park and other nodes under similar circumstances.			
XC102- in PS is not matched to corresponding PLD services but probably should be as it is a Bristol-Plymouth service which is represented in both models.	XC102- Bristol-Plymouth service matches to XC104- in PLD. Both transit lines stop between Bristol Parkway and Plymouth at a number of stops.	Matched XC102- to XC104-.	Yes.	No.
PLD XC transit line 'XC210-' BathSpa-Glgc - No corresponding PS transit lines for this TOC over the Bath Spa - Bristol Temple Meads section.	Corresponding PS transit line is XC130- BathSpa-Glasgow, but this is incorrectly matched.	XC130- in PS has been correctly matched.	Yes.	No.
Commentary of the matching of London Midlands (LM) transit lines within the preload process seems incorrect - A and B direction indicators appear to be inconsistent.	Commentary incorrectly refers to 'to London' and 'from London' directions, so these descriptions must be swapped.	Commentary updated as suggested.	Yes.	No.
Comments within the PLD-PS preloads process generally require checking, tidying and filling of gaps for clarity.	Investigations showed that many gaps existed within the commentary, even after the changes detailed above.	Commentary for the following TOC's was added: GN, GW, HT, HX, SN, WC and XR.	Yes.	No.
Lack of error check - These spreadsheets have the problem that if a line or a link is not found which should be in, it would not report the error and the link/service is ignored.	The process has been reviewed, since the process is required to run automatically there is no obvious way of error checking without user intervention. A basic check is available to the user prior to the model run by inspection of the matching process however this is time consuming and in practise is unlikely to be carried out.	No action, but the implementation of the process should be reviewed fully as some stage and options for reimplementation evaluated.	Yes.	Yes.

A3 PFMv4.6 Model Development Updates

A3.1 PFMv4.5.1b Model Development

Automation Updates

PLANET South Demand Matrices

The PLANET South demand matrices are located inside the PS 01base databanks. Prior to running the PS 02test model, matrices are copied from the 01 base scenario. Input matrices are consistent between Phase 1 and Phase 2 model runs for equivalent years. The matrix slots for these matrices are mf256-mf261.

Coding changes have been made in order that these matrices can be included as an input in the \HS2\Inputs folder and automatically batched in to the 01base databank. In addition, a check has been carried out to ensure the presence of these matrices prior to a model run.

In order to automate the inclusion of these matrices two files have been created:

File	**MovePSDemMatrices.bat**	**PS_ImportDemMatricesBase.mac**
Location	\HS2\	\HS2\02PS\Macros\
Function	Moves matrices from the HS2\Inputs folder to \02PS\01Base\	Clears current mf256-261 from PS base EMMEbank and batches in new matrices from \02PS\01Base
Called By	2026_DM.bat/2036_DM.bat	2026_DM.bat/2036_DM.bat
File input requirements	Requires PS_mf256_01base.mtx etc. to be present in HS2\Inputs folder	Requires PS_mf256_01base.mtx etc. to be present in \02PS\01base folder

Three other files have also been modified in order to facilitate this:

File	**Run_All.bat Changes**	**2026_DM.bat and 2036_DM.bat Changes**
Function of modification	Modified to check that input matrices are present in HS2\Inputs folder	Modified to call MovePSDemMatrices.bat and PS_ImportDemMatricesBase.mac
Location of modification	Prior to calling of inputs_All	Both scripts called just after "Title 1.2 PS"
Location of modification in auto1 files	Lines 193-216	Lines 141-148

The following matrices are required to be present in the '\HS2\Inputs\' folder prior to carrying out a model run:

- PS_mf256_01base.mtx
- PS_mf257_01base.mtx
- PS_mf258_01base.mtx
- PS_mf259_01base.mtx
- PS_mf260_01base.mtx
- PS_mf261_01base.mtx

Fares

The PLD fare matrices are located in each of the three PLD demand databanks (note: that the fare matrices in the assign databanks are currently not utilised in model runs). The fare matrices are consistent between each of 01base, 02base and 03test. The slots in which these matrices are located are: mf111-mf119.

A number of coding changes have been made in order that these matrices can be included as an input in the \HS2\Inputs folder and automatically batched in to their respective databanks. In addition, a check has been implemented to ensure the presence of these matrices prior to a model run.

In order to automate the inclusion of these matrices two files have been created:

File	**MoveFareMatrices.bat**	**PLD_ImportFareMatrices.mac**
Location	\HS2\	\HS2\01PLD\Macros
Function	Moves fare matrices from the HS2\Inputs folder to \01PLD\01Base\01base_demand\Input, \01PLD\02Base\02base_demand\Input, and \01PLD\03test\03test_demand\Input	Clears current mf111-119 from PLD EMMEbanks and batches in new matrices from respective Input folders
Called By	2026_DM.bat/2036_DM.bat	2026_DM.bat/2036_DM.bat/2026_DS.bat/2036_DS.bat
File input requirements	Requires mf111_Com-Rail_Fare_2010_cncaf01 etc. to be present in HS2\Inputs folder	Requires mf111_Com-Rail_Fare_2010_cncaf01 etc. to be present in respective Input folders

Several other files have been modified in order to facilitate this:

File	Run_All.bat	2026_DM.bat/2036_DM.bat	2026_DS.bat/2036_DS.bat
Function of modification	Modified to check that input matrices are present in HS2\Inputs folder	Modified to call MoveFareMatrices.bat and PLD_ImportFareMatrices.mac	Modified to call PLD_ImportFareMatricest.mac
Location of modification	Prior to calling of inputs_All	Both scripts called just prior to application of control matrices under title 1.1 PLD	Fare matrices imported to o2base under Title 1.1 PLD DoSom just prior to application of PLD control matrix, fare matrices imported to o3test just prior to running of DefaultHeathrow.mac, 20 lines under title 2.1 PLD DoSom
Location of modification in auto1 files	Lines 157-193	Lines 45-52	Lines 59-62, 236-239

The following matrices are required to be present in the '\HS2\Inputs\' folder prior to carrying out a model run:

- mf111_Com-Rail_Fare_2010_cncaf01.mtx
- mf112_Com-Rail_Fare_2010_cfcaf01.mtx
- mf113_Com-Rail_Fare_2010_ctcaf01.mtx
- mf114_Bus-Rail_Fare_2010_bncaf01.mtx
- mf115_Bus-Rail_Fare_2010_bfcaf01.mtx
- mf116_Bus-Rail_Fare_2010_btcaf01.mtx
- mf117_Lei-Rail_Fare_2010_lncaf01.mtx
- mf118_Lei-Rail_Fare_2010_lfcaf01.mtx
- mf119_Lei-Rail_Fare_2010_ltcaf01.mtx

Ensembles

Automation of ensemble input has already been completed in a previous version of the PFM. A review has been carried out to check that the automation process is working correctly and that the latest ensemble files are being imported into the respective databanks. Based on this review, there is no further action in relation to automation of ensembles.

Heathrow Airport Access Model Base Year Costs

The spreadsheet 'Heathrow_Cost_Components.xls' imports data from six text files present in the following directory '\HS2\Heathrow\'. To provide greater clarity of the base year cost files that are being included in the process, an automation process has been developed that copies the files from '\HS2\Inputs' into '\HS2\Heathrow'.

In order to automate the inclusion of these files, one script file has been created:

File	**ImportHeathrowBYCosts.bat**
Location	\HS2\
Function	Moves Heathrow base year cost text files from \HS2\Inputs folder into \HS2\Heathrow folder for pickup by the model
Called By	2026_DM.bat/2036_DM.bat
File input requirements	BY_Air_CB_1.txt etc. present in \HS2\Inputs

Two files have also been modified in order to facilitate this:

File	**Run_All.bat**	**2026_DM.bat/2036_DM.bat**
Function of modification	Modified to check that input files are present in HS2\Inputs folder	Calls ImportHeathrowBYCosts.bat
Location of modification	Prior to calling of inputs_All	Called immediately after deletion of B2_Heathrow_Demand.311
Location of modification in auto1 files	Lines 133-157	Lines 130-132

The following base year cost matrices are required to be present in the '\HS2\Inputs\' folder prior to carrying out a model run:

- BY_Air_CB_1.txt
- BY_Air_CO_1.txt
- BY_Car_CB_1.txt
- BY_Car_CO_1.txt
- BY_CRail_Ref_CB_1.txt
- BY_CRail_Ref_CO_1.txt

Regional Model Assignment Procedure Updates

As part of the upgrade of EMME/2 to EMME/3 there have been a series of changes to the public transport rail assignment options. One of these changes is a feature to automatically save a "path" file from the public transport assignment. This "path" file contains all the routes used by services from each origin and destination together with the proportion of demand using each route. Having this "path" file available means that it is possible to undertake supplementary analysis, for example select line analysis or the creation of station to station matrices without undertaking an additional assignment. This means that the results from any additional analysis are consistent with the main assignment results. Usually the assignment results from any additional analysis are slightly different from the main assignment because they use a slightly different set of costs paths.

As part of the model development contract, HS2 Ltd have requested that procedures to automatically save the "path" file are introduced to all the regional model rail assignments. The assignment procedures used in PLD already automatically save the path files.

This modification to the assignment procedures does not change the rail assignment algorithm used, it just changes where it is called from in the EMME menu process. In the current version of PFM the rail assignment in the regional models is the EMME optimal assignment algorithm; this is a "frequency" based assignment and remains unchanged with the revised process.

A3.2 PFMv4.5.2 Model Development

TOC Code Updates

A comprehensive review of the TOC codes included in all macros has been carried out. All of the individual TOC codes present in each PLANET model were identified by extracting the transit line itineraries for DM and DS scenarios. All macros that contained TOC codes were then compared against this listing to determine if all TOC codes were picked up in every macro.

The review identified the following:

PLD:

- a number of missing TOC codes in outnet.mac
- The LU (London Underground) TOC is missing from TOCRev_DS.mac and Rassignsetup.mac

PS:

- a number of missing TOC codes in net.mac
- Mode u (representing London Underground) missing from setup_2009.mac

PM:

- a number of missing TOC codes in net.mac
- The EW TOC missing from setup_2009.mac and PM-Economic.mac
- TOC code ZZ was missing from all relevant macros in PM

PN:

- A number of missing TOC codes in net.mac
- The EM TOC missing from PN-Economic_RJF

TOC code ZZ was missing from all relevant macros in PM. TOC ZZ covers a number of bus services in the PM model linking Stafford, Stone and Stoke on Trent. TOC code ZZ has been added to all relevant macros in PM as part of the issue below.

Rassignsetup.mac prepares the rail assignment in PLD. As part of the process it defines the crowding parameters to be used for each TOC. It does not include the LU TOC representing London Underground. This is correct as crowding is not implemented on London Underground in PLD.

Setup_2009.mac prepares the rail assignment in the regional models. As part of the process it defines the crowding parameters to be used for each TOC. In PS it does not include mode u, this is correct as crowding parameters for London Underground services are defined in equilibrium.mac.

The issues identified relating to EW TOC in PM were identified post model runs following feedback from the auditors. These changes were not addressed in the model run, but it is recommended that they are incorporated in a future version of the model.

The following macros have not been updated as part of the TOC code updates as the functionality by TOC held within the macros was found to be unused or the macro was found not to be used as a whole within the PFM:

- PN-Economic_RJF.mac removed from PN for all four models, with no impact upon model expected.
- Outnet.mac, net.mac and TOCREV_DS.mac have not been updated.
- The reliability macros have not been updated.

As part of the updates to the standard output spreadsheet and subsequent review by the model auditors, it was identified that the TOC code CC in PS was missing from the standard output spreadsheet. Investigations indicated that information from PS for TOC CC was passed to the standard output spreadsheet, but was not included in the summary tabulations in the Smry_net_stats tab. The summary tabulations have been updated to include this.

Financial Year Macro Changes

It has been identified that there are some inconsistencies in the definition of the year of the inputs to the modelling and appraisal process. Some of the inputs represent a calendar year whereas others represent a financial year - this related to both demand and cost items. It is recognised that all inputs should ideally be in financial years.

A review was carried out in PFM to identify all inputs to determine whether they represented a calendar year or forecast year and to recommend which inputs to update. The review identified that several inputs were already in the correct year. For items that did not represent a calendar year, a recommendation was made whether to update it or not, depending on how feasible it was to update it. The following inputs were identified for update:

- Highway VOC in the base year and future years. Although these have previously been adjusted to a 2010/2011 financial year base, the factors used to do this did not use the correct index.
- Future-year air fares are provided in 2008 prices. There was uncertainty as to whether these had been adjusted to 2010/2011 prices using the correct index.

Highway VOC

VOC (both fuel and non-fuel) are calculated for the base year and future-year using parameters included in WebTAG. At the time of the model development this used WebTAG version 3.5.6. All parameter values in WebTAG 3.5.6 represent a 2010 calendar year. Although these had been corrected to a 2010/2011 financial year, this used the Retail Price Index. WebTAG states that the CPI should be used, therefore the vehicle operating costs have been recalculated using the CPI. A revised adjustment factor has been calculated using the average CPI index for 2010 calendar year compared to the 2010/2011 financial year. It should be noted that the change in factor using this approach was insignificant compared to the RPI, with the only change being at the third decimal place.

Note that as the change in factor to adjust VOC is insignificant, and the demand model is applied using the cost differences between the DM and DS; this change is not expected to have much impact.

Future-year Air Fares

Future-year air fares are provided in 2008 calendar year prices. Fares for each service are provided in transit line attributes ut1 and ut2 for business and leisure respectively. These need to be converted into 2010/2011 calendar year prices before input to the model. Investigations identified that in the most recent issue of air transit lines, no adjustment had been made to the air fares and these remained in 2008 prices.

A growth factor was calculated using the CPI index to update the 2008 calendar year prices to 2010/2011 financial year prices. The resultant factors were applied to both the DM and DS air transit lines for future years separately.

As the demand model uses the change in air fares between the DM and DS and there is no difference in air supply between the DM and DS, this change is not expected to have any impact on the demand model and demand model outputs. The one area where it will have a minor impact is in the HAM where the model pivots from the base year in both the DM and DS, so there is expected to be a slightly reduced air mode share to the airport in both the DM and DS as air fares will have increased slightly.

A4 PFMv4.7 Model Development Updates

A4.1 Detailed WebTAG Alterations

Rail Fares

Base year rail fares are held in matrix slots mf141-mf149 of the PLD base demand databank and are currently based on 2010/2011 LENNON and MOIRA data. The base year data was not updated as part of this work. The calculation to forecast future-year rail fares is carried out in the macro "setup.mac". The current basis on which rail fares are inflated is that they will increase at a rate of RPI + 1% per annum. Since growth is considered in real terms, in practice this means that the rail fare matrices are increased at a rate of 1% per annum from the 2010/2011 base year. The latest government guidance suggests that rail fares should be increased at a rate of RPI + 1% per annum, except for the years 2014 and 2015, where an increase of RPI + 0% should instead be applied. As such this change has been applied to "setup.mac" so that the rail fare matrices are multiplied by 1.01 for each year between the base year and the forecast year, except for 2014 and 2015.

This results in the following change in factors from 2010 to 2026 and the cap year, noting that the cap year has changed from 2036 in PFMv4.6 to 2040 in PFMv4.7:

Description	2010 to 2026	2010 to Cap Year
PFMv4.6 factor	1.17	1.30
PFMv4.7 factor	1.15	1.32
Percentage Change	-2.0%	2.0%

Heathrow Access Model (HAM) Rail and Coach Fares

In terms of the fare increases which have previously been applied in the HAM access model, a rate of 2% per annum has been used between 2010 and 2014, with a rate of 1% thereafter (a rate of 1% pa is used between 2003 and 2008, and a rate of 2% is used between 2008 and 2010, though this has no bearing on model results). It is assumed that this growth is in real terms, meaning that the actual growth rate is considered to be RPI + 2% between 2010 and 2014, and RPI + 1% thereafter. In order to keep consistency with the approach used in the wider model, the indices used have been modified to represent growth in rail fares at a rate of RPI + 1%, excepting 2014 and 2015 with RPI + 0%.

The indices used to grow coach fares in the Heathrow model have been found to be equal to those used to grow rail fares. In order to retain consistency of approach the coach fare indices have been modified on the same basis described above.

This results in the following change in factors from 2010 to 2026 and the cap year, noting that the cap year has changed from 2036 in PFMv4.6 to 2040 in PFMv4.7:

Description	2010 to 2026	2010 to Cap Year
PFMv4.6 factor	1.22	1.36
PFMv4.7 factor	1.15	1.32
Percentage Change	-5.7%	-2.9%

Heathrow Access Model Taxi Fares and Parking Fares

There is no requirement to update the base year taxi and parking fares contained within the HAM as part of the WebTAG updates.

The base year taxi and parking fares are grown by an 'earnings trend' which is stated within the HAM and closely matches growth in VOT and GDP per capita. Therefore the indices have been updated as per the latest guidance on growth in VOT from WebTAG. This results in the following change in growth factors, noting that the cap year has changed from 2036 in PFMv4.6 to 2040 in PFMv4.7:

Description	2010 to 2026	2010 to Cap Year
PFMv4.6 factor	1.44	1.81
PFMv4.7 factor	1.30	1.73
Percentage Change	-9.7%	-4.6%

Vehicle Occupancies (VOC)

Base year VOC are currently held in matrix slots mf751-753 of the PLD demand databanks and are both journey purpose and origin-destination specific. It is believed that these values are derived from the 1999-2001 National Travel Survey and factored to a year 2000 base. Currently WebTAG only provides values split by journey purpose as derived from 2000 data. Therefore the current origin-destination based data in the model was retained for the base year as it is more specific to the PFM than those values that WebTAG suggests.

Future-year VOC are coded into the macro "voc.mac". Contained within this macro are the forecasts for VOC (in pence/km per vehicle) by year (previously 2026, 2036, 2043), journey purpose (business, commute, other), and fuel and non-fuel elements. The guidance in WebTAG currently provides a method to calculate VOC in terms of average speed; this method has been adopted in line with earlier versions of the PFM, and uses base year data from the PFM to calculate average speeds in order to forecast the future-year VOC's. As part of this work the

spreadsheet has been adapted to calculate values for 2036, as this calculation was not previously present.

Once the revised WebTAG parameters were calculated, new values were entered into voc.mac for 2026 and the new cap year. The table below displays the observed change in these values.

Component	Value	Commute		Business		Other	
		2026	Cap Year	2026	Cap Year	2026	Cap Year
Fuel	Previous value pence/km/vehicle	5.453	5.104	4.581	4.295	5.461	5.111
	New value pence/km/vehicle	5.415	5.627	4.551	4.735	5.422	5.635
	Percentage Change	-0.7%	10.2%	-0.7%	10.2%	-0.7%	10.3%
Non-Fuel	Previous value pence/km/vehicle	3.805	3.745	6.532	6.447	3.805	3.745
	New value pence/km/vehicle	3.805	3.745	6.532	6.447	3.805	3.745
	Percentage Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Values of Time (VOT)

VOT for the base year are calculated as a function of trip distance in the macro "modesplit1.mac". The technical note which describes how the equations used to calculate these values are derived states that for business travel this is "a distance-damped relationship calibrated to the LDM SP data". For commute and other travel, the calculation used, which is also dependent upon (amongst other things) trip distance, is stated as having been derived from WebTAG Unit 3.12.2, Modelling Road Pricing. This part of WebTAG has since been withdrawn. However, current TAG Unit M2: Variable Demand Modelling states in section 3.3.14 that a similar function of a more general form may be used. Since both of these formulae utilise parameter values which have been specifically calibrated, it is recommended that VOT for the base year remain as they are.

VOT for future years are grown in modesplit1.mac using factors taken from the "Annual Parameters" sheet of the WebTAG databook. The factor used is the same regardless of journey purpose. The factors hard coded into the macro have been updated to match those in the October 2014 release forthcoming change v2.

Description	2010 to 2026	2010 to Cap Year
Old factor	1.31	1.60
New factor	1.30	1.73
Percentage Change	-0.5%	8.2%

Heathrow Access Model Values of Time

No source is given for the HAM base year VOT in the spreadsheet, but it is stated that these VOT are Heathrow specific. For specificity the base year values have been retained.

VOT for the HAM appears to have been grown on the same basis as for the wider model, and the spreadsheet containing the relevant factors states WebTAG as a source. For business travellers no elasticity has been applied. For leisure travellers however, an elasticity of between 0.801 and 0.808 has been applied. The exact value appears to vary depending on the year, although this may be due to the storage of a limited number of decimal places in the spreadsheet. In the absence of any note explaining the elasticity applied to non-work values of time, an elasticity which is the arithmetic mean of all present values (0.804) is carried forwards.

The consequent change in utilised factor values (ignoring unused data) is displayed in the table below, noting that the cap year has changed from 2036 in PFMv4.6 to 2040 in PFMv4.7.

Description	VOT - Business		VOT – Leisure	
	2010 to 2026	2010 to Cap Year	2010 to 2026	2010 to Cap Year
PFMv4.6 factor	1.32	1.61	1.25	1.47
PFMv4.7 factor	1.30	1.73	1.24	1.55
Percentage Change	-1.3%	7.3%	-1.0%	5.9%

Heathrow Access Model Vehicle Operating Costs

The base year HAM VOCs are split between UK & non-UK, and business & leisure types. For UK business users the base year VOCs included both fuel and non-fuel components, for the other segments it only includes the fuel component. This means that growth in fuel costs only is applied to a base year cost which also includes a non-fuel component for UK business users, but this is considered a simplification.

Base year fuel VOCs for the HAM model have been set to be the same as in the wider model.

In order to calculate growth indices/factors for fuel costs the following method has been employed:

- VOC for "business" and "other" journey types have been calculated using the same process as for the wider model for the years 2010, 2026 and 2040. Speeds for the different demand segments have been taken from the 2010 base year model.
- The HAM demand vectors for each of the years 2010, 2026 and 2040 have been analysed and the UK business and UK leisure sections summed.

- The proportion of this demand from the different segments has been used to take a weighted average of the fuel cost parameter values, and the indices adjusted so that the 2010 value is 100.
- Note that index values have not been calculated for years outside of 2010, 2026 and 2040, and that these cells in the spreadsheet have been left blank.

Since the index has changed, with 2010, rather than 2003, now equal to a base value of 100 it makes sense to compare the actual resulting vehicle operating cost values for the relevant years, noting that the cap year has changed from 2036 in PFMv4.6 to 2040 in PFMv4.7:

Demand Segment	2010			2026			Cap Year		
	PFMv4.6 Value (p/km)	**PFMv4.7 Value (p/km)**	**% Change**	**PFMv4.6 Value (p/km)**	**PFMv4.7 Value (p/km)**	**% Change**	**PFMv4.6 Value (p/km)**	**PFMv4.7 Value (p/km)**	**% Change**
UK Business	13.17	12.89	-2.1%	9.93	9.55	-3.8%	9.31	9.90	6.0%
Other Trip Purposes	6.02	7.29	21.1%	4.54	5.40	18.9%	4.25	5.60	31.8%

Resulting Appraisal Spreadsheet Updates

The resulting updates to the appraisal process as a result of the WebTAG changes is documented in the table below.

Item	Sheet	Cells	Updated in v4.6.1	Updated in v4.6.2	Source File
VOT Employer's Business (2010 prices and values)	WebTAG	M17:M21	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.1)
Car Occupancy per Vehicle Km Travelled (Work) (2000 values)	WebTAG	L27	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.3)
Green Book Discount Rates	WebTAG	D36:D41	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.1.1)
Market Price Adjustment	WebTAG	D45	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.1)
% Passenger Km increase diverted from Car	WebTAG	D49	Y	Y	WebTAG Unit A5.4 para 2.2.3
Proportion of Travel and Trips in Work/Non-Work Time	WebTAG	C54:I56	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.4)
Wider Impact Assessment	WebTAG	C62	Y	Y	WebTAG Unit A2.1, para 4.1.9
Average Speed	WebTAG	C107	Y	Y	Average vehicle speed PLD to PLD exported from Base EMME bank and averaged.
Central value of non-traded carbon, £ per tonne CO_2e (2010-2100) - 2010 Prices	WebTAG	M150:CY150	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A3.4)
VOT (Work and Non-work) Growth Rates (2003-2010)	VOT	F6:G13	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (Annual Parameters)

Appendices

Item	Sheet	Cells	Updated in v4.6.1	Updated in v4.6.2	Source File
Rail Fares Growth Rates (including change to RPI+0% for 14/15)	Other Assumptions	B114:E115	Y	Y	N/A
Vehicle Fleet Proportions (2004-2060)	WebTAG	G119:BK120	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.9)
Marginal External Costs by Road type and congestion band	Hwy from WebTAG	Whole sheet	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A5.4.2)
Fuel Consumption Parameters (2006-2060)	WebTAG	I111:BK118	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.11)
Fuel Costs per litre (2002 prices)	WebTAG	E124:BK129	Y	Y	WebTAG Data Book - Autumn 2014 - forthcoming change (A1.3.7)
Short-term GDP forecasts	VOT	C14:C21	N	Y	March_2014_EFO_Charts_and_tables-1.xls (Table 4.1)
Long-term GDP forecasts	VOT	C22:C66	N	Y	Fiscal sustainability report – Supplementary data series July 2014.xls (Table 1.1)
Population annual forecast growth rate	VOT	D15:D128	N	Y	Population forecasts: from the ONS low migration variant, available on the ONS website[3]; - consistent with the population forecasts that fed into the forecast GDP growth rates published by the OBR

Appendices

Item	Sheet	Cells	Updated in v4.6.1	Updated in v4.6.2	Source File
RPI Growth Relative to GDP Deflator	Other Assumptions	M18:AV18	N	Y	Fiscal-sustainability-report-supplementary-tables-July-2013.xls
GDP Deflators	WebTAG	C82:BI84	N	Y	Available online from HM Treasury 'GDP Deflators at market prices, and money GDP'

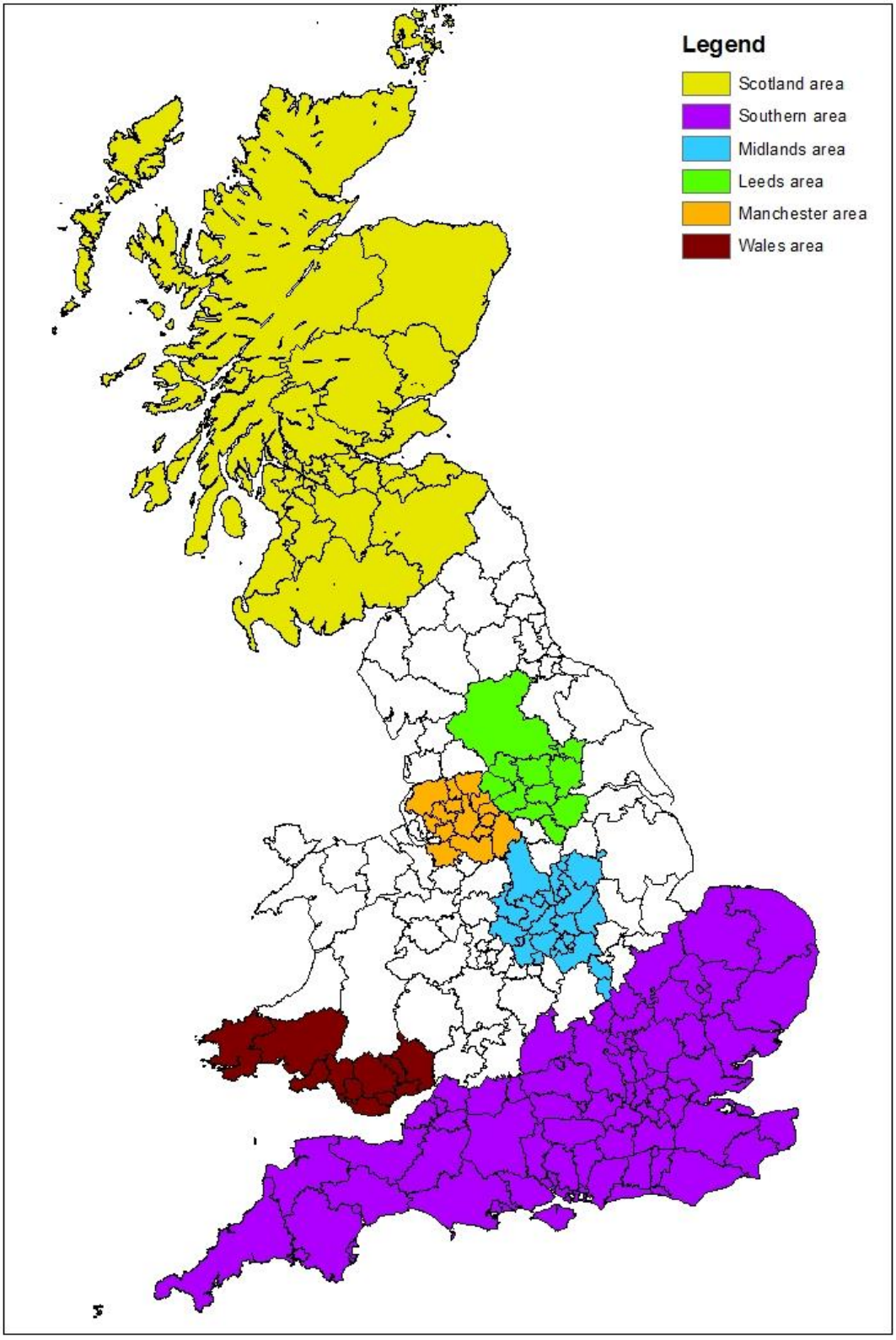
A4.2 Control Matrix Updates

This section presents where there is masking of demand within the PLD model. It does not show where the short distance regional model masking takes place within the Regional models (PLANET North, South and Midlands).

As can be seen in the image below, there are regions where demand is masked within the PFM model. Each group cannot travel to any other zone within the same group.

The tables following the map show which zones are in each group, as well as the surrounding zones which shows geographically the extent of the masking for each group of zones.

Appendices


Legend
Scotland area
Southern area
Midlands area
Leeds area
Manchester area
Wales area

Group of masked zones in Scotland

Zones within group	
Zone No	Zone Name
2	Aberdeen City, Aberdeenshire & Moray
16	Borders
36	City Of Edinburgh
37	City Of Glasgow
57	Dumfries & Galloway
58	Dundee & Angus
65	East Ayrshire
66	East Dunbartonshire
67	East Lothian
68	East Renfrewshire
74	Falkirk
75	Fife
95	Highland
131	Midlothian
144	North Lanarkshire
164	Perth & Kinross
174	Renfrewshire
196	South Ayrshire
197	South Lanarkshire
203	Stirling & Clackmannan
223	West Dunbartonshire
224	West Lothian
229	West Of Glasgow

Surrounding zones	
Zone No	Zone Name
21	Carlisle
149	Northumberland North
151	Northumberland West

Group of masked zones in Southern region

Zones within group	
Zone No	Zone Name
4	Bath & Ne Somerset
10	Bournemouth
13	Bedfordshire North
14	Berkshire East
15	Berkshire West
17	Brighton & Hove
18	Buckinghamshire
25	City Of Bristol
30	Cambridge City & South
31	Cambridgeshire East
32	Cambridgeshire North & West
38	Cornwall
52	Devon
53	Devon East
54	Devon North West
55	Devon South West
56	Dorset
62	Eastleigh
69	East Sussex
70	Essex East
71	Essex South
72	Exeter
73	Fareham
76	Gosport
78	Gatwick & Crawley
83	Havant
85	Hampshire East
86	Hampshire New Forest
87	Hampshire North
88	Hampshire Test Valley
89	Hampshire Winchester
90	Heathrow & Hillingdon
92	Hertfordshire ECML
93	Hertfordshire MML
94	Hertfordshire WCML
97	Isle Of Wight

Surrounding zones	
Zone No	Zone Name
34	Cheltenham & Cotswold
59	East Northamptonshire
79	Gloucester, Stroud, Forest Of Dean
114	Lincolnshire South East
148	Northamptonshire WCML
165	Peterborough
219	Wellingborough
222	Warwickshire South

102	Kent Ashford & Shepway
103	Kent East
104	Kent West
117	London Central
118	London North
119	London North East
120	London South / Croydon
121	London South East
122	London South West
123	London West
124	Luton
127	Mid Bedfordshire
132	Milton Keynes
137	North Somerset
142	Norfolk East
143	Norfolk West
158	Oxford City
159	Oxfordshire North
160	Oxfordshire South
162	Poole
166	Plymouth
167	Portsmouth
173	Reading
182	South Bedfordshire
184	South Gloucestershire
191	Swindon
194	Somerset East
195	Somerset West
201	Southampton
202	Stansted & Uttlesford
205	Suffolk Main
206	Suffolk West
207	Surrey East
208	Surrey North West
209	Surrey South West
225	West Sussex Central
226	West Sussex Chichester
227	West Sussex Coast
228	West Sussex Horsham
230	Wiltshire North
231	Wiltshire South

Group of masked zones in Midlands area

Zones within group	
Zone No	Zone Name
6	Blaby
24	Charnwood
33	Cannock & Lichfield
45	Derby City
51	Derbyshire West
61	East Staffordshire
64	Erewash
81	Harborough
84	Hinckley & Bosworth
98	Kettering
106	Leicester
111	Leicestershire North & West
112	Leicestershire South
126	Melton
138	North Warwickshire
139	Nottingham
140	Nuneaton & Bedworth
153	Nottinghamshire Mansfield
154	Nottinghamshire Newark & Sherwood
155	Nottinghamshire South & East
156	Nottinghamshire West
183	South Derbyshire
211	Tamworth
219	Wellingborough

Surrounding zones	
Zone No	Zone Name
5	Birmingham
13	Bedfordshire North
28	Corby
29	Coventry
49	Derbyshire High Peak
50	Derbyshire North East
59	East Northamptonshire
113	Lincoln City And Coast
115	Lincolnshire South West
132	Milton Keynes
148	Northamptonshire WCML
152	Nottinghamshire Bassetlaw
172	Rutland
175	Rugby
179	Sheffield
181	Solihull
186	Stafford
198	South Staffordshire
204	Stoke & Staffordshire North
217	Walsall

Group of masked zones in South Wales

Zones within group	
Zone No	Zone Name
12	Bridgend
20	Cardiff
22	Carmarthenshire
129	Monmouthshire
133	South Wales West
134	Newport
161	Pembrokeshire
190	Swansea
199	South Wales Central
200	South Wales East
214	Vale Of Glamorgan

Surrounding zones	
Zone No	Zone Name
23	Ceredigion
79	Gloucester, Stroud, Forest Of Dean
91	Herefordshire
163	Powys

Group of masked zones in Manchester

Zones within group	
Zone No	Zone Name
7	Blackburn
9	Bolton
49	Derbyshire High Peak
108	Lancashire South East
109	Lancashire West
125	Macclesfield
130	Manchester Including Metrolink Area
157	Oldham
170	Rochdale
185	St Helens
187	Stockport
210	Tameside
215	Vale Royal
218	Warrington
220	Wigan

Surrounding zones	
Zone No	Zone Name
3	Barnsley
19	Calderdale
26	Congleton
35	Chester & Ellesmere Port
42	Crewe
51	Derbyshire West
80	Halton
100	Kirklees
101	Knowsley
107	Lancashire Ribble & Pendle
168	Preston, Fylde, Wyre
177	Sefton
179	Sheffield
204	Stoke & Staffordshire North

Group of masked zones in Leeds

Zones within group	
Zone No	Zone Name
3	Barnsley
11	Bradford
19	Calderdale
46	Doncaster
100	Kirklees
147	North Yorkshire West
171	Rotherham
178	Selby
216	Wakefield
235	York

Surrounding zones	
Zone No	Zone Name
41	County Durham West
43	Cumbria South
44	Darlington
49	Derbyshire High Peak
50	Derbyshire North East
60	East Riding Of Yorkshire
63	Eden
99	Kingston Upon Hull
107	Lancashire Ribble & Pendle
108	Lancashire South East
110	Lancaster
136	North Lincolnshire
145	North Yorkshire ECML
146	North Yorkshire East
152	Nottinghamshire Bassetlaw
157	Oldham
170	Rochdale
179	Sheffield

A5 PFMv5.0 Model Development Updates

A5.1 – Cross-Country Network Changes

Item	TOC	Route	Service number	Edits
1	Cross Country DM, Phase 1, Phase 2	Manchester Piccadilly – Birmingham New St	(PLD) XC136- (PLD) XC135- (PM) XC475-	Change total capacity from 399 to 324
2	Cross Country DM, Phase 1, Phase 2	Birmingham New St – Manchester Piccadilly	(PLD) XC134-	Change total capacity from 798 to 648
			(PLD) XC131- (PLD) XC130- (PN) XC104- (PM/PS) XC109-	Change total capacity from 399 to 324
3	Cross Country DM, Phase 1, Phase 2	Birmingham New St – Newcastle	(PN) XC102- (PLD) XC116- (PM) XC105-	Change total capacity from 399 to 324
4	Cross Country DM, Phase 1, Phase 2	Manchester Piccadilly – Bournemouth	(PLD) XC380- (PLD) XC382- (PLD) XC383- (PLD) XC384- (PM) XC322- (PM) XC324- (PN) XC307- (PN) XC308- (PS) XC323- (PS) XC325-	Change seat capacity from 271 to 275 Change total capacity from 465 to 324
5	Cross Country DM, Phase 1, Phase 2	Bristol Temple Meads – Manchester Piccadilly	(PN) XC106-	Change headway from 90.00 to 180.00
6	Cross Country DM, Phase 1, Phase 2	Manchester Piccadilly – Bristol Temple Meads	(PM) XC139- (PN) XC115-	Change headway from 90.00 to 180.00

Appendices

Item	TOC	Route	Service number	Edits
7	Cross Country DM, Phase 1, Phase 2	Cambridge – Birmingham New St	(PN) XC120-	Add this service in PN transit line 1 per period, capacity 200/335
8	Cross Country DM, Phase 1, Phase 2	Newcastle – Glasgow	(PN) XC212-	Add this service in PN transit line 1 per period, capacity 275/399
9	Cross Country DM, Phase 1, Phase 2	Manchester Piccadilly – Paignton	(PM) XC224- (PN) XC224- (PS) XC224-	Add this service to regional transit line files 1 per period, capacity 275/399
10	Cross Country DM, Phase 1, Phase 2	Southampton – Manchester Piccadilly	(PLD) XC354- (PS) XC315-	Change PLD headway from 480.00 to 320.00 Change PS headway from 90.00 to 60.00
11	Cross Country DM, Phase 1, Phase 2	Bath Spa – Edinburgh	(PN) XC111-	Replace service title of Bath Spa – Glasgow in transit line with Bath Spa – Edinburgh
12	Cross Country DM, Phase 1, Phase 2	Birmingham New St – Edinburgh	(PN) XC110-	Change total capacity from 798 to 648
13	Cross Country DM, Phase 1, Phase 2	Birmingham – Bournemouth	(PLD) XC468-	Add this service to PLD transit line 1 per period, capacity 275/324
14	Cross Country DM, Phase 1, Phase 2	Derby – Newcastle	(PN) XC101- (PLD) XC114-	Change total capacity from 399 to 324
15	Cross Country DM, Phase 1, Phase 2	Sheffield – Reading	(PN) XC116- (PLD) XC240-	Change total capacity from 399 to 324
16	Cross Country DM, Phase 1, Phase 2	York – Plymouth	(PLD) XC469- (PM) XC469- (PS) XC469- (PN) XC469-	Add this services to all transit line files 1 per period, capacity 275/324

Item	TOC	Route	Service number	Edits
17	Cross Country DM, Phase 1	Birmingham New St – Glasgow	(PLD) XC466-	Add this service to PLD transit line 1 per period, capacity 275/324

A5.2 – Network Changes Crossrail

TOC	Route	Service number	Edits
Crossrail – PS DM, Phase 1, Phase 2-network	Abbey Wood-Reading	XR111W	Transit lines extended to Reading via Twyford. Journey time of 5.5 minutes used on both links. The frequency has been coded as 2 tph in line with information provided on the Crossrail website.
Crossrail – PS DM, Phase 1, Phase 2-network	Reading – Abbey Wood	XR104E	Extended transit lines to Reading via Twyford. Journey time of 5.5 minutes used on both links. The frequency has been coded as 2 tph in line with information provided on the Crossrail website.
Crossrail – PLD DM, Phase 1, Phase 2-network	Abbey Wood-Reading	XR111W	Extended transit lines to Reading via Twyford. Journey time of 5.5 minutes used on both links. A frequency of 2 tph cannot be completed in the PLD model without large scale recoding, therefore 6 trains per day has been used to represent the route.
Crossrail – PLD DM, Phase 1, Phase 2-network	Reading – Abbey Wood	XR104E	Extended transit lines to Reading via Twyford. Journey time of 5.5 minutes used on both links. A frequency of 2 tph cannot be completed in the PLD model without large scale recoding, therefore 6 trains per day has been used to represent the route.

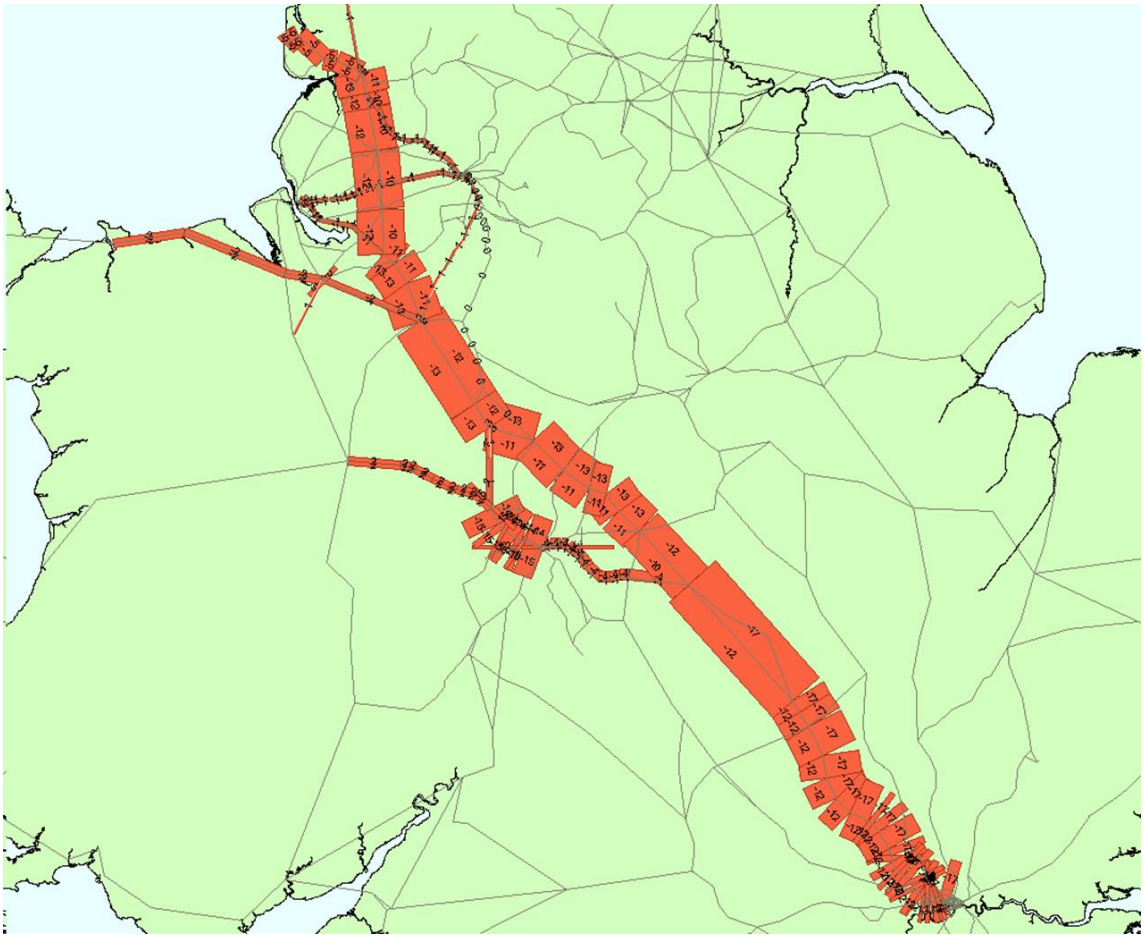
A5.3 West Coast Mainline

Do Minimum – Change in the Level of Service

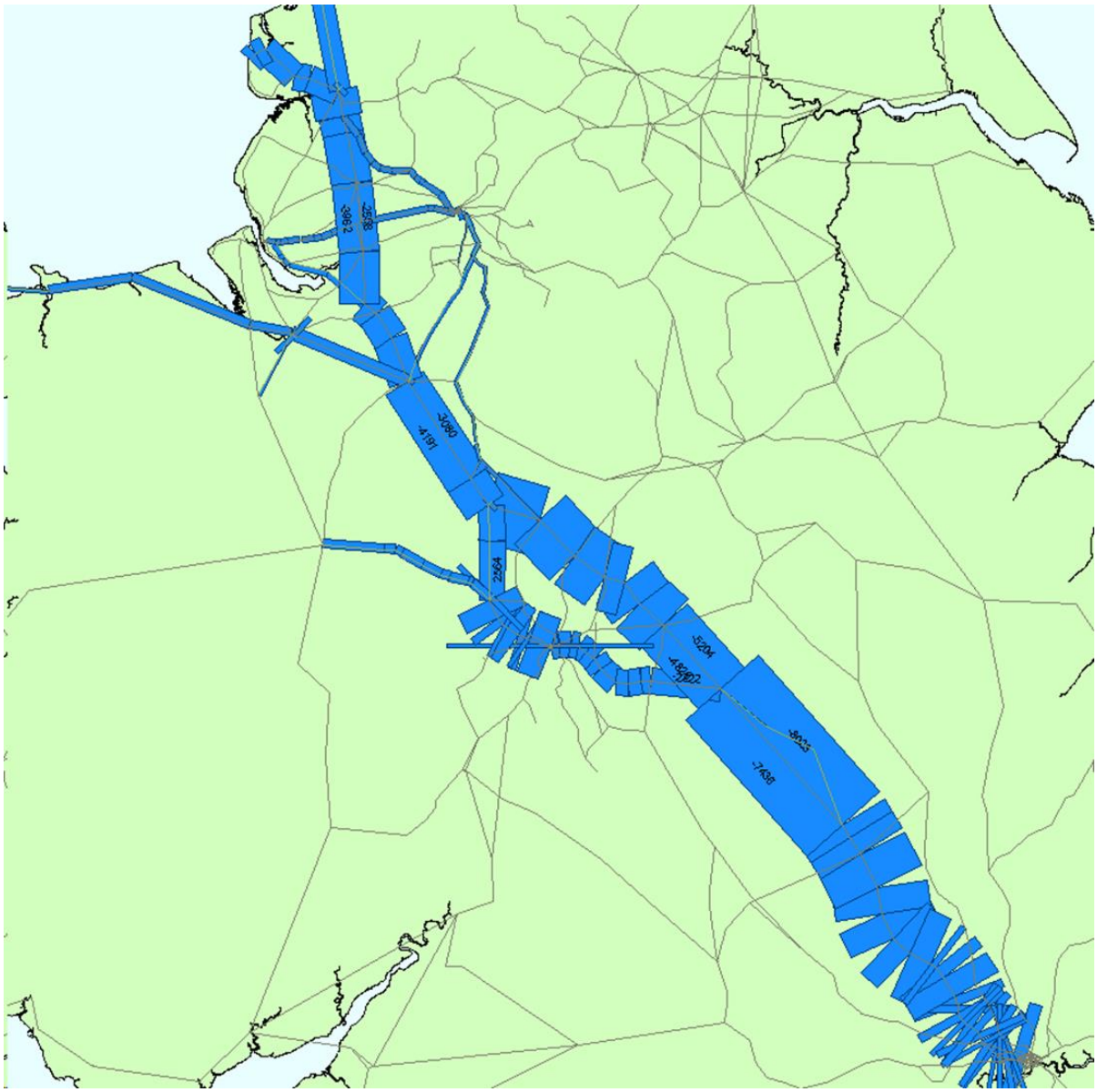
WCML– Change in Do Minimum Level of Service

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv4.8	PFMv5.0	Diff	%	PFMv4.8	PFMv5.0	Diff	%
Euston - Glasgow	D	13	19	6	32%	260	283	23	9%
	U	14	20	6	30%	266	288	22	8%
Euston - Edinburgh	D	0	5	5	100%	0	333	n/a	n/a
	U	0	6	6	100%	0	340	n/a	n/a
Euston - Manchester	D	42	42	0	0%	129	128	-1	-1%
	U	46	46	0	0%	130	131	1	1%
Euston - Liverpool	D	19	17	-2	-12%	134	133	-1	-1%
	U	18	16	-2	-13%	134	133	0	0%
Euston - Birmingham	D	46	45	-1	-2%	86	85	0	0%
	U	50	46	-4	-9%	85	85	1	1%
Euston - Wolverhampton	D	23	22	-1	-5%	112	115	3	3%
	U	25	23	-2	-9%	109	110	1	1%
Euston - Preston	D	28	29	1	3%	126	153	27	21%
	U	27	28	1	4%	134	164	30	22%
Euston - Blackpool	D	6	1	-5	-500%	152	176	24	16%
	U	5	0	-5	-100%	164	0	n/a	n/a
Euston - Lancaster	D	13	22	9	41%	135	171	37	27%
	U	15	25	10	40%	147	179	33	22%
Birmingham - Preston	D	15	12	-3	-25%	90	97	7	8%
	U	15	16	1	6%	97	107	10	11%
Birmingham - Glasgow	D	7	6	-1	-17%	225	237	12	5%
	U	7	7	0	0%	232	242	10	4%
Birmingham - Edinburgh	D	7	5	-2	-40%	237	242	5	2%
	U	7	7	0	0%	240	248	8	4%

WCML Change in Number of Trains per Day (PFMv5.0-PFMv4.8) - Do Minimum



WCML – Change in Number of Seats per Day (PFMv5.0-PFMv4.8) - Do Minimum

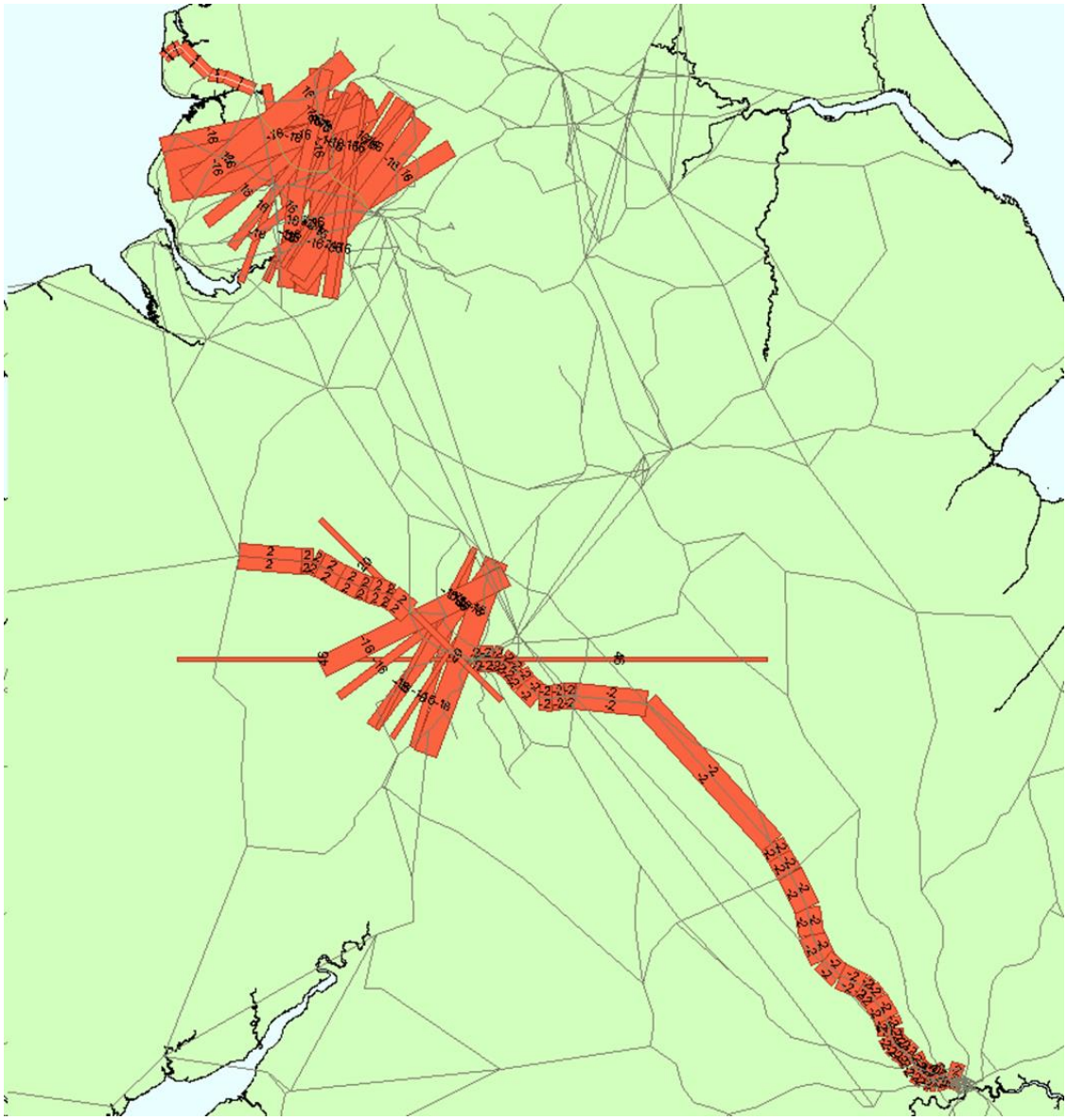


Do Something – Change in the Level of Service

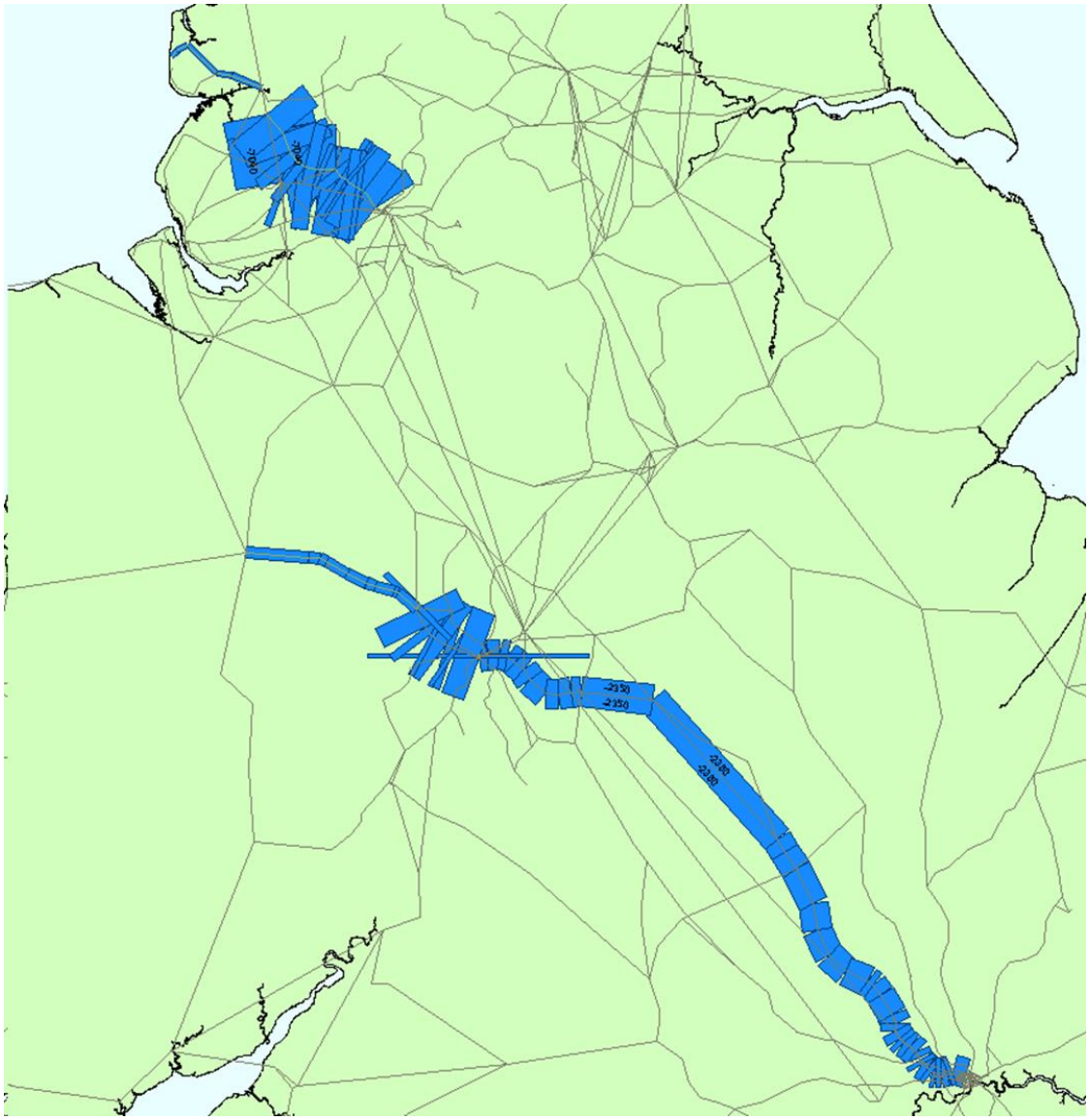
WCML – Change in Level of Service – Do Something Phase 1

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv4.8	PFMv5.0	Diff	%	PFMv4.8	PFMv5.0	Diff	%
Euston - Glasgow	D	8	15	7	47%	329	317	-12	-4%
	U	8	15	7	47%	333	332	0	0%
Euston - Edinburgh	D	8	15	7	47%	326	321	-5	-1%
	U	8	15	7	47%	334	337	4	1%
Euston - Manchester	D	19	19	0	0%	130	130	0	0%
	U	19	19	0	0%	132	132	0	0%
Euston - Liverpool	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a
Euston - Birmingham	D	32	30	-2	-7%	93	93	1	1%
	U	32	30	-2	-7%	94	95	1	1%
Euston - Wolverhampton	D	32	30	-2	-7%	114	117	3	3%
	U	32	30	-2	-7%	114	120	6	5%
Euston - Preston	D	16	30	14	47%	175	176	1	1%
	U	16	30	14	47%	178	192	14	8%
Euston - Blackpool	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a
Euston - Lancaster	D	16	30	14	47%	198	196	-2	-1%
	U	16	26	10	38%	201	211	10	5%
Birmingham - Preston	D	15	15	0	0%	90	90	0	0%
	U	15	15	0	0%	97	108	11	11%
Birmingham - Glasgow	D	7	7	0	0%	225	219	-6	-3%
	U	7	7	0	0%	232	238	6	3%
Birmingham - Edinburgh	D	7	7	0	0%	237	232	-5	-2%
	U	7	7	0	0%	240	247	7	3%

WCML – Change in Number of Trains per Day (PFMv5.0-PFMv4.8) – Phase 1



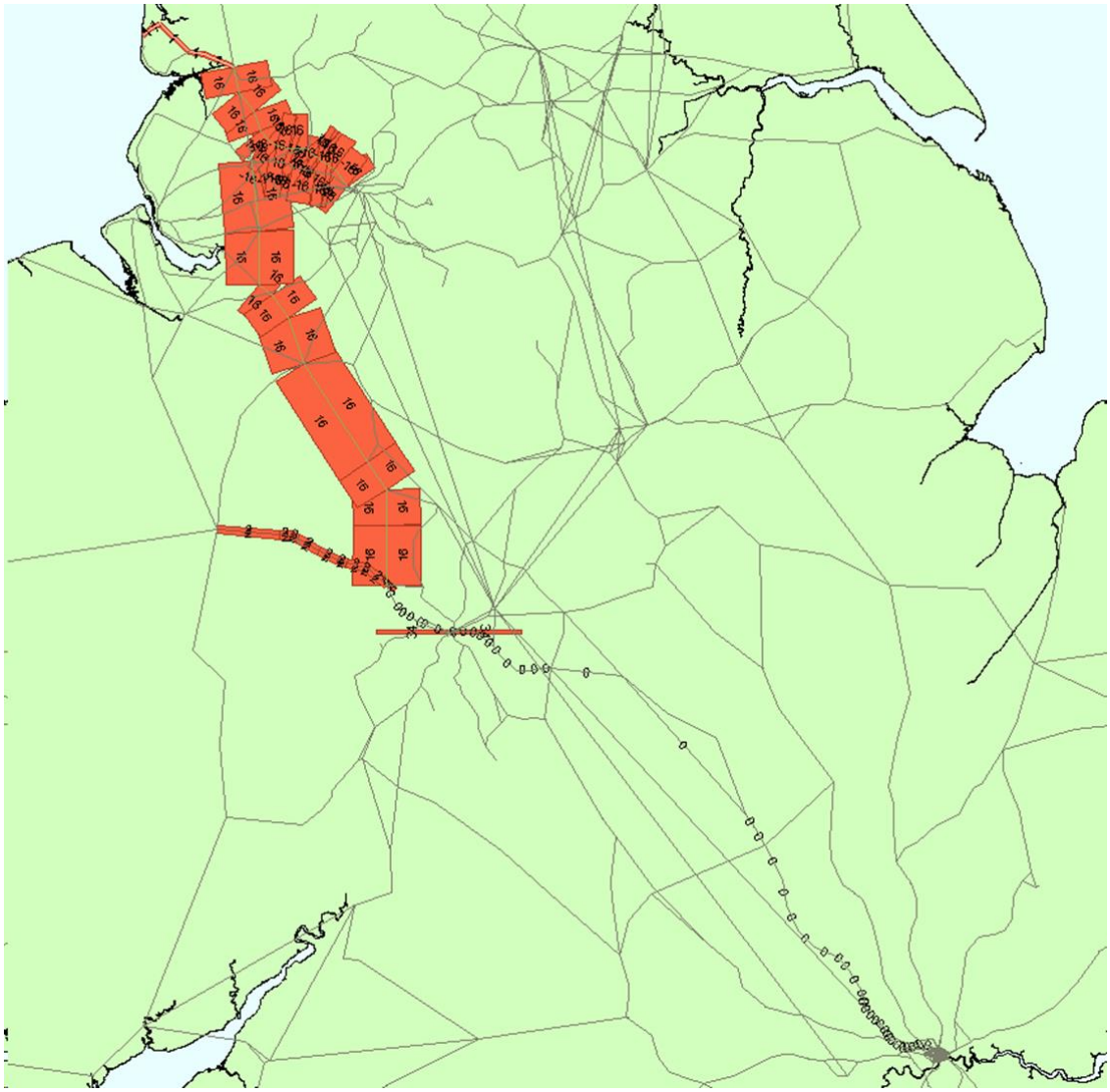
WCML – Change in Number of Seats per Day (PFMv5.0-PFMv4.8) – Phase 1



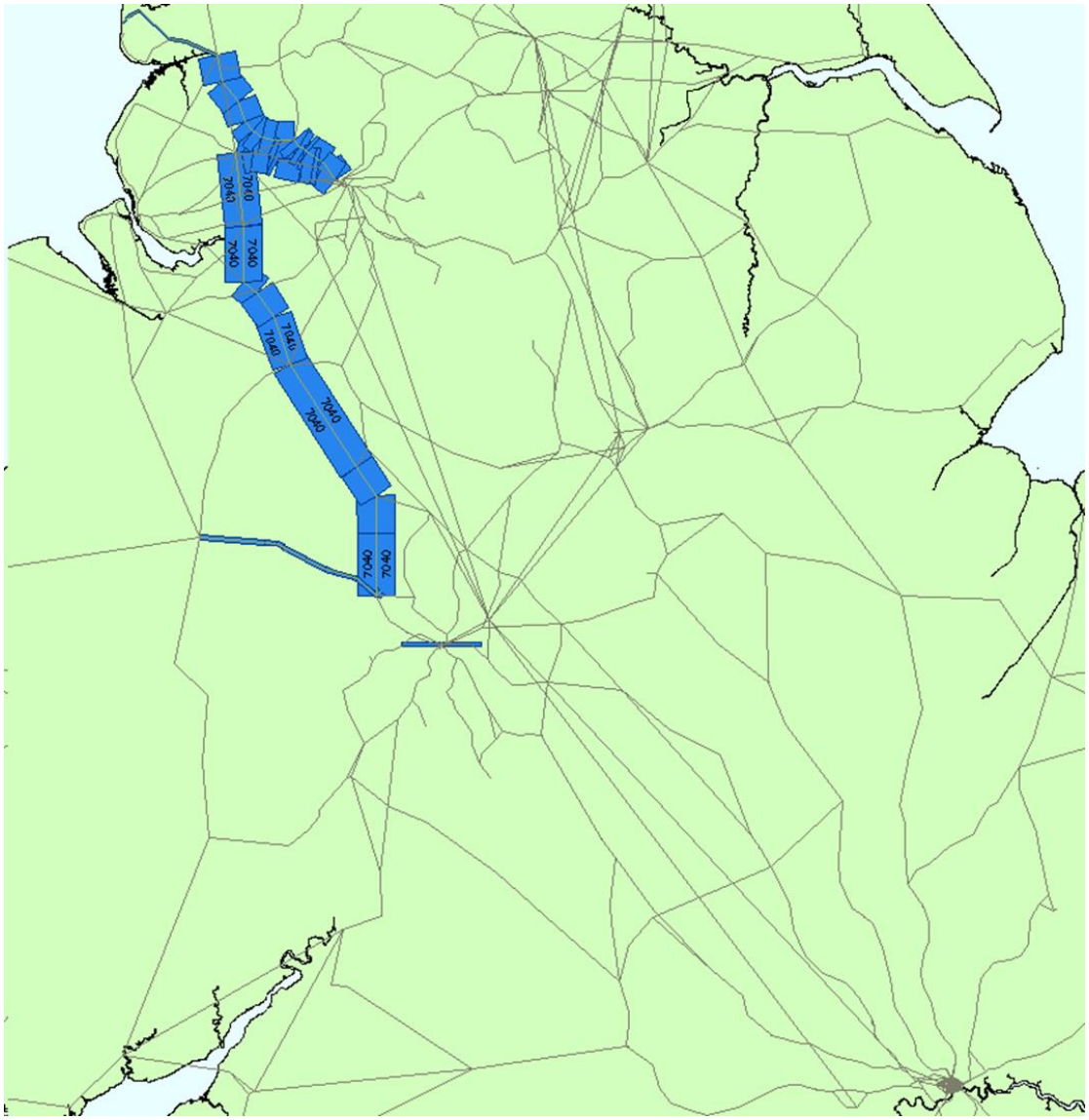
WCML – Change in Level of Service – Do Something Phase 2

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv4.8	PFMv5.0	Diff	%	PFMv4.8	PFMv5.0	Diff	%
Euston - Glasgow	D	8	8	0	0%	329	317	-12	-4%
	U	8	8	0	0%	333	330	-3	-1%
Euston - Edinburgh	D	8	8	0	0%	326	315	-12	-4%
	U	8	8	0	0%	334	331	-3	-1%
Euston - Manchester	D	19	19	0	0%	130	130	0	0%
	U	19	19	0	0%	132	132	0	0%
Euston - Liverpool	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a
Euston - Birmingham	D	32	32	0	0%	93	93	0	0%
	U	32	32	0	0%	94	95	1	1%
Euston - Wolverhampton	D	32	32	0	0%	114	114	1	0%
	U	32	32	0	0%	114	118	4	4%
Euston - Preston	D	16	32	16	50%	175	182	7	4%
	U	16	32	16	50%	178	190	12	6%
Euston - Blackpool	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a
Euston - Lancaster	D	16	16	0	0%	198	191	-7	-4%
	U	16	16	0	0%	201	203	2	1%
Birmingham - Preston	D	0	16	16	100%	0	104	n/a	n/a
	U	0	16	16	100%	0	103	n/a	n/a
Birmingham - Glasgow	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a
Birmingham - Edinburgh	D	0	0	0	0%	0	0	0	n/a
	U	0	0	0	0%	0	0	0	n/a

WCML – Change in Number of Trains per Day (PFMv5.0-PFMv4.8) – Phase 2



WCML – Change in Number of Seats per Day (PFMv5.0-PFMv4.8) – Phase 2



A5.4 East Midlands

Do Minimum network changes

TOC	Route	Trains Per Day
East Midlands	St Pancras - Corby	Add new service codes to PLD: EM835D, EM836D, EM830D, EM827D Remove old service codes in PLD: EM115D, EM118D, EM123D, EM124D, EM125D, EM131D Regional service codes consistent with PLD: EM835D (PS), EM830D (PN), EM827D (PM)
East Midlands	Corby – St Pancras	Add new service codes in PLD: EM837U, EM838U Remove old service codes in PLD: EM101U , EM102U , EM103U , EM104U , EM105U , EM106U Regional service codes consistent with PLD: EM837U (PS)
East Midlands	St Pancras - Nottingham	Add new service codes in PLD: EM824D , EM825D, EM826D, EM827D Remove old service codes in PLD: EM114D , EM117D , EM120D , EM126D , EM130D , EM138D, EM140D, EM328D , EM334D , EM335D Regional service codes consistent with PLD: EM824D (PS/PN), EM825D (PS/PN), EM820D (PM), EM821D (PM)
East Midlands	Nottingham – St Pancras	Add new service codes in PLD: EM820U, EM821U , EM823U , EM839U , EM824U , EM825U Remove old service codes in PLD: EM143U , EM145U , EM146U , EM147U , EM148U , EM149U , EM150U , EM309U Regional service codes consistent with PLD: EM820U (PS/PN), EM821U (PS/PN), EM824U (PM), EM825U (PM)
East Midlands	St Pancras - Sheffield	Add new service codes in PLD: EM816D , EM817D , EM818D , EM819D , EM814D , EM815D

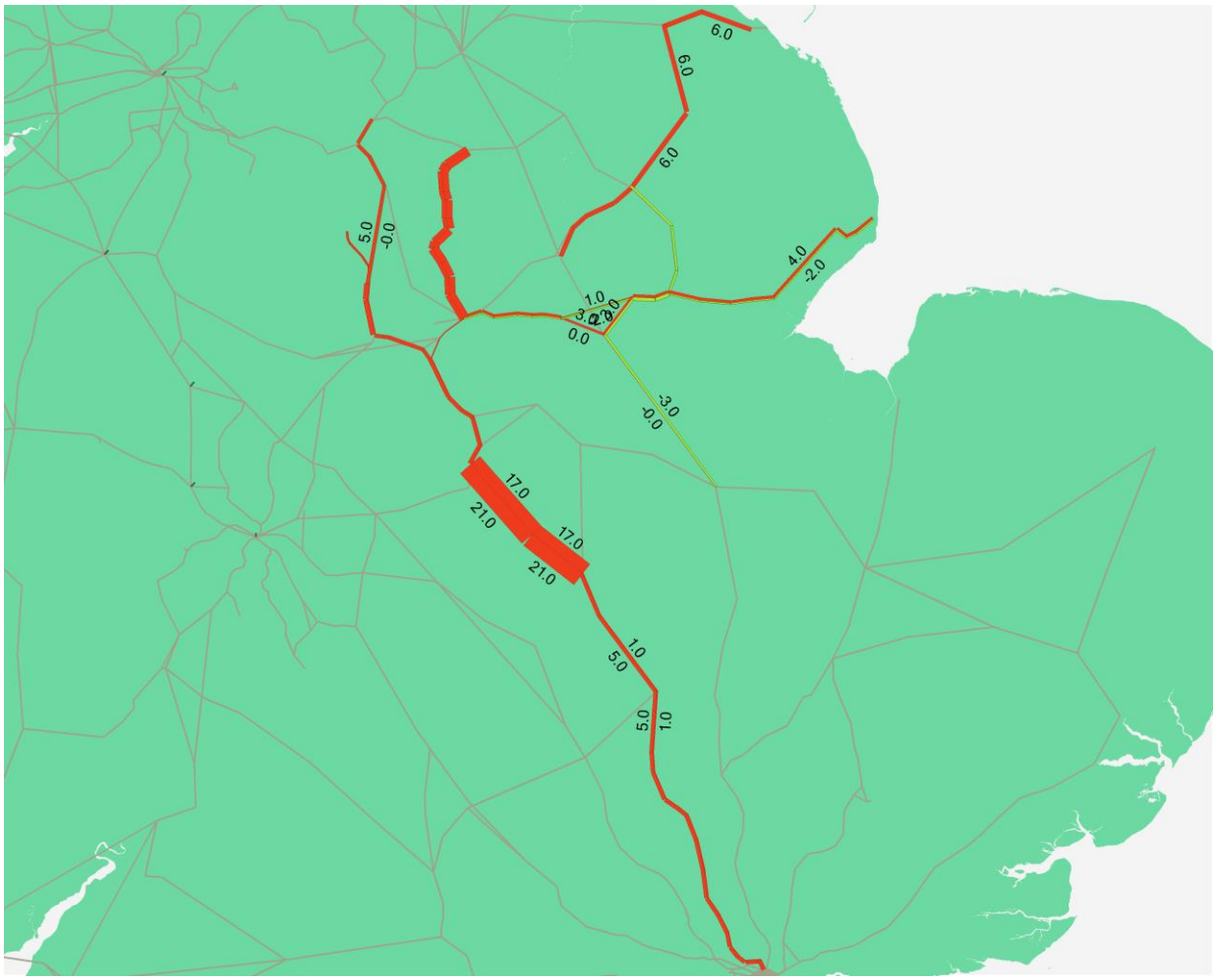
TOC	Route	Trains Per Day
		Remove old service codes in PLD: EM116D , EM119D , EM121D , EM127D, EM129D, EM132D, EM141D Regional service codes consistent with PLD: EM814D (PM), EM815D (PM), EM816D (PS/PN), EM817D (PS/PN)
East Midlands	Sheffield – St Pancras	Add new service codes in PLD: EM158U, EM812U , EM813U , EM814U, EM815U Remove old service codes in PLD: EM153U , EM154U , EM155U , EM156U Regional service codes consistent with PLD: EM812U (PS/PM), EM813U (PS/PN/PM), EM814U (PN), EM815U (PN)
East Midlands	Leicester – St Pancras	Add new service codes in PLD: EM832U , EM834U Regional service codes consistent with PLD: EM832U (PS/PN), EM828U (PM), EM829U (PM), EM833U (PN)
East Midlands	St Pancras - Leicester	Add new service codes: EM828D, EM829D Regional service codes consistent with PLD: EM828D (PN/PS) EM830D (PM)

Do Minimum – Change in the Level of Service

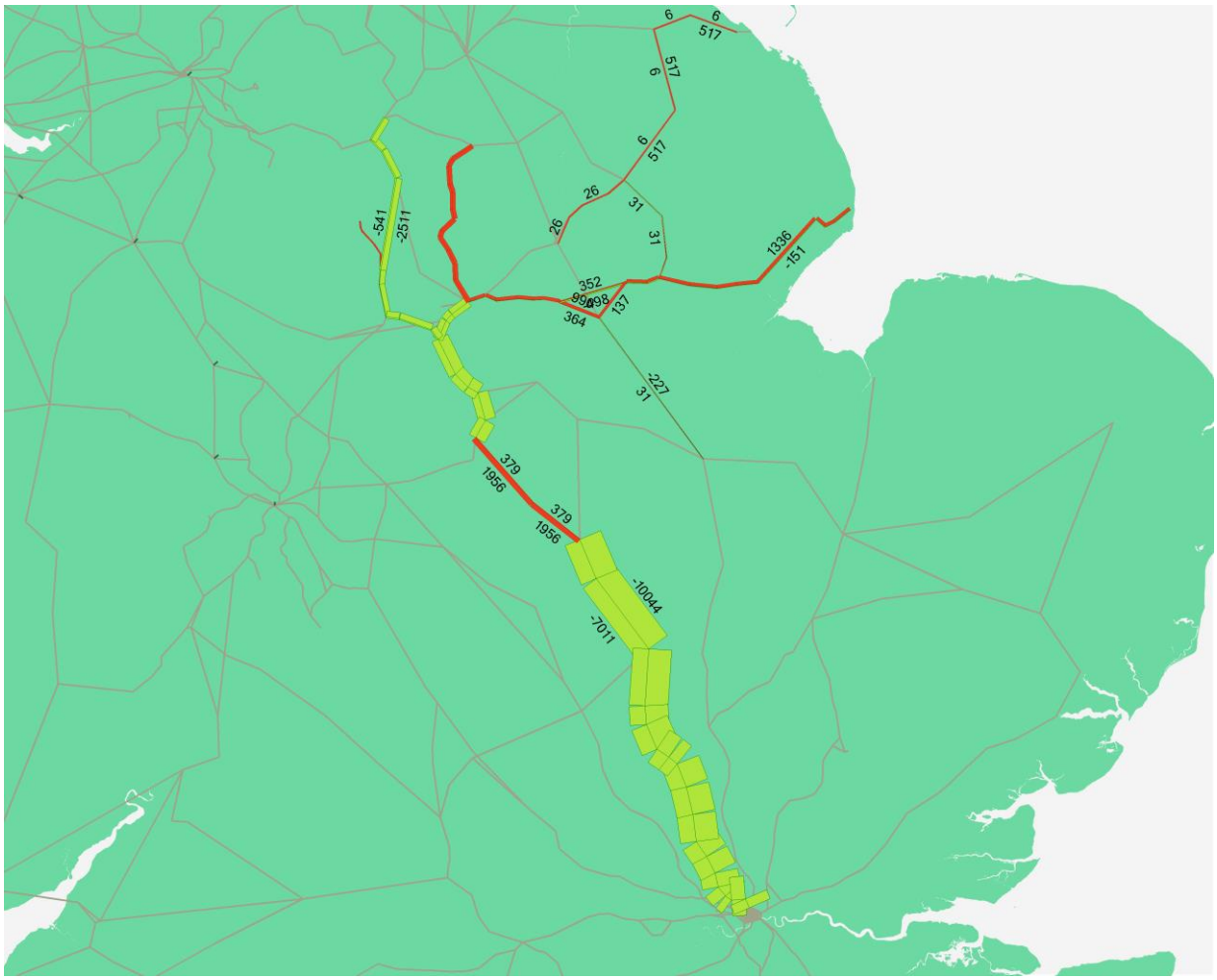
East Midlands – Change in Do Minimum Level of Service

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv4.8	PFMv5.0	Diff	%	PFMv4.8	PFMv5.0	Diff	%
St Pancras - Sheffield	D	26	31	5	16%	129	117	-12	-10%
	U	31	31	0	0%	123	116	-7	-6%
St Pancras - Derby	D	30	35	5	14%	100	90	-10	-11%
	U	31	33	2	6%	95	91	-4	-4%
St Pancras - Nottingham	D	31	31	0	0%	96	91	-5	-5%
	U	30	31	1	3%	97	93	-4	-4%
St Pancras - Leicester	D	61	82	21	26%	68	68	0	0%
	U	61	80	19	24%	70	71	1	1%
St Pancras – Corby (Kettering in PFM)	D	36	35	-1	-3%	59	55	-4	-7%
	U	32	32	0	0%	60	59	-1	-2%
Leicester - Liverpool	D	15	15	0	0%	216	216	0	0%
	U	14	14	0	0%	201	201	0	0%
Nottingham - Liverpool	D	29	29	0	0%	163	163	0	0%
	U	28	28	0	0%	159	159	0	0%
Norwich - Liverpool	D	11	11	0	0%	332	332	0	0%
	U	11	11	0	0%	316	316	0	0%
Derby - Sheffield	D	29	33	4	12%	33	32	-1	-3%
	U	32	32	0	0%	29	26	-3	-12%
Leicester - Lincoln	D	10	10	0	0%	114	114	0	0%
	U	12	12	0	0%	101	101	0	0%

East Midlands Change in Trains per Day (PFMv5.0 – PFMv4.8) – Do Minimum



East Midlands Change in Seats per Day (PFMv5.0 – PFMv4.8) – Do Minimum

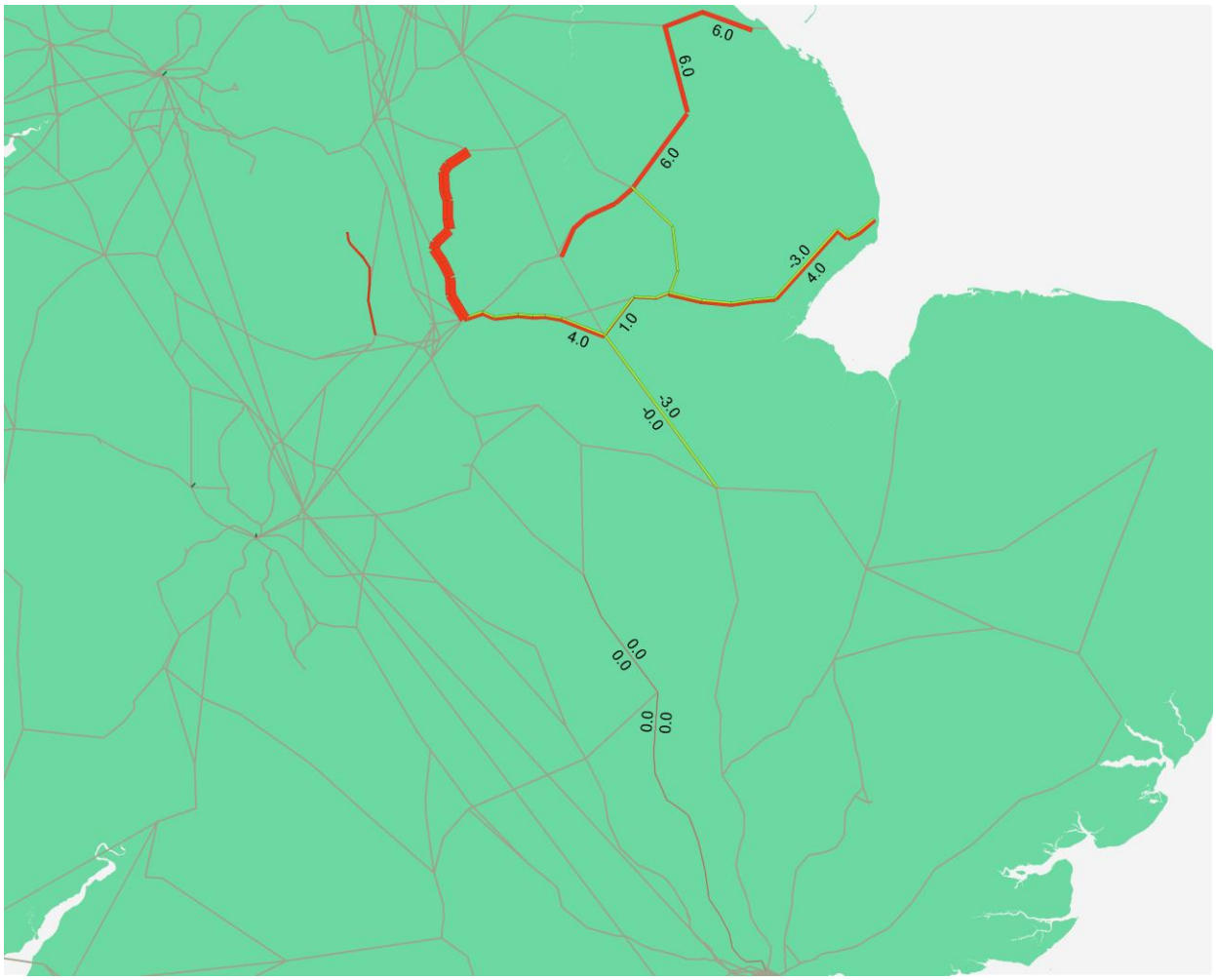


Do Something – Change in the Level of Service

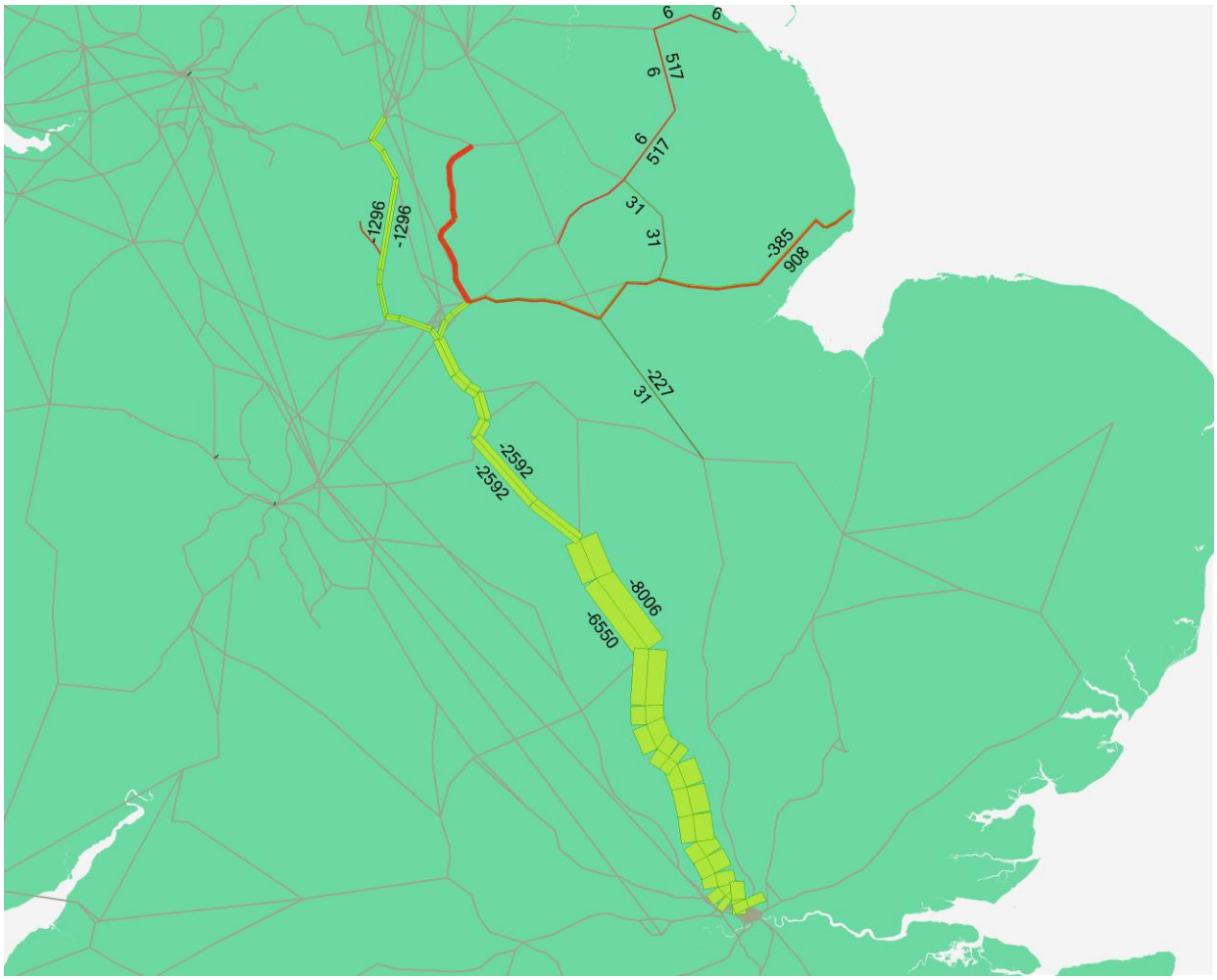
East Midlands – Change in Phase 2 Level of Service

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv4.8	PFMv5.0	Diff	%	PFMv4.8	PFMv5.0	Diff	%
St Pancras - Sheffield	D	16	16	0	0%	127	128	1	1%
	U	16	16	0	0%	121	121	0	0%
St Pancras - Derby	D	32	32	0	0%	122	120	-2	-2%
	U	32	34	2	6%	124	122	-2	-2%
St Pancras - Nottingham	D	16	16	0	0%	103	90	-13	-14%
	U	16	16	0	0%	96	93	-3	-3%
St Pancras - Leicester	D	48	48	0	0%	75	70	-5	-7%
	U	48	50	2	4%	77	76	-1	-1%
St Pancras – Corby (Kettering in PFM)	D	48	48	0	0%	58	54	-4	-7%
	U	48	48	0	0%	64	61	-3	-5%
Leicester - Liverpool	D	15	15	0	0%	216	216	0	0%
	U	14	14	0	0%	201	201	0	0%
Nottingham - Liverpool	D	29	29	0	0%	164	164	0	0%
	U	28	28	0	0%	162	162	0	0%
Norwich - Liverpool	D	11	11	0	0%	333	333	0	0%
	U	11	11	0	0%	323	323	0	0%
Derby - Sheffield	D	19	18	-1	-6%	28	33	5	15%
	U	17	17	0	0%	28	27	-1	-4%
Leicester - Lincoln	D	10	10	0	0%	114	114	0	0%
	U	12	12	0	0%	101	101	0	0%

East Midlands change in trains per day (PFMv5.0 – PFMv4.8) – Phase 2



East Midlands change in seats per day (PFMv5.0 – PFMv4.8) – Phase 2



A6 PFMv5.1 Model Development Updates

A6.1 HS2 Timetable Updates

Key:

This represents a standard hourly service pattern, unless noted otherwise.	
	= captive HS train (GB or GC gauge)
	= classic-compatible HS train (UK gauge)
2	= (2-minute) station dwell
30.5	= (30.5-minute) sectional running time between stations
-3	= (3-minute) journey time saving assumed by increased maximum speed for non-tilting trains.
2	= (2-minute) Network Rail engineering allowance - derived from 2014 Timetable Planning Rules.
The vehicle lengths shown are for ease of modelling a consistent all-day service.	

Appendices

Phase 1 High Speed Service Pattern

	Length	400m	400m	400m	400m	400m	400m	200m	200m	200m	200m
LONDON SERVICES		1	2	3	4	5	6	7	8	9	10A
London Euston (HS2)											
(HS1 Link)											
		6	6	6	6	6	6	6	6	6	6
Old Oak Common (HS2)		0	0	0	0	0	0	0	0	0	0
HeathrowAirport											
		27	27	27							
Birmingham Interchange		0	0	0							
		10	10	10							
Washwood Heath Depot											
Birmingham Curzon Street											
Handsacre Junction											
									41		
Stafford									0		
								56		56	
Crewe								0		0	
								19	34		
Runcorn								0	0		
								18	18		
Liverpool Lime Street											
							73				
Wilmslow							0				
					79	79	9				
Stockport					0	0	0				
					8	8	8				
Manchester Piccadilly											
										18	
Warrington Bank Quay										0	
										11	
Wigan North Western										0	
										14	89
Preston											0
Lancaster											
Oxenholme											
Penrith											
Carlisle											
Lockerbie											
Carstairs											
Motherwell											
											133.5
Glasgow Central											
Haymarket											
Edinburgh Waverley											
{Rounding}		0	0	0	0	0	0	0	0	0	0
Journey time hh:mm		**0:43**	**0:43**	**0:43**	**1:33**	**1:33**	**1:36**	**1:39**	**1:39**	**1:45**	**3:48**
		43	**43**	**43**	**93**	**93**	**96**	**99**	**99**	**105**	**228.5**
		####	####	####	####	####	####	####	####	####	TRUE

Phase 2 High Speed Service Pattern

LONDON SERVICES

	1	2	3	4	5	6	7	8	9	10A	10B	11A	11B	12	13	14A	14B	15	16	17	18
Length	400m	400m	400m	400m	400m	400m	200m	200m	200m	200m (Combined)	200m (Combined)	200m (Combined)	200m (Combined)	400m	400m	200m (Combined)	200m (Combined)	200m	200m		
London Euston (HS2)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Path reserved for future use by services to / from HS1 or Heathrow,	Path reserved for future use by services to / from HS1 or Heathrow,
(HS1 Link)																					
Old Oak Common (HS2)	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0	6 / 0		
Heathrow Airport																					
Birmingham Interchange	27 / 0	27 / 0		27 / 0								27 / 0	27 / 0		27 / 0						
Washwood Heath Depot																					
Birmingham Curzon Street	10	10	33																		
Washwood Heath Depot																					
Stafford								41 / 0													
Crewe							40 / 0		40 / 0												
Runcorn							19 / 0	34 / 0													
Liverpool Lime Street							18	18													
Manchester Airport (HS2)				27 / 0	48 / 0																
Manchester Piccadilly (HS2)				7	7	51															
Toton														39 / 0	17 / 0	39 / 0	39 / 0				
Meadowhall (HS2)															15 / 0	15 / 5 (Divide)	15 / 3 (Divide)				
Leeds (HS2)														25	14	14					
York																	21	67 / 0	67 / 0		
Darlington																		28 / 0			
Durham																					
Newcastle																		28	52		
Warrington Bank Quay									18 / 0												
Wigan North Western									11 / 0												
Preston									14	61 / 0	61 / 0	40 / 0	40 / 0								
Lancaster																					
Oxenholme																					
Penrith																					
Carlisle																					
Lockerbie																					
Carstairs										112 / 3 (Divide)	112 / 3 (Divide)	112 / 3 (Divide)	112 / 3 (Divide)								
Motherwell																					
Glasgow Central										25.5		25.5									
Haymarket											0		0								
Edinburgh Waverley											32 / 0		32 / 0								
Rounding																					
Journey time hh:mm	0:43	0:43	0:39	1:07	1:01	0:57	1:23	1:39	1:29	3:27	3:34	3:33	3:40	1:10	1:19	1:19	1:24	2:09	2:05		
Check	TRUE #	TRUE #	TRUE #	TRUE #	TRUE #	TRUE #	TRUE #	TRUE #	TRUE #	TRUE	TRUE #	TRUE	TRUE #	TRUE #	TRUE #	TRUE	TRUE #	TRUE #	TRUE #		

Any of trains 21 - 26 could be through **Classic** service from South East or South West via Birmingham New Street instead of starting at Curzon Street.

BIRMINGHAM SERVICES

	21	22	23A	23B	24	25	26
Length	200m	200m	200m (Alternate Hours)	200m (Alternate Hours)	200m	200m	200m
Birmingham Curzon Street	■	■	■	■	■	■	■
Washwood Heath Depot							
Stafford							
Crewe							
Runcorn							
Liverpool Lime Street							
Manchester Airport (HS2)	29 / 0	29 / 0					
Manchester Piccadilly (HS2)	7	7					
Toton					17 / 0	17 / 0	17 / 0
Meadowhall (HS2)					15 / 0	15 / 0	15 / 0
Leeds (HS2)					14	14	
York							22 / 0
Darlington							28 / 0
Durham							18 / 0
Newcastle							14
Warrington Bank Quay							
Wigan North Western			31 / 0	31 / 0			
Preston			14 / 0	14 / 0			
Lancaster			15 / 0	15 / 0			
Oxenholme			12 / 0				
Penrith				35 / 0			
Carlisle			41 / 0	18 / 0			
Lockerbie			22 / 0	22 / 0			
Carstairs							
Motherwell			42 / 0				
Glasgow Central			16				
No Haymarket				0			
Edinburgh Waverley				56			
Journey time hh:mm	0:36	0:36	3:13	3:11	0:46	0:46	1:54
##	TRUE #	TRUE #	TRUE	TRUE #	TRUE #	TRUE #	TRUE

A6.2 East Coast

Do Minimum – Change in the Level of Service

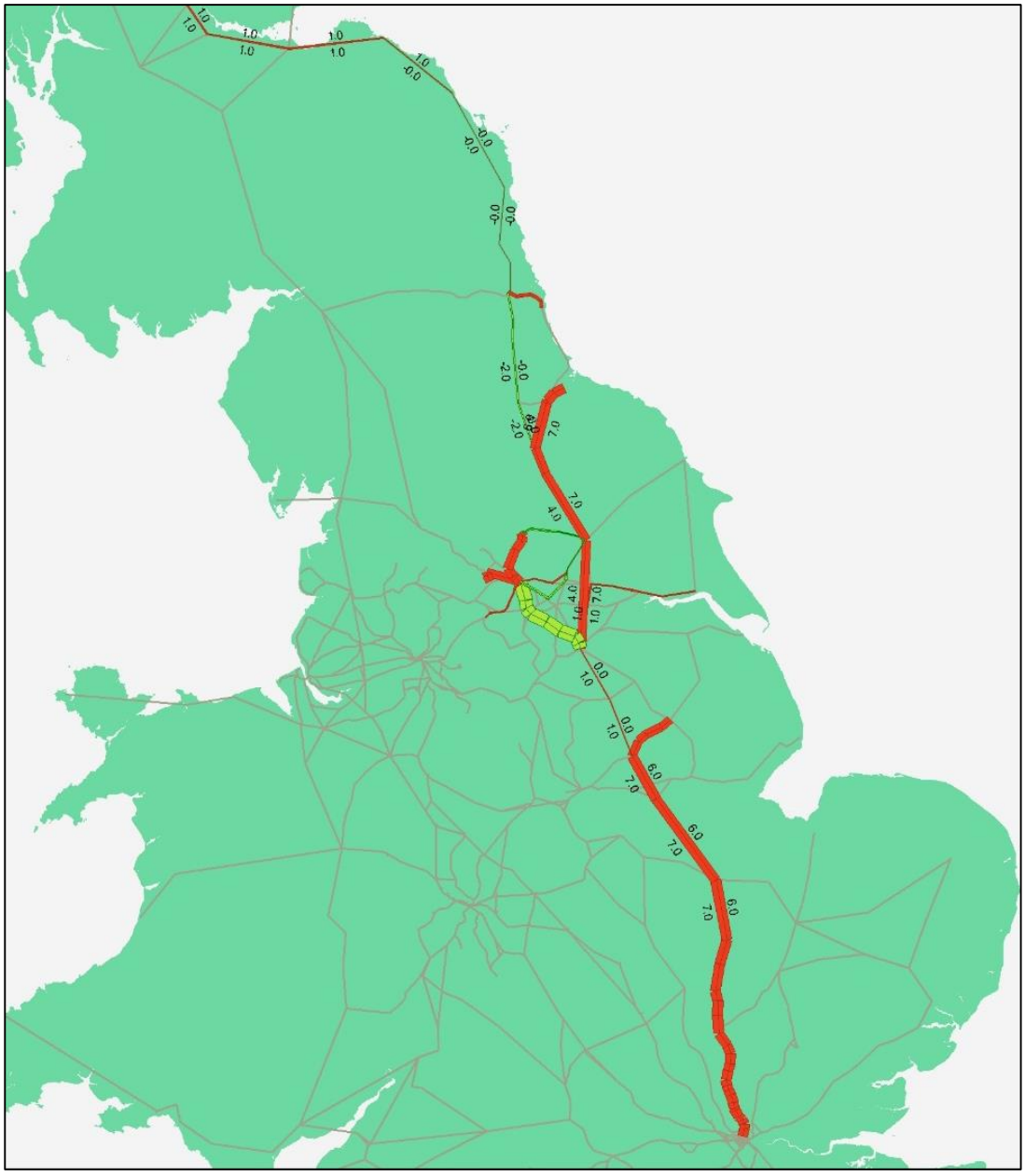
ECML Do Minimum: Changes to the level of service on London routes (PLD)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Kings Cross - Inverness	D	1	1	0	0%	469	464	-5	-1%
	U	1	1	0	0%	453	464	11	2%
Kings Cross - Aberdeen	D	3	3	0	0%	409	422	13	3%
	U	3	3	0	0%	402	421	19	5%
Kings Cross - Glasgow Central	D	1	1	0	0%	321	286	-36	-11%
	U	1	1	0	0%	328	335	7	2%
Kings Cross - Edinburgh	D	26	26	0	0%	256	252	-4	-1%
	U	26	26	0	0%	260	255	-5	-2%
Kings Cross - Sunderland	D	n/a	2	n/a	n/a	n/a	196	n/a	n/a
	U	n/a	2	n/a	n/a	n/a	205	n/a	n/a
Kings Cross - Middlesbrough	D	n/a	6	n/a	n/a	n/a	161	n/a	n/a
	U	n/a	7	n/a	n/a	n/a	167	n/a	n/a
Kings Cross - Newcastle	D	42	42	0	0%	174	174	0	0%
	U	44	43	-1	-2%	182	175	-7	-4%
Kings Cross - York	D	43	43	0	0%	116	117	1	1%
	U	44	45	1	2%	126	120	-5	-4%
Kings Cross - Skipton	D	1	1	0	0%	168	159	-9	-5%
	U	1	1	0	0%	172	159	-13	-8%
Kings Cross - Harrogate	D	1	6	5	500%	165	161	-4	-3%
	U	1	6	5	500%	168	171	3	2%
Kings Cross - Huddersfield	D	n/a	1	n/a	n/a	n/a	155	n/a	n/a
	U	n/a	1	n/a	n/a	n/a	169	n/a	n/a
Kings Cross - Hull	D	n/a	1	n/a	n/a	n/a	146	n/a	n/a
	U	n/a	1	n/a	n/a	n/a	149	n/a	n/a

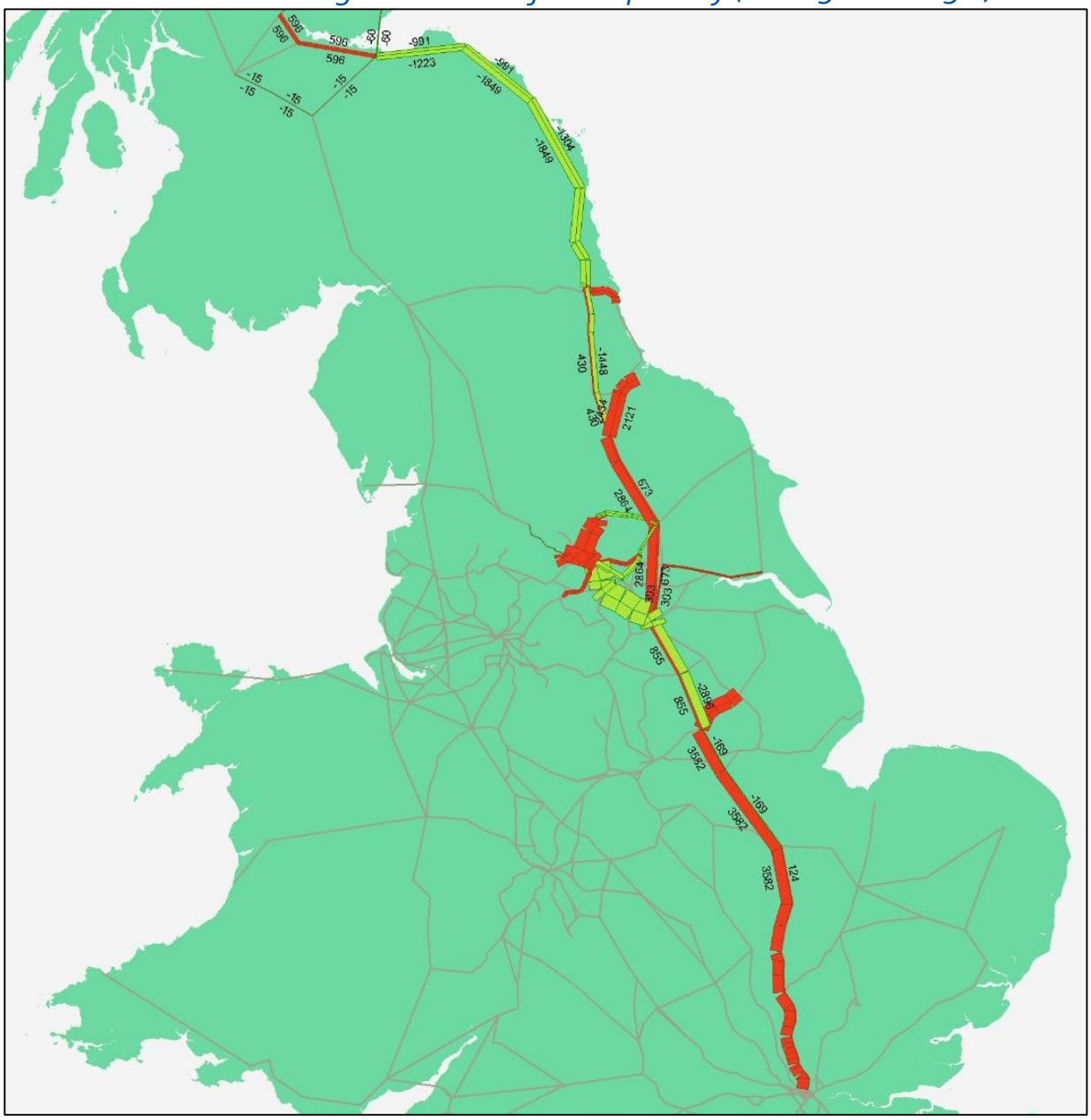
Appendices

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Kings Cross - Bradford FS	D	1	6	5	500%	154	146	-8	-5%
	U	1	7	6	600%	157	150	-7	-4%
Kings Cross - Leeds	D	44	35	-9	-20%	129	120	-8	-7%
	U	45	36	-9	-20%	131	126	-5	-4%
Kings Cross - Lincoln Central	D	1	7	6	600%	97	100	3	3%
	U	1	6	5	500%	111	102	-9	-8%

ECML Do Minimum: Change in Number of Trains per Day (PFMv5.1-PFMv5.0)



ECML Do Minimum: Change in Number of Seats per Day (PFMv5.1-PFMv5.0)

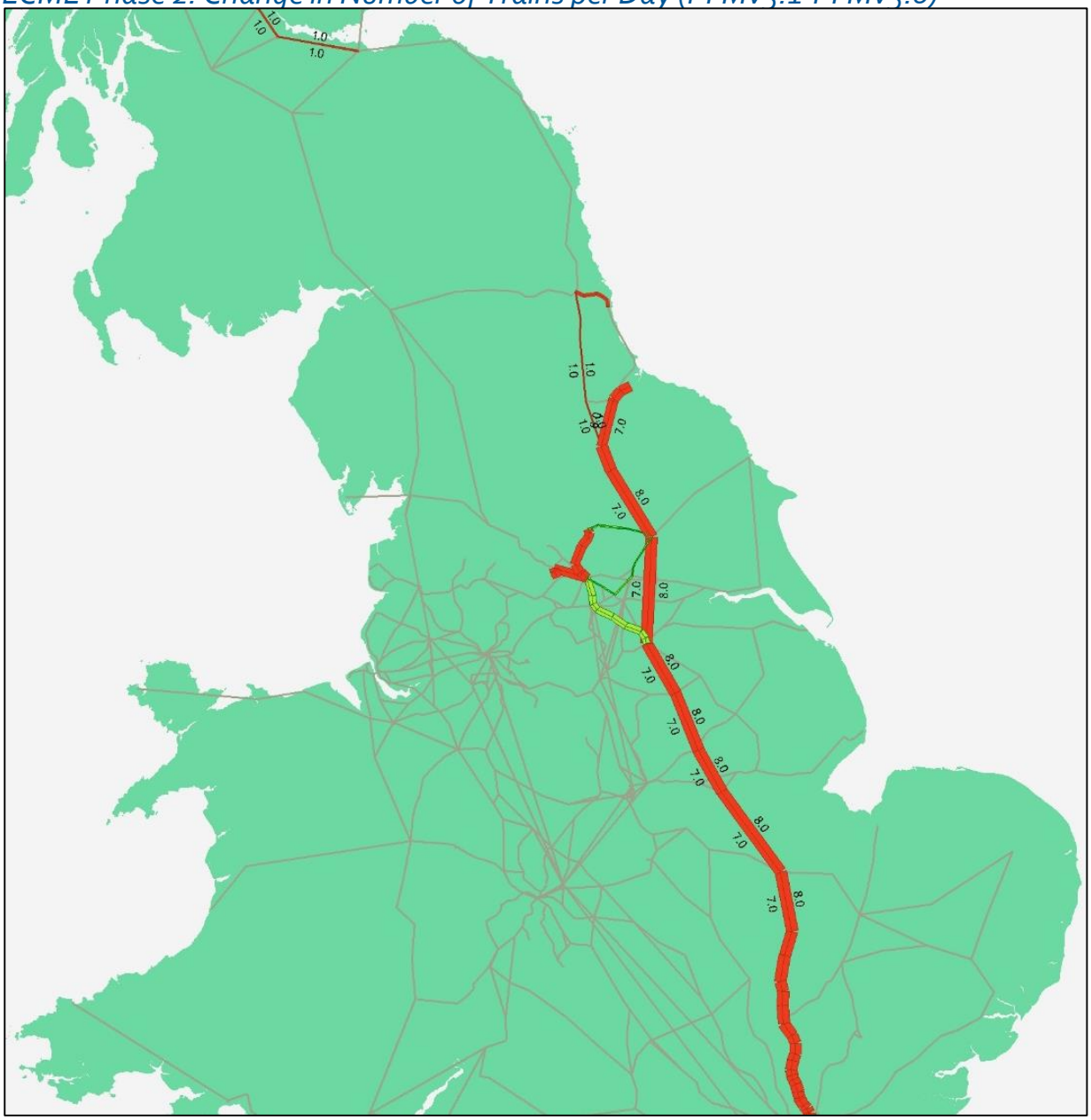


Do Something – Change in the Level of Service

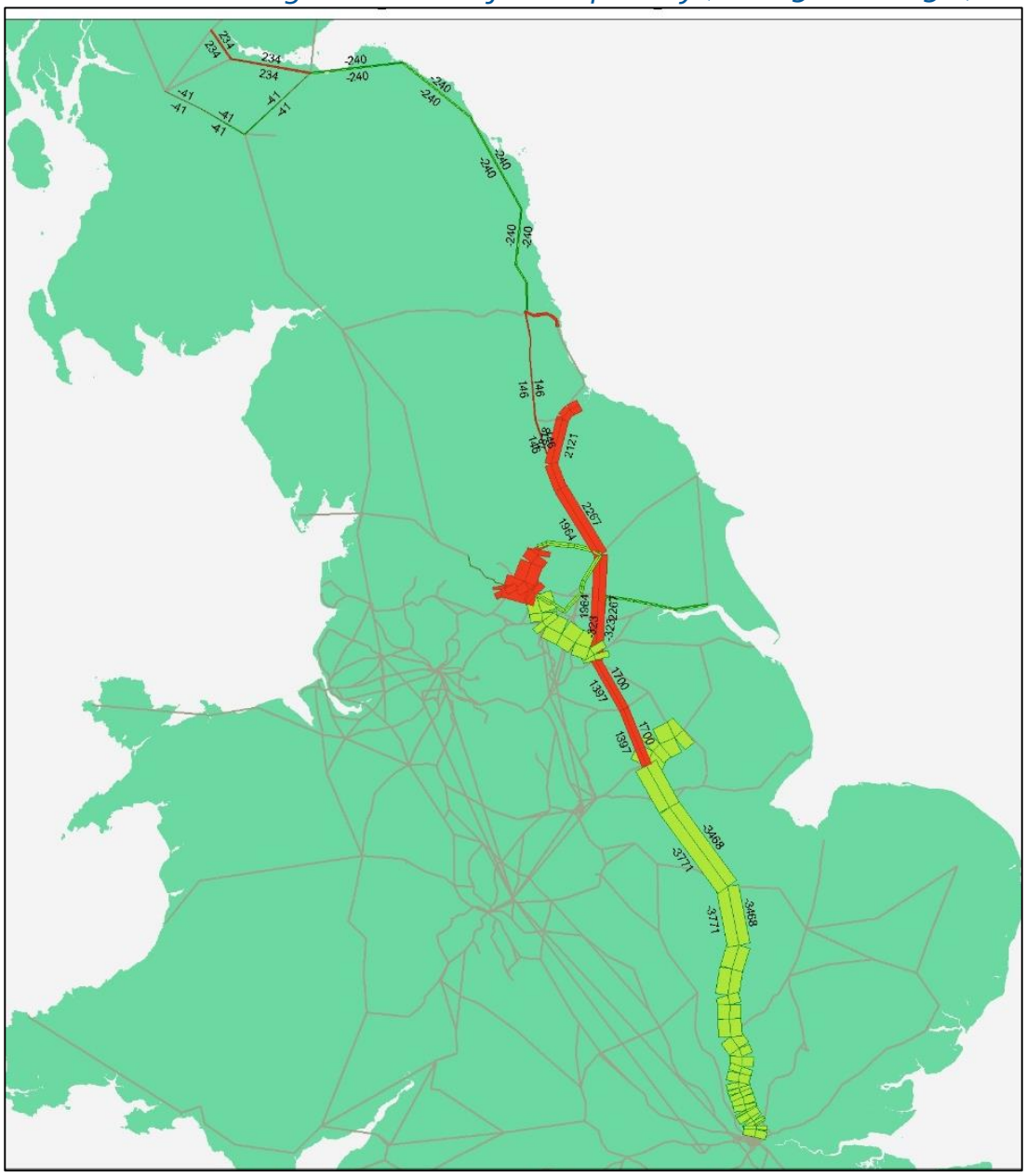
ECML Phase 2: Changes to the level of service on London routes (PLD)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Kings Cross - Edinburgh	D	16	16	0	0%	269	267	-2	-1%
	U	16	16	0	0%	286	267	-19	-7%
Kings Cross - Newcastle	D	31	32	1	3%	185	184	-1	-1%
	U	31	32	1	3%	190	186	-4	-2%
Kings Cross - Middlesbrough	D	n/a	6	n/a	n/a	n/a	168	n/a	n/a
	U	n/a	7	n/a	n/a	n/a	168	n/a	n/a
Kings Cross - Skipton	D	1	1	0	0%	178	172	-7	-4%
	U	1	1	0	0%	174	174	0	0%
Kings Cross - Harrogate	D	1	6	5	500%	175	165	-11	-6%
	U	1	6	5	500%	170	172	2	1%
Kings Cross - Hull	D	n/a	1	n/a	n/a	n/a	163	n/a	n/a
	U	n/a	1	n/a	n/a	n/a	163	n/a	n/a
Kings Cross - Bradford Forster Square	D	1	7	6	600%	167	159	-9	-5%
	U	1	7	6	600%	161	161	0	0%
Kings Cross - Leeds	D	16	16	0	0%	139	133	-6	-4%
	U	16	16	0	0%	140	136	-4	-3%
Kings Cross - Lincoln Central	D	16	16	0	0%	107	109	3	2%
	U	16	16	0	0%	122	121	-1	-1%

ECML Phase 2: Change in Number of Trains per Day (PFMv5.1-PFMv5.0)



ECML Phase 2: Change in Number of Seats per Day (PFMv5.1-PFMv5.0)



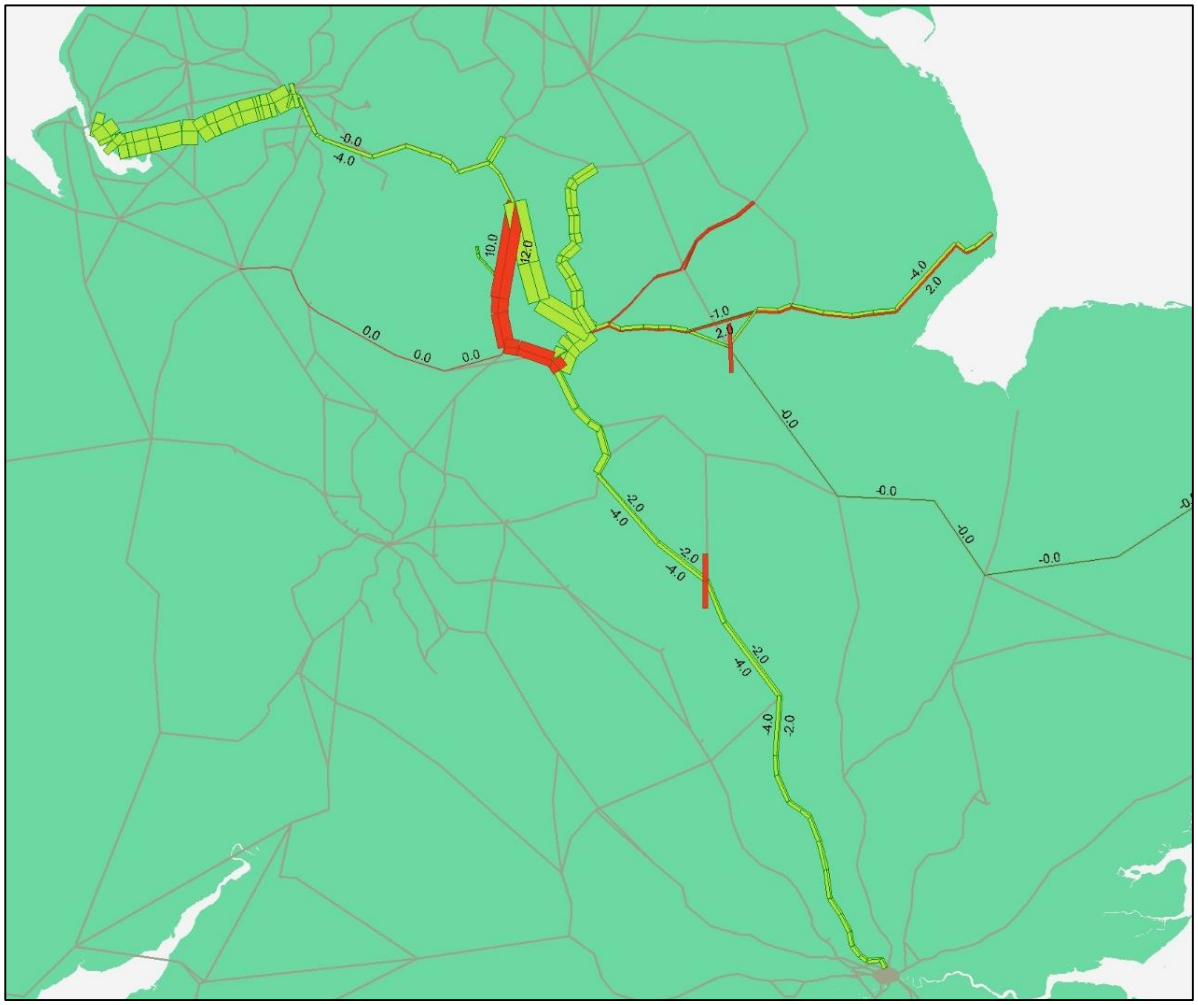
A6.3 East Midlands

Do Minimum – Change in the Level of Service

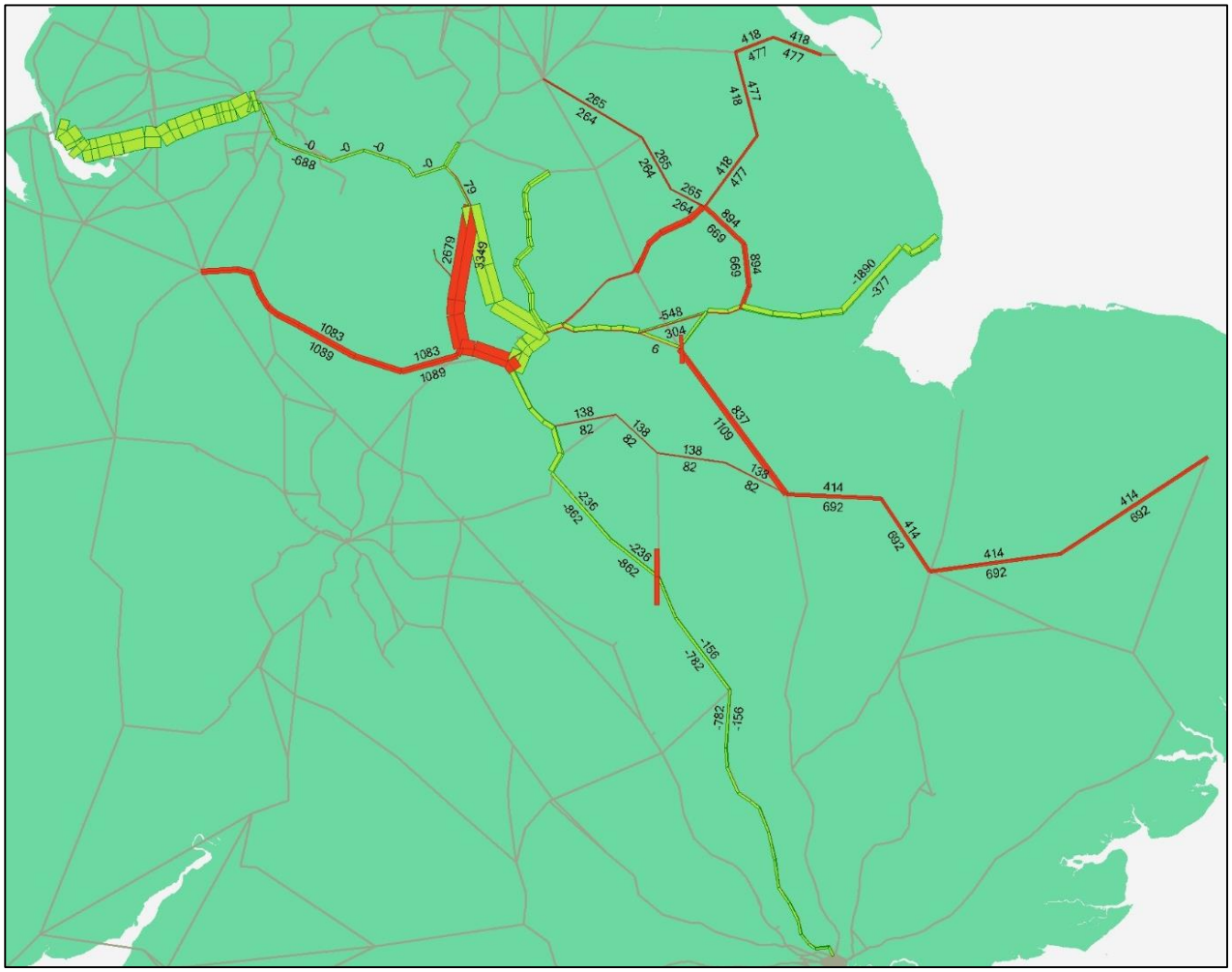
EM Do Minimum: Changes to the level of service on London routes

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
St Pancras - Sheffield	D	31	31	0	0%	117	117	0	0%
	U	31	31	0	0%	116	116	0	0%
St Pancras - Derby	D	35	31	-4	-11%	90	86	-4	-4%
	U	33	31	-2	-6%	91	90	-1	-1%
St Pancras - Nottingham	D	31	31	0	0%	91	91	0	0%
	U	31	31	0	0%	93	93	0	0%
St Pancras - Leicester	D	82	78	-4	-5%	68	67	-1	-1%
	U	80	78	-2	-3%	71	71	0	0%
St Pancras - Corby	D	16	16	0	0%	52	52	0	0%
	U	16	16	0	0%	55	55	0	0%

EM Do Minimum: Change in Number of Trains per Day (PFMv5.1-PFMv5.0)



EM Do Minimum: Change in Number of Seats per Day (PFMv5.1-PFMv5.0)

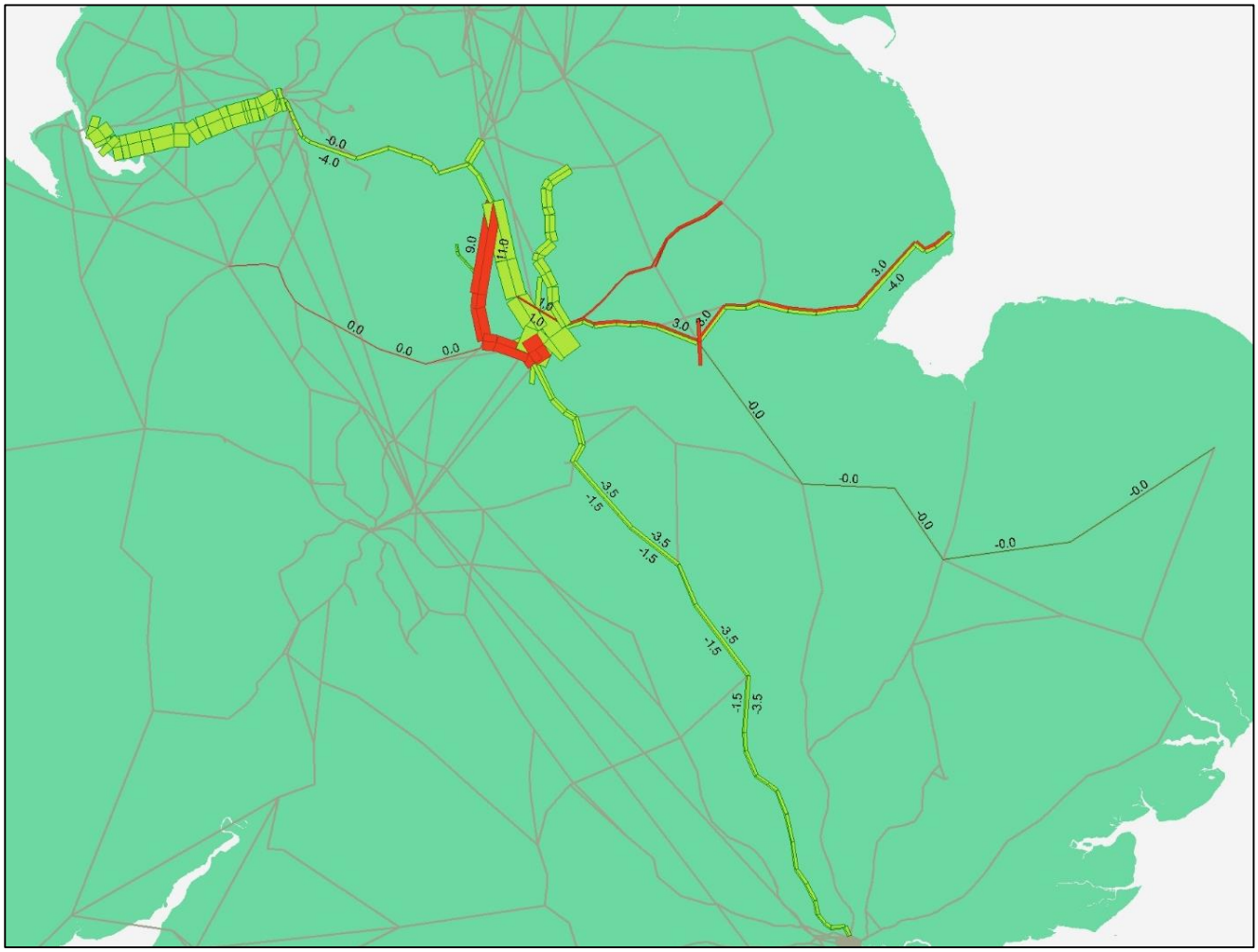


Do Something – Change in the Level of Service

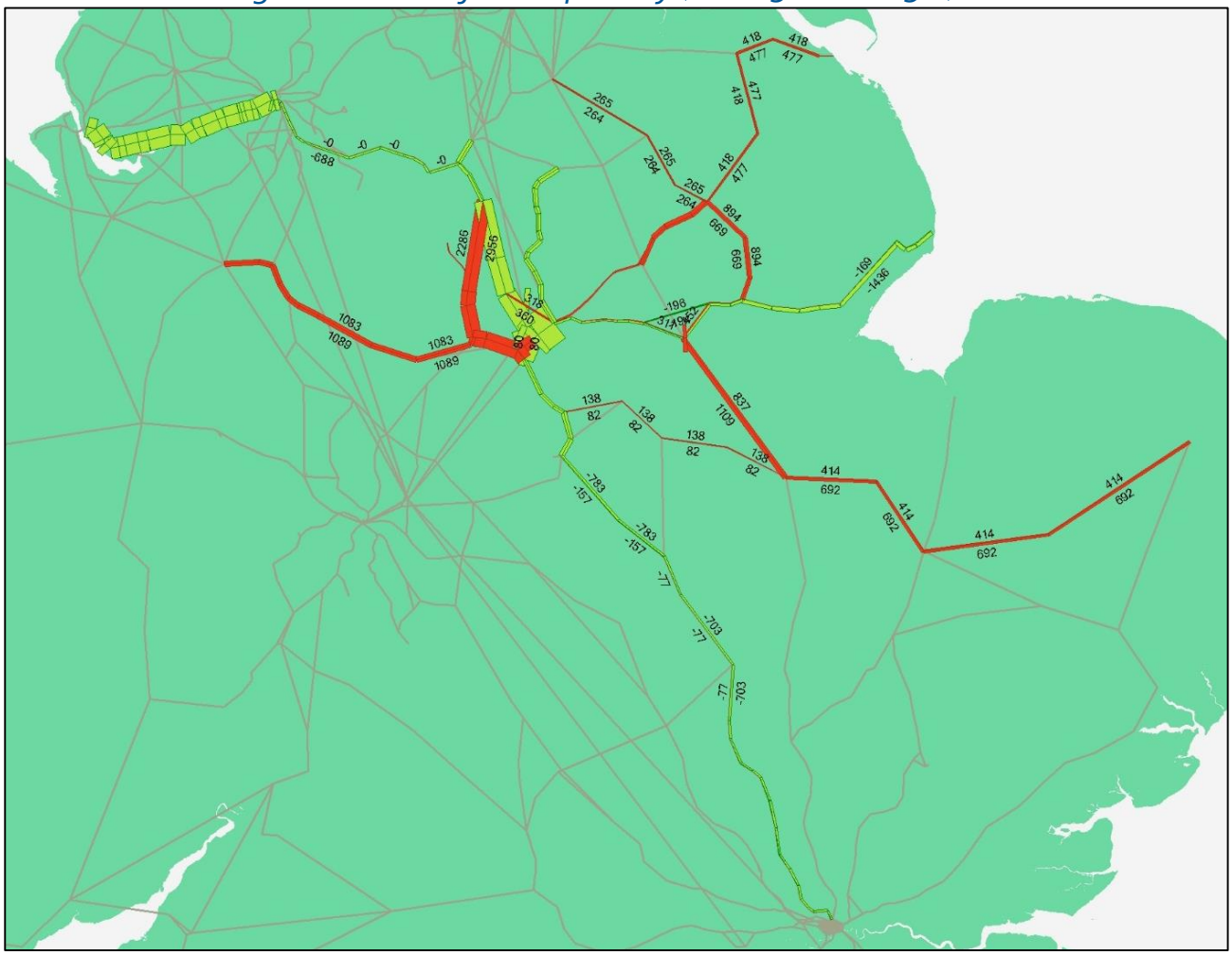
EM Phase 2: Changes to the level of service on London routes (PLD)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
St Pancras - Sheffield	D	16	15	-1	-6%	128	117	-11	-8%
	U	16	15	-1	-6%	121	116	-4	-3%
St Pancras - Derby	D	32	31	-1	-3%	120	90	-30	-25%
	U	34	31	-3	-9%	122	94	-28	-23%
St Pancras - Nottingham	D	16	15	-1	-6%	90	91	1	1%
	U	16	16	0	0%	93	94	1	1%
St Pancras - Leicester	D	64	62	-2	-3%	75	68	-7	-9%
	U	66	63	-3	-5%	81	72	-9	-11%
St Pancras - Corby	D	16	16	0	0%	52	52	0	0%
	U	16	16	0	0%	55	55	0	0%

EM Phase 2: Change in Number of Trains per Day (PFMv5.1-PFMv5.0)



EM Phase 2: Change in Number of Seats per Day (PFMv5.1-PFMv5.0)



A6.4 Chiltern

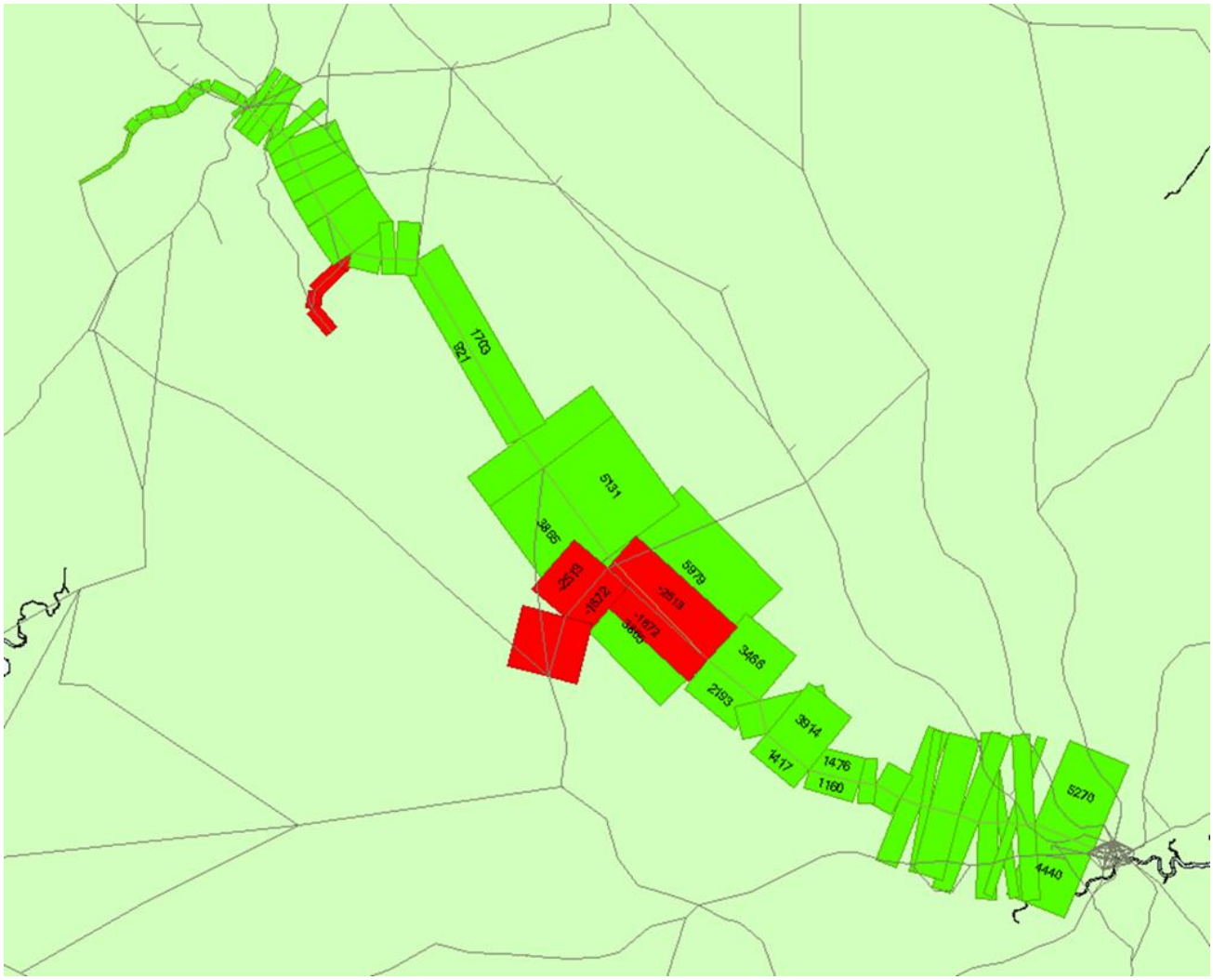
Do Minimum – Change in the Level of Service

Chiltern – Change in Level of Service – Do Minimum (PLD)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Marylebone - Ruislip (South & West)	D	20	20	-1	-3%	18	20	2	8%
	U	22	23	1	4%	21	23	2	8%
Marylebone - Oxford	D	27	32	5	16%	72	64	-9	-14%
	U	28	33	5	15%	108	67	-41	-61%
Marylebone - Birmingham Moor Street	D	32	34	2	6%	121	110	-11	-10%
	U	29	32	3	9%	127	110	-16	-15%
Marylebone - Kidderminster	D	4	4	0	0%	164	153	-11	-7%
	U	5	4	-1	-25%	173	149	-24	-16%
Marylebone - Banbury	D	37	50	13	26%	72	65	-7	-11%
	U	37	47	10	21%	77	69	-8	-12%
Marylebone – Princes Risborough	D	59	38	-21	-55%	43	43	0	1%
	U	58	41	-17	-41%	47	46	-1	-1%
Marylebone – High Wycombe	D	84	83	-1	-1%	36	31	-4	-14%
	U	94	84	-10	-12%	39	35	-4	-11%
Marylebone – Gerrards Cross	D	58	66	8	12%	25	24	-1	-4%
	U	68	71	3	4%	28	29	0	1%
Leamington Spa - Stratford	D	9	8	-1	-13%	31	37	6	17%
	U	8	7	-1	-14%	29	33	4	13%
Leamington Spa – Birmingham Moor Street	D	40	41	1	2%	33	35	2	6%
	U	36	39	3	8%	34	33	-1	-2%

Chiltern Change in Number of Trains per Day (PFMv5.1-PFMv5.0) - Do Minimum

Chiltern – Change in Number of Seats per Day (PFMv5.1-PFMv5.0) - Do Minimum



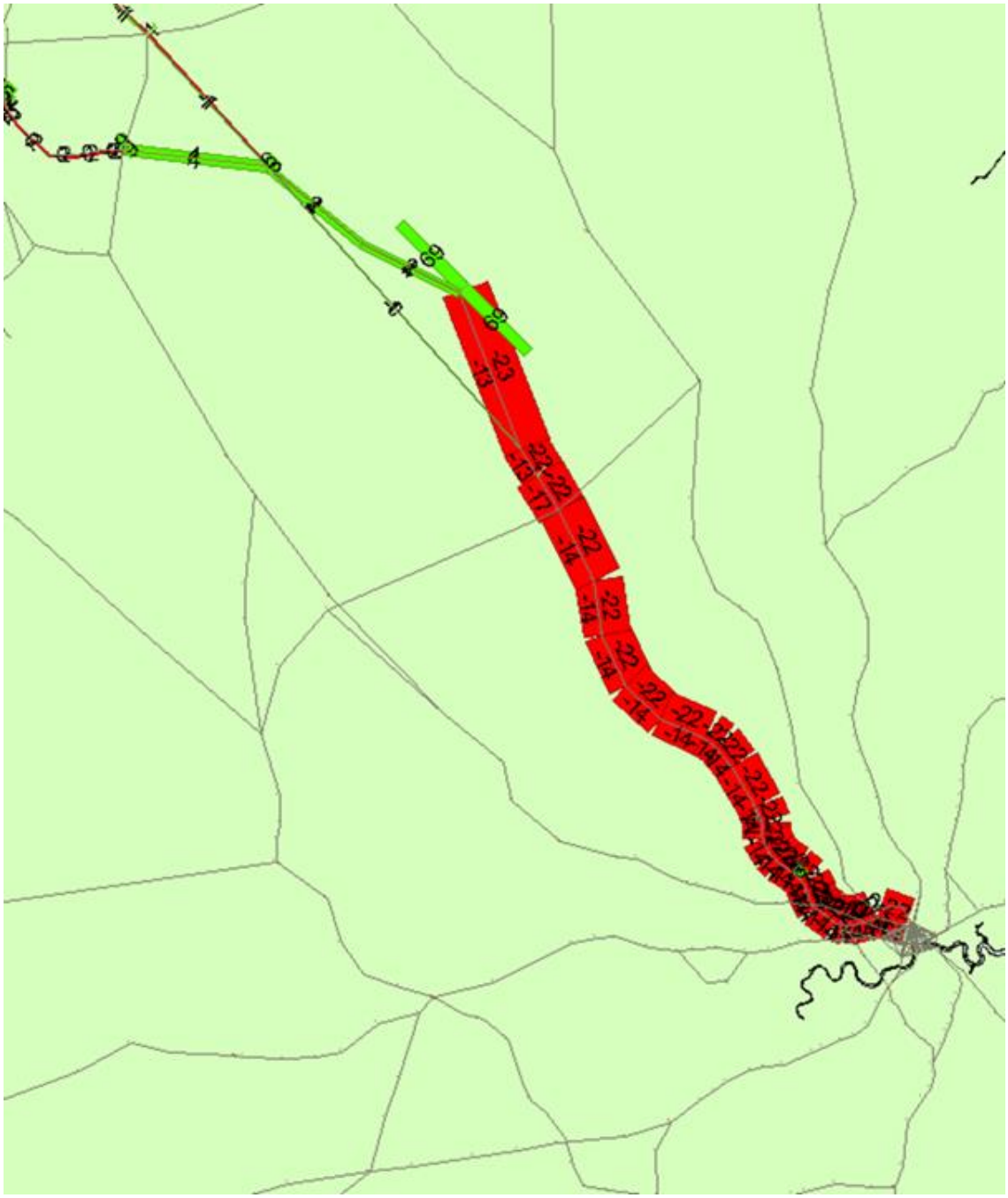
A6.5 London Midland

Do Minimum – Change in the Level of Service

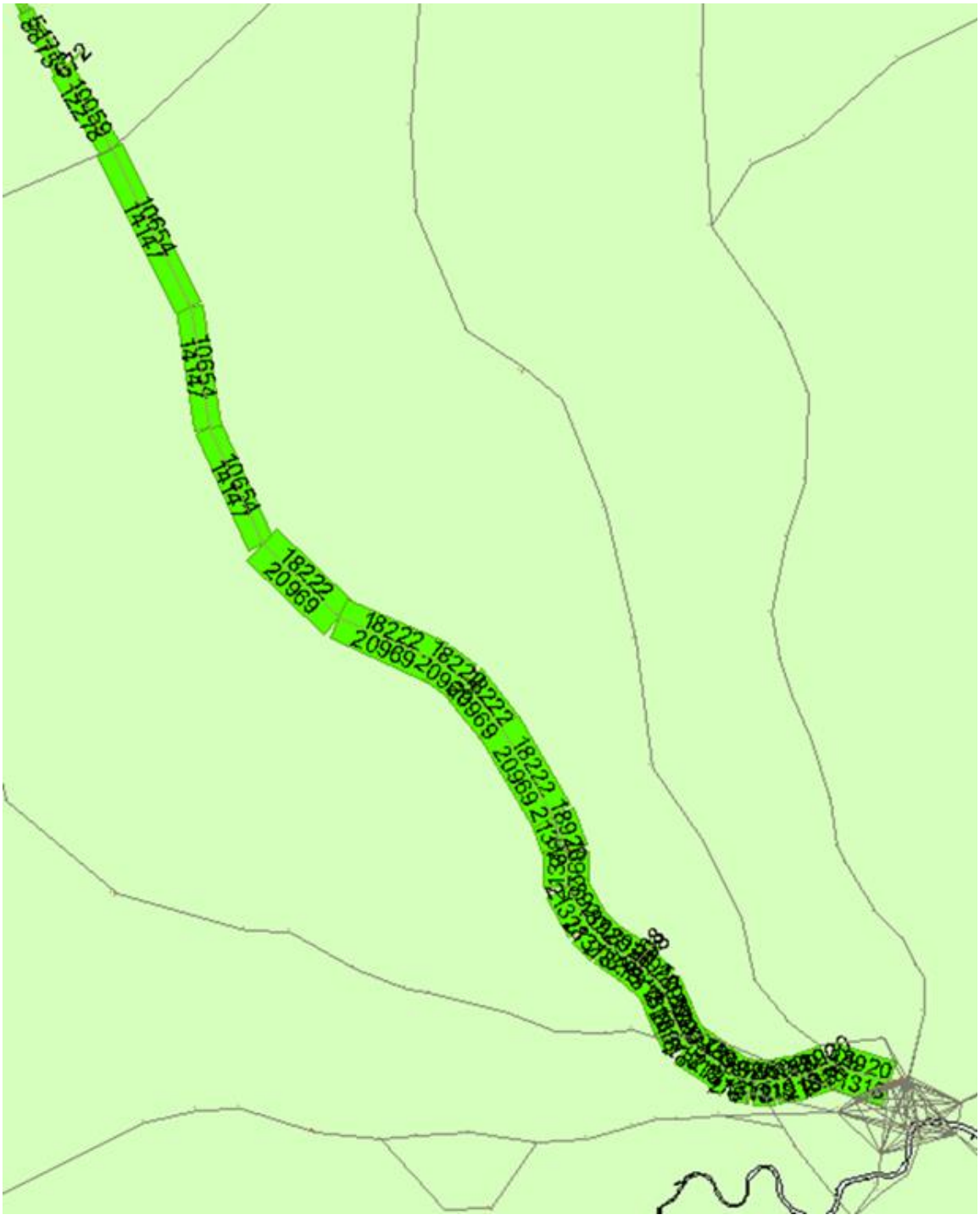
London Midland – Change in Level of Service – Do Minimum (PLD)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Euston – Birmingham New Street	D	29	32	3	9%	129	132	2	2%
	U	36	40	4	10%	138	135	-4	-3%
Euston - Northampton	D	64	50	-14	-28%	64	63	-1	-2%
	U	71	48	-23	-48%	66	62	-3	-5%
Euston - Tring	D	53	52	-1	-2%	41	41	0	0%
	U	51	51	0	0%	41	41	0	0%
Euston – Watford Junction	D	79	78	-1	-1%	19	19	0	2%
	U	87	81	-6	-7%	21	20	-1	-3%
Euston - Crewe	D	13	14	1	7%	157	162	4	3%
	U	13	14	1	7%	164	170	6	3%
Euston - Bletchley	D	54	52	-2	-4%	48	48	0	0%
	U	56	51	-6	-11%	50	48	-2	-5%
Euston – Milton Keynes	D	97	80	-17	-21%	47	47	0	-1%
	U	97	75	-22	-29%	49	47	-1	-3%
Northampton - Birmingham New Street	D	40	44	4	9%	69	67	-2	-4%
	U	40	44	4	9%	67	64	-3	-5%
Birmingham New Street - Wolverhampton	D	77	73	-4	-5%	22	23	1	3%
	U	81	84	3	4%	22	22	0	-1%
Birmingham New Street - Liverpool	D	27	25	-2	-8%	97	97	0	0%
	U	29	29	0	0%	101	102	1	1%

London Midland - Change in Number of Trains per Day (PFMv5.1-PFMv5.0) - Do Minimum



London Midland – Change in Number of Seats per Day (PFMv5.1-PFMv5.0) - Do Minimum



Do Something – Change in the Level of Service

London Midland – Change in Level of Service – Do Something (Phase 1 & Phase 2)

Key Movement	Dir	Trains Per Day				Average Journey Time (minutes)			
		PFMv5.0	PFMv5.1	Diff	%	PFMv5.0	PFMv5.1	Diff	%
Euston – Birmingham New Street	D	32	32	0	0%	120	120	0	0%
	U	32	32	0	0%	118	118	0	0%
Euston - Northampton	D	44	44	0	0%	56	56	0	0%
	U	44	44	0	0%	56	56	0	0%
Euston - Tring	D	96	96	0	0%	40	40	0	0%
	U	96	96	0	0%	40	40	0	0%
Euston – Watford Junction	D	108	108	0	0%	22	22	0	0%
	U	108	108	0	0%	22	22	0	0%
Euston - Crewe	D	16	16	0	0%	139	137	-2	-1%
	U	16	16	0	0%	135	133	-2	-2%
Euston - Bletchley	D	54	54	0	0%	51	51	0	0%
	U	54	54	0	0%	52	52	0	0%
Euston – Milton Keynes	D	70	70	0	0%	44	44	0	0%
	U	70	70	0	0%	44	44	0	0%
Northampton - Birmingham New Street	D	32	32	0	0%	63	63	0	0%
	U	32	32	0	0%	61	61	0	0%
Birmingham New Street - Wolverhampton	D	83	83	0	0%	21	21	0	0%
	U	84	84	0	0%	22	22	0	0%
Birmingham New Street - Liverpool	D	32	32	0	0%	99	97	-2	-2%
	U	32	32	0	0%	106	104	-2	-2%

London Midland – Change in Number of Seats per Day (PFMv5.1-PFMv5.0) - Do Something (Phase 1 & Phase 2)