Office of Rail Regulation

Schedule 8 Payment Rates Recalibration

Phase A

FINAL HALCROW/ITS Technical Report

07 October 2013

Halcrow

Document history

Final Technical Report

Schedule 8 Payment Rates Recalibration

ORR

This document has been issued and amended as follows:

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1.0	7 May 2013	Draft 1	SH		JRC
1.1	15 May 2013	Draft 2	SH		JRC
1.2	5 June	With Exec Summary	SH		JRC
1.3	26 June	Incorporate RM comments (both sets),and JS comments and added section on data confidentiality and quality assurance	SH	JRC	
1.4	14 August	Addressed further RM comments	SH	JRC	
1.5	28 August	Incorporated Option 5 run	SH	JRC	
1.6	6 September	Incorporated final validation meeting notes Addressed final comments re GJT definitions Updated non airport passenger %	SW		
1.7	7 October	Incorporated final comments from ORR.	SH	SH	SH

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Contents

Glossary

ATOC: Association of Train Operating Companies;

LENNON: The rail industry's central ticketing system. LENNON holds information on the vast majority of national rail tickets purchased in Great Britain and is used to allocate the revenue from ticket sales between train operating companies;

Flow: A flow represents a distinct station-to-station journey on the rail network with a defined start and end point;

Generalised Journey Time (GJT): GJT is a measure of total journey time by rail including station-to-station journey time, frequency, and the number of interchanges;

GJT Elasticity: GJT elasticity measures the sensitivity of demand to variances in GJT;

Late Time Multiplier: The passenger valuation of unanticipated lateness, relative to [changes in] scheduled journey time;

MOIRA: Software used to forecast the impact of timetables on passenger revenue. It is used to analyse the effect of changes to a timetable caused by factors such as stopping patterns, infrastructure, rolling stock and franchise geography on the passenger numbers carried and therefore the revenue impact;

MRE: Marginal revenue effect, the forecast loss of farebox revenue to a passenger train operator resulting from one minute of lateness per passenger journey;

NR: Network Rail;

Network Rail Payment Rate (NRPR): Network Rail pays compensation to (receives a bonus from) a passenger train operator in relation to a particular service group when it underperforms against (outperforms) its benchmark;

NALCO: The location code used to define the origin or destination of a passenger journey as on the passengers ticket in Lennon;

OD: Origin/Destination;

ORR: Office of Rail Regulation;

PDFC: Passenger Demand Forecasting Council;

PDFE: Passenger Demand Forecasting Executive;

PDFH: Passenger Demand Forecasting Handbook;

Service Code: means the third, fourth and fifth digits of an eight character train service code applied in the Performance Monitoring System to Trains and used to identify them;

Service Group: Group of train services, operating in a similar geographic (franchise) area and of a similar type

SQL: Structured Query Language (SQL) is a special-purpose programming language designed for managing data held in a relational database management system (RDBMS).

TOC: Train Operating Company – a passenger train operator.

1 Introduction & summary

1.1 Executive summary

The Office of Rail Regulation (ORR) and Network Rail (NR) commissioned Halcrow and ITS in November 2012, to recalibrate the payment rates and performance benchmarks in Schedule 8 of passenger train operators' track access contracts.

Our detailed findings and estimates for individual Train Operating Companies (TOCs) are not discussed in the main body of this report. This is because these findings and estimates are commercially confidential. This executive summary therefore provides only summary, non-confidential outputs from the study rather than detailed outputs by TOC – which are included in the confidential appendices.

The calculated Network Rail Payment Rates (NRPRs[1]) in our report are based on draft PDFH 5.1[2] parameters for Late Time Multipliers[3] and GJT[4] elasticities. This report uses the final parameters in PDFH 5.1 accounting for the changes to GJT elasticticies as mandated by the ORR letter of the 16 July from Carl Hetherington.

Key activities: estimating Marginal Revenue Effects (MREs) and Network Rail Payment Rates (NRPRs)

For Phase A our key activities were to:

1. Calculate the revised Marginal Revenue Effects (MREs)[5];
2. Update the Network Rail Payment Rates (NRPRs).

We calculate the MREs at flow and service code level, while NRPRs were calculated at service group level. NRPRs are calculated by multiplying the MREs by passenger journeys.

MREs are estimated from the following inputs:

- Total revenue by service group;
- Generalised Journey Time (GJT);
- GJT elasticities; and
- Late Time Multipliers.

A key element of the study was our review of existing PDFH values for Late Time Multipliers and GJT elasticities and revision of these values. These parameters were revisited as part of a separate study undertaken by MVA and ITS. A key conclusion from the MVA/ITS research was that the current approach using Late Time Multipliers,

[1] The Network Rail payment rate is designed to reflect the impact of performance on a train operator's long term revenue. It is composed of the estimated average marginal revenue effect (MRE) per passenger journey within a service group multiplied by the number of passenger journeys per day in that service group;
[2] PDFH is the passenger demand forecasting handbook.
[3] Late Time Multipliers are a measure of how much passengers value lateness compared to scheduled journey time;
[4] Generalised Journey Time is a function of station to station journey time, frequency and the number of interchanges.
[5] The MRE represents the impact of a minute's lateness on fare revenue over time;

linked to GJT elasticities, should be maintained. ITS however did provide alternative values for these parameters. We have used the draft recommended values provided by ITS in order to develop our reference case (also referred to as Option 4). Our final run uses the final values as contained in the ORR letter of the 16 July. Our final run is referred to as Option 5. Option 4 and Option 5 are identical in all areas except for the final Late Time Multipliers and GJT elasticity values used. We have conducted sensitivity analysis on variations around these recommended parameter values.

Data: sources and analysis

In delivering this work we have developed an integrated approach to modelling and data processing. Our approach relied on a back-end SQL database[6] to undertake much of the data-hungry processes. This was supplemented by a front-end spreadsheet model. This spreadsheet model used the processed data from the database as inputs. The spreadsheet model then employed a set of calculations in order to calculate payment rates for all TOCs.

The primary data sources we used were LENNON and Moira data for the railway year 2011/12. From LENNON, we extracted demand and revenue data related to: Origin Code; Destination Code; Service Code; Primary Product Group; Adjusted Earnings and Journeys. The primary product group was used to classify revenues and journeys into ticket types. For some TOCs, we used additional revenue and journey data they supplied to augment the LENNON dataset, where there were material additional revenue streams not included in LENNON.

We extracted GJT and Distance data from Moira for each flow and ticket type. We then mapped the LENNON flows to the Moira flows. The flow distance was used for the classification of flows into the required flow types, whilst GJT was used directly in the MRE calculation.

In order to ensure our approach is as robust as possible, we have sought to include 80% of revenue and journey data in the analysis of MREs and NRPRs. In all instances, we have managed to exceed this threshold using LENNON data. In order to account for the non-allocated revenues and journeys, we have adjusted the MREs by the ratio of total yield (total revenues/total journeys) divided by the yield for the top 90% flows (top 90% flows by revenue/ top 90% flows by journey) to get the final MREs for all flows.

The entire process of data extraction and analysis can be summarised in the following steps:

- **Revenue and journey data processing:** This was done by the back-end SQL database, primarily based on LENNON data;
- **Database processing:** We generated a number of processed datasets to be loaded into our spreadsheet model. This data included revenue, journeys, GJT and distance by flow, ticket type and service code for all flows;

[6] This is a standard database programme use to manipulate large data sets.

- **Flow allocation:** Flows were allocated to consistent station origins and destinations;
- **Applied peak/off peak splits:** These have been based on a separate model developed by Halcrow;
- **Identified LENNON flows representing London or PTE travelcards / zonal tickets:** This was done in order to establish a basis for proxy GJTs for these flows;
- **Assessed other model inputs:** Other inputs included percentage of airport flows and commuting splits;
- **Calculated MREs and NRPRs:** We calculated the MREs by flow, service code and finally both MREs and NRPRs by service group.

Market segmentation

In developing the reference case model, we have structured the data into market segments to represent differing passenger behaviour in each of the segments. We have applied parameters and other assumptions in developing estimates of MREs and NRPRs for each segment, based on the best available evidence.

The first element of the segmentation was to split data by ticket types. The following ticket types were used:

Table 1.1: Ticket types

Name	Description
T_F	Full
T_R	Reduced
T_S	Season

The second element of the segmentation was by geographic market, based on origin and destination using the following station types:

Table 1.2: Station types

Name	Description
S_LN	London
S_SE	South East
S_OSE	Outside Southeast
S_AP	Airports

The third element of the segmentation was distance. The ITS/MVA study demonstrated a difference in passenger behaviour around a distance threshold of 20 miles.

The fourth element of the segmentation was to split the journey by purpose. This provided us with commuting and non commuting splits.

We finally assessed the proportion of demand to/from Airport stations that is not airport users in order to apply the appropriate Late Time Multiplier and GJT elasticity parameters for Airport demand.

Stakeholder engagement

Our approach has relied heavily on stakeholder involvement and feedback and we have maintained a high level of engagement on all the key elements of our work including:

- timetable;
- our method;
- provision of data not contained in LENNON;
- reporting on both general and TOC-specific study findings.

In general, stakeholders engaged well with us during the process. We received active engagement from 19 of the TOCs throughout the study period. Other TOCs engaged more sporadically, however, we have accommodated them as far as possible given time and budgetary constraints.

Our engagement process has included workshops and direct meetings with TOC representatives. A particular focus of the face-to-face meetings was to discuss draft estimates of MREs and NRPRs. During these validation meetings, we discussed our findings with TOCs, and sought to obtain clarification or additional information where necessary. These meetings served as an important sense check to our work and provided validation of our results. The engagement process produced several actions for us and for TOCs. These actions were recorded and monitored in a central issue log to ensure they were resolved wherever possible.

We made a number of adjustments to our analysis as a result of the comments from the TOC validation meetings, including:

- Revised mapping for some flows;
- changes due to Travelcard data;
- confirmation and revision of airport flows;
- discussion of unmapped flows and revisions to these where appropriate;
- adjustments for non-geographic items such as treatment of journeys made by British Transport Police.

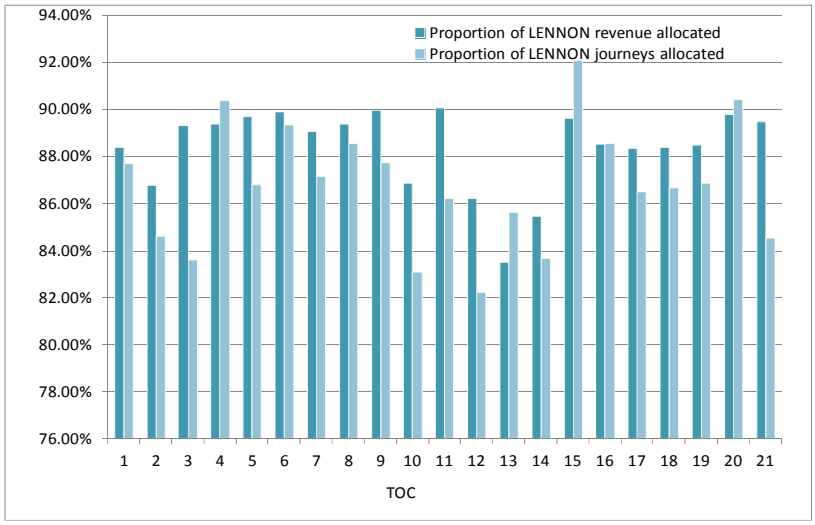
A level of engagement has been maintained with NR throughout phase A of the study, particularly with members of the NR regulation team. The engagement process also involved direct consultation with NR route managers. We invited all route managers to separate discussions where our estimates of NRPRs were discussed for the relevant TOCs on each route. This serves as a further and important validation activity for our work.

Summary outputs

We provided each TOC – and ORR - with the detailed outputs from our analysis. We also disclosed summary NRPR estimates to NR. We provide an overall summary of key parameters in the main report.

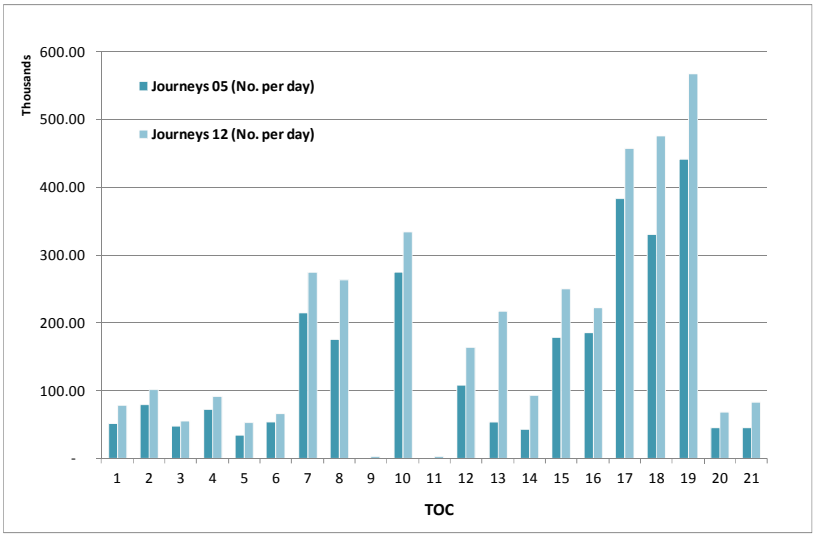
The following chart illustrates the proportion of LENNON journeys and revenues that were allocated for different TOCs:

Figure 1.1: Proportion of LENNON journeys and revenues by TOC



The following chart shows the number of journeys per day by TOC based on the 2012 service groups for 2012 and 2005.

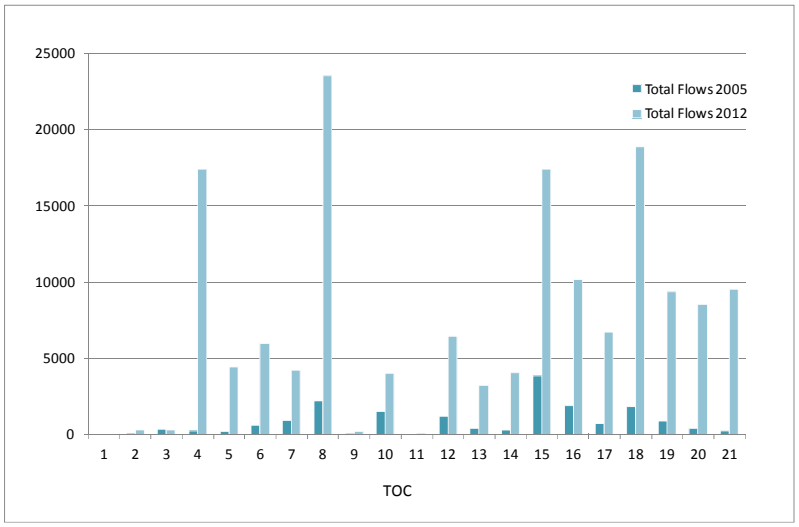
Figure 1.2: Number of journeys/day by TOC



This shows the number of journeys per day have increased overall between the two periods.

The following chart shows the number of flows that we have used in our analysis compared to the 2005 study. It clearly shows that we used a significantly greater number of flows this time compared to the 2005 study.

Figure 1.3: Number of flows by TOC



Late Time Multipliers were revised compared to 2005: The reference case used the following Late Time Multipliers:

Table 1.3: ITS Late Time Multipliers used for Option 4

	Suburban (less than 20 miles)		Inter urban (>20 miles)	
Flow type	**Commuting**	**Non commuting**	**Commuting**	**Non commuting**
London TCA	3.0	2.3	3.9	2.3
South East to/from London	3.0	2.3	3.9	3.4
South East to South East	3.0	2.3	3.9	3.4
London to/from outside LSE	3.0	2.3	3.9	3.0
Non LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

In order to show how this compares with the values used in the 2005 study we have shown the 2005 Late Time Multipliers below:

Table 1.4: 2005 AEA Late Time Multipliers

2005 AEA Late Time Multipliers source: page 5 of AEA report			
Flow Type	**Full Ticket**	**Reduced Ticket**	**Season Ticket**
Airports	6.5	6.5	6.5
LDHS	6.05	4.21	4.56
Others	2.5	2.5	2.5
LDHS = Long-distance high-speed			

The key distinctions between Option 4 and the 2005 Late Time Multipliers is:

- There are more Late Time Multipliers in the reference case compared to the 2005 study;
- the reference case splits Late Time Multipliers by Suburban and Inter-urban.

The Late Time Multipliers that we have used in our Option 5 model are provided in table 1.5 below:

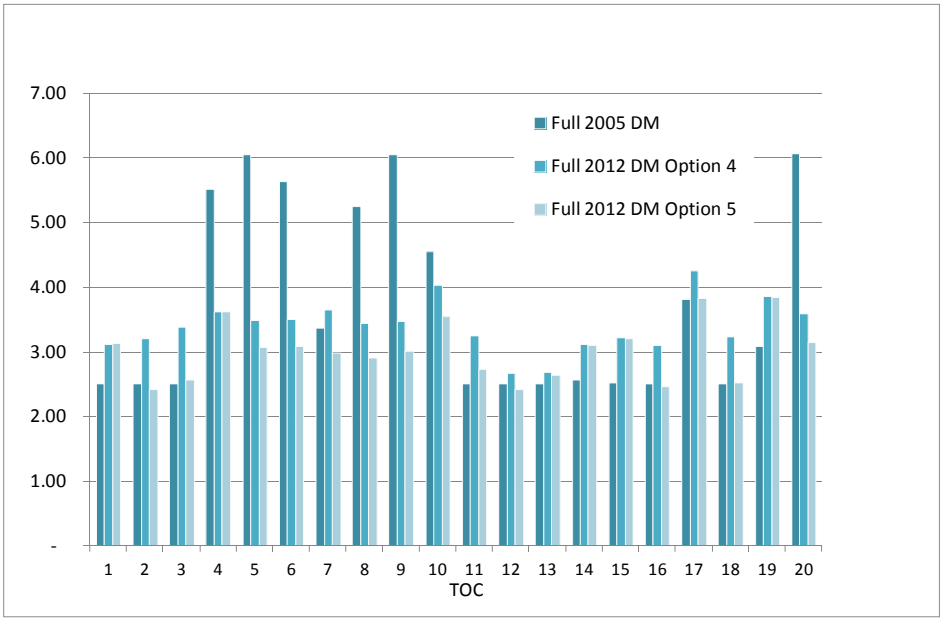
Table 1.5: ITS Late Time Multipliers used for Option 5

	Suburban (less than 20 miles)		Inter urban (>20 miles)	
Flow type	Commuting	Non commuting	Commuting	Non commuting
London TCA	2.5	2.3	2.5	2.3
South East to/from London	2.5	2.3	2.5	2.3
South East to South East	3.0	2.3	3.9	3.4
London to/from outside LSE	2.5	3.0	2.5	3.0
Non LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

These broadly match the values we have used for the reference case except for London Flows which have been further refined. The values here were prescribed by ORR in a letter from Carl Hetherington, reference above.

We conducted some analysis of weighted average late time multipliers. This is shown in the chart below for full tickets. The key observation is that the variance across TOCs of the revised delay time multipliers is much less compared to the 2005 study.

Figure 1.4: Weighted Average Late Time Multipliers



The overall variance in values between Option 4 and Option 5 is due to the final Late Time Multipliers used for Option 5 and adjusted elasticities used for the London flows. The adjusted elasticities are the PDFH 5.1 values with a 10% adjustment factor applied for London flows.

Our analysis shows that the relationship is similar for Reduced and Season tickets.

We have undertaken some sensitivity tests around our reference case (Option 4). These are referred to as Option 1 and Option 4.1[7]. Option 4.1 is a variance on the reference case. It uses the same values as the reference case but the 2005 AEA values for London and the South East for suburban commuting.

The sensitivity analysis we undertook for Option 1 uses the 2005 AEA study values for both the elasticities and Late Time Multipliers.

1.2 Structure of report

This rest of this Phase A report is structured as follows:

- Chapter 2 provides some background to the study;
- Chapter 3 summarises our method;
- Chapter 4 discusses sources of data and our use of data during calculation of the revised payment rates;
- Chapter 5 describes the model run and how we developed the central case;
- Chapter 6 provides a summary of the non-confidential results;
- Chapter 7 describes the additional model runs and sensitivities that we undertook;
- Chapter 8 is the technical appendices. These set out the detail results for each of the TOCs, TOC specific issue logs plus other technical information.

[7] ORR has used estimated payment rates for Option 4.1 for some of the calculations in its June 2013 draft determination. Examples include the schedule 4 access charge supplement income and the schedule 8 freight operator payment rate.

2 Background

2.1 Introduction

Halcrow and ITS were commissioned in November 2012 to undertake the recalibration of payment rates and performance benchmarks in Schedule 8 of passenger train operators' track access contracts.

Phase A of the study considers NRPRs – this is designed to reflect the impact of performance on a train operator's long term revenue. It is composed of the estimated average marginal revenue effect (MRE) per passenger journey within a service group multiplied by the number of passenger journeys per day in that service group.

This Chapter explains the background to the study.

2.2 2005 AEA study

Current estimates of MRE rates are based on the study that AEA conducted in 2005 for ORR, as part of the Structure of Costs and Charges Review, based on revenue data and GJT values from 2004/05, indexed on RPI in the usual way. The report acts as a reference point for our analysis, and includes appendices which detail where changes were made in the previous update. The full report is available here:

http://www.rail-reg.gov.uk/upload/pdf/sch8-aeat-payment-review-dec05.pdf

2.3 Summary of study scope/terms of reference

The scope of the study includes recalibration across all regulated passenger service groups in Great Britain, including franchised train operators and open access train operators. The overall remit involves two phases:

Phase A

a) Calculating revised Marginal Revenue Effects;
b) Updating Network Rail Payment Rates (NRPR).

Phase B

c) Updating passenger train operator payment rates;
d) Updating Network Rail benchmarks (including allowing for the application of a performance improvement trajectory determined for Network Rail as part of the PR13);
e) Updating the passenger train operator benchmarks (including allowing for the application of a performance improvement trajectory).

This report is specific to Phase A of the study: we will produce a separate report covering Phase B of our work.

2.3.1 Marginal Revenue Effect (MRE)

The MRE is the forecast loss of farebox revenue to a passenger train operator that results from one minute lateness. Key factors driving the variability of MRE's include total revenue by service group, Generalised Journey Time (GJT), GJT elasticity and Late Time Multipliers. In order to calculate NRPR it is necessary to calculate MREs by flow, service code and service group. The formula to calculate MREs at the flow level (based on station origins/destinations (ODs), with an individual station OD considered a "flow"), by ticket type is:

$$MRE_{ft} = \left(LateTimeMultiplier_{ft} * GJT\ elasticity_{ft} * revenue_{ft} / GJT_{ft}\right)$$

Where:

MRE_{ft} = Marginal Revenue Effect by flow by ticket type;

Late Time $Multiplier_{ft}$ = Late Time Multiplier by ticket type by flow;

GJT $elasticity_{ft}$ = GJT elasticity by ticket type by flow;

$revenue_{ft}$ = Revenue by ticket type by flow;

GJT_{ft} = GJT by ticket type by flow;

f = 1…,n represents the different flows available;

t = 1,2,3 represents three ticket types (Full, Reduced and Seasons).

The formulas to calculate MREs at the service code and service group level are:

$$MRE_{SC} = WAvgByJoumeys(MRE_{ft})$$

$$MRE_{SG} = WAvgByJoumeys(MRE_{SC})$$

Where:

WAvgByJourneys(MRE_{ft}) = Marginal Revenue Effects for all flows which belong to a specific service code weighted by journeys on those flows;

WAvgByJourneys(MRE_{SC}) = Marginal Revenue Effects for all service codes which belong to a specific service group weighted by journeys on those service codes.

MRE_{SG} = Average Marginal Revenue Effect for a Service Group

2.3.2 NRPR

The payment rates are calculated simply by multiplying the MREs by passenger journeys for service groups.

2.4 Chronology of study

Halcrow was originally commissioned to deliver a final set of NRPR and MRE values by 4th February 2013. This was based on the assumption that a definitive view from ITS/MVA on Late Time

Multipliers and GJT elasticities would be accepted by ORR, NR and stakeholders in January.

However, as the study has developed it has become evident that a consensus on values for Late Time Multipliers and GJT elasticities has not been as straightforward as initially expected. This has resulted in two impacts:

1) A delay in agreement between stakeholders on whether the updated Late Time Multipliers and GJT elasticities are appropriate for use in Schedule 8. Importantly, the PDFH 5.1 delay multipliers and GJT elasticities were not finalised in time for approved values to be included in the NR payment rate calculations due on 4 February; and;

2) A challenge, following concerns raised by Network Rail, to the revised Late Time Multipliers and elasticities for LSE commuter services that were accepted in the most recent version of PDFH 5.1.

Due to the delay in agreeing a final set of Late Time Multipliers and GJT elasticities, we have used various versions of these parameters as the study has progressed. The table below shows the source of the values that were used for the first two iterations of results:

Table 2.1: First two iterations of parameters

Date/name of MRE/NRPR estimates	Values used for GJT Elasticities	Values used for Late Time Multipliers
Initial draft: Jan 28 – Feb 1 2013	PDFH 5.0	ITS Interim Report
Updated draft: March 2 – 8 2013	PDFH 5.0	ITS Interim Report

Effectively the difference between these two sets of estimates was a revised set of baseline assumptions and more complete data for the updated draft results compared to the initial draft results. We consulted with each TOC on both sets of results: for the first set of Initial Draft results, we carried out a full set of engagement meetings with TOCs.

Reference Case (Option 4), Option 5 – and sensitivity testing

Following discussions at PDFC and PDFE, the reference case run (Option 4), as defined by ORR/NR, was based on the following parameters:

Table 2.2: Reference case parameters

Date of Run	Values used for GJT Elasticities	Values used for Late Time Multipliers
Mar 11 – 15: 2013	Draft PDFH 5.1	Draft PDFH 5.1

These parameters were based on the values provisionally accepted by PDFE [8].

The outputs from the reference case model were also discussed with TOCs as part of the validation process.

As the reference case was based on provisional parameters (i.e. not accepted by the industry at that stage), we were instructed to carry out a further two runs based on:

a) A variation of the reference case parameters (Option 4.1);
b) A further iteration based on values contained in the 2005 AEA study for both Late Time Multipliers and GJT elasticities (Option 1).

The table below shows the source of these parameter values:

Table 2.3: Parameter sources for sensitivity runs

Date of Run	Values used for GJT Elasticities	Values used for Late Time Multipliers
Option 4.1: Mar 25 – 29: 2013	PDFH 5.1 but 2005 AEA values for London and the South East for Suburban commuting.	PDFH 5.1 but 2005 AEA values for London and the South East for Suburban commuting.
Option 1: Mar 25 – 29: 2013	2005 AEA study values for both the elasticities and Late Time Multipliers.	2005 AEA study values for both the elasticities and Late Time Multipliers.

Section 6 of this report discusses the parameters we have used for these sensitivities in more detail.

The discussions about how to address NR's concerns on the final accepted Late Time Multipliers and GJT elasticities resulted in a final set of parameters being advised to Halcrow to use in the current August run, as shown below:

Table 2.4: Final model run (Option 5)

Date of Run	Values used for GJT Elasticities	Values used for Late Time Multipliers
August 1 – 9: 2013	Final PDFH 5.1 but with a 10% downward adjustment to elasticity values for London flows	Final PDFH 5.1

[8] Note: a further iteration resulted in a change in Late Time Multipliers for some flows in the final accepted PDFH 5.1 update recommendations.

The values to use in the final run was advised to the industry in a letter from Carl Hetherington at ORR dated 16 July 2013.

3 Summary of our method

3.1 Introduction

In order to define a suitable method for the study, we have undertaken the following key steps:

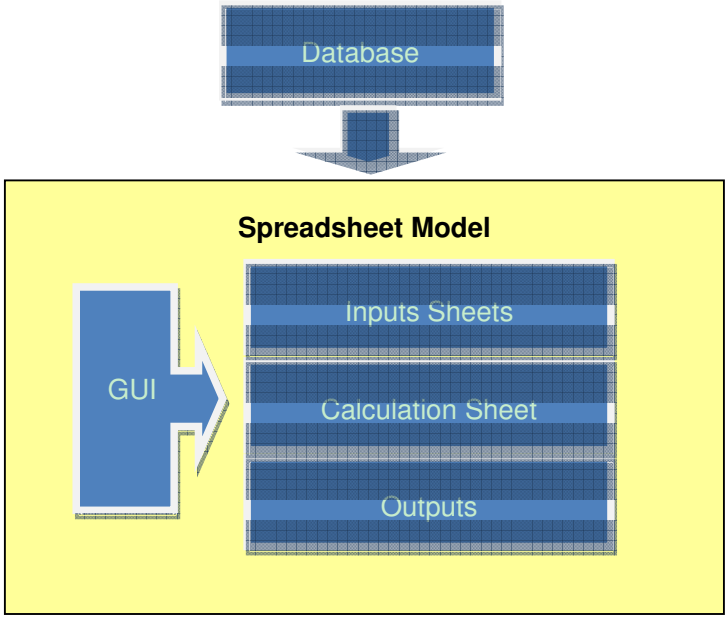
- Developed our approach, embodied in an analytical model for calculating Marginal Revenue Effects and NRPRs and defined the source data requirement and processing steps;
- Developed revised parameter estimates to be used for MRE calculations;
- Consulted with stakeholders on the method;
- Undertaken the required data processing in order to estimate the revised MREs and NRPRs, allowing for stakeholder feedback, based on the method and revised parameters.

We discuss these steps in the remainder of this chapter.

3.2 Model structure

The structure of the recalibration model is based on five main components, using source data from LENNON and Moira (see below). These components are illustrated in figure 3.1 below:

Figure 3.1: Data processing flowchart



We discuss each of these components below:

a) **MS SQL Database (back end processing):** We created a Microsoft SQL database to undertake the heavy data processing required. This takes individual TOC information at flow level for revenue and journeys from LENNON and the GJTs from Moira. The individual TOC database was enhanced where appropriate, building on the original LENNON data, to

reflect TOC-specific data or issues raised during the validation meetings. A full list of TOC data adjustments can be found in the TOC-specific appendices that follow this report.

Section 3.3 below provides a full description of the steps we followed in processing the data, using our SQL database.

b) **Spreadsheet Model – data user interface:** The spreadsheet model allows the user to upload TOC specific information into the model from the database for further processing.

c) **Spreadsheet Model - Input Sheets:** The input sheets take key TOC specific parameters required to calculate MREs and NRPRs. The input sheets also contain some fixed constants that do not change with different TOCs (e.g. Late Time Multiplier and GJT elasticity) and information for the particular TOC, as loaded from the database. The types of input data used are listed below:

i. Model parameter variables include:

- Late Time Multipliers;
- GJT elasticities;
- Commuting %;
- Non airport passengers %, and;
- Flow type mappings.

ii. List of service codes and service groups;

iii. Top 90% revenue flows for all ticket types which have been successfully mapped in Moira to get corresponding GJT;

iv. Unmapped allocated top 90% revenue flows for all ticket types which cannot be directly mapped in Moira, but allocated using default flow types.

v. Unmapped unallocated top 90% revenue flows for all ticket types which cannot be directly mapped in Moira and are not material. Those flows are not included in the sample calculation process.

vi. MREs, Journeys and NRPRs from the 2005 AEA study.

The key parameters used for our “reference case” model runs are described in Chapter 5.

d) **Spreadsheet Model - Calculation Sheets:** The model undertakes calculations of the MRE and NRPRs based on the formulas set out in Chapter 2, using data from the SQL database and other input sheets in order to calculate the NRPRs and the MREs.

We have maintained the separation of MREs and NRPRs in order to ensure that we maintain transparency in the calculation method.

e) **Spreadsheet Model - Output Module:** This displays results for three levels of analysis:

i. **Total revenue/journeys summary results.** Shows the total revenue/journeys, top 90% mapped revenue/journeys and top 90% unmapped revenue/journeys for a specific TOC;

ii. **Comparison to 05 study results summary.** Comparison of the 2005 journeys, MREs and NRPRs for service groups with the values for 2012;

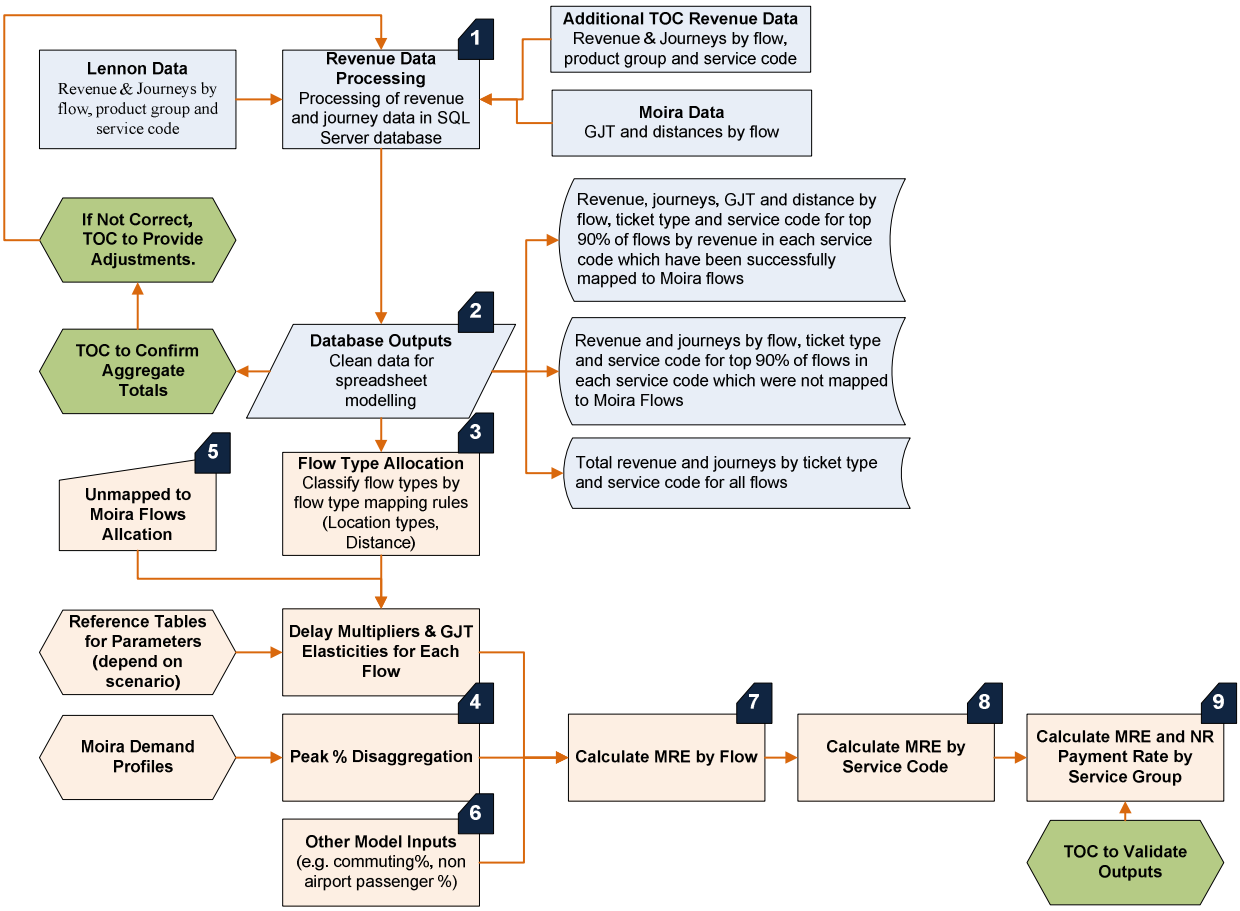
iii. **Journeys Segmentation Summary.** Provides a more detailed summary of outputs by flow type and ticket type, providing information on commuting and peak percentages amongst other things.

3.3 Data processing: stages

Building on section 3.2 above, this section provides further details on the key steps of the modelling exercise, where data was processed and analysed in order to calculate the NRPRs and the MREs. Data sources are described in Chapter 4.

The flow chart below illustrates the overall model structure that was followed for each TOC.

Figure 3.2: Data processing steps



We carried out nine steps in the overall data processing. Steps one and two were performed by the back end database due to the size of the datasets, whilst the remaining steps were performed by our Excel spreadsheet model. The key stages that we followed are described below:

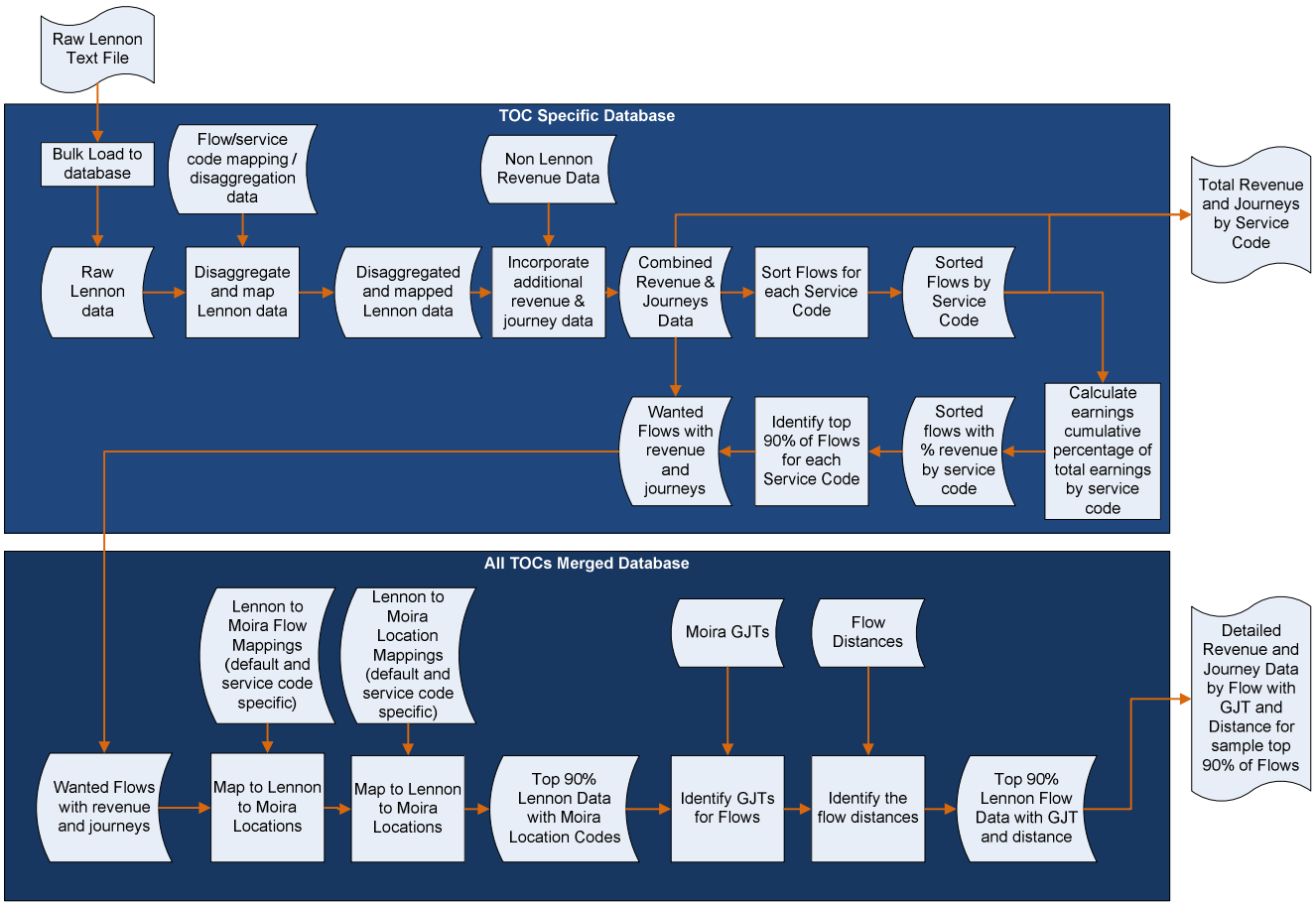
Stage 1: Revenue and journeys data processing.

The following processing steps take place in the SQL Server database to prepare the data for the spreadsheet model:

- LENNON revenue that relates to non-passenger product groups and service codes were discarded and the LENNON Primary Product Groups were mapped onto the ticket types: Full, Reduced and Seasonal.
- If required for the TOC, revenue and journeys were mapped or disaggregated between service codes and onto different flows.
- Any revenue and journey data that is not included within LENNON was combined with the LENNON data;
- The top 90% of flows by revenue within each service code were identified.
- The LENNON flows based on NALCO locations codes (see Glossary) were mapped to the flows available from Moira using either default location mappings or TOC-specific overrides to identify the generalised journey times and distances for each flow.

The detailed flow chart describing the database processing is shown in figure 3.3 below:

Figure 3.3: Database process - details



Stage 2: Database Processing.

We generated the following from Step 1, to be loaded into the spreadsheet model:

- Revenue, journeys, GJT and distance by flow, ticket type and service code for the top 90% of flows by revenue in each service code which were successfully mapped to Moira flows;
- Revenue and journeys by flow, ticket type and service code for the top 90% of flows in each service code which were not mapped to Moira Flows;
- Total revenue and journeys by ticket type and service code for all flows.

Stage 3: Flows were allocated by station origin to destination matrix.

We allocated flow types to market segments, consistent with the ITS recommendations, using geographic flow characteristics. Station origin, destination and distance were used to identify the flow types which are consistent with the flow types in the parameter table used in each scenario.

For Airport flows we have assessed the proportion of passengers that are air passengers.

Stage 4: Applied peak / off-peak split based on flow type (informed by NRTS sample, MOIRA profiles).

The peak percentages (proportion of each flow in the peak and off-peak hours) were calculated in a separate model which contains 84 Moira demand profiles of departure time for different ticket types, flow types and journey times. The model generates estimated peak proportions by categorising the individual flow into the specific profile flow type using station "blueness". The station blueness is an integer indicating the importance of the station. The stations with higher blueness are cities with large commuter flows, such as Manchester and Leeds. If both origin and destination are non-London stations, and the origin blueness divided by the destination blueness is less than 0.7, then the flow is identified as "To Blue". If both origin and destination are non-London stations, and the destination blueness divided by the origin blueness is less than 0.7, then the flow is identified as "Ex Blue". London stations are considered within a separate category without assigning them with blueness factors. Flows to London stations are identified as "To London" and flows from London stations are identified as "Ex London". The list of flow profile types are shown below:

Table 3.1: Flow profile types

Flow Profile Type
To London
Ex London
To Blue
Ex Blue
Other Flow

The peak percentage is selected for each specific flow to match its flow profile type and journey band in the Moira demand profiles. We sense-checked our approach against observed TOC daily flow profile data and confirm it shows relatively high reliability and consistency. We note there is an absence of robust current information in the industry on peak / off-peak splits by flow type.

Stage 5: Identified LENNON flows representing London or PTE travelcards / zonal tickets and establish basis for proxy GJTs.

We identified and categorised flows that represented PTE travelcards / zonal tickets. We categorised these by the standard flow type classifications (see next Chapter). This allowed us to assign a GJT value to sets of categorised flows based on the mix of passenger travel for these flows.

Stage 6: Other Model Inputs.

We assessed values for other parameters that are required in order to calculate MREs and NRPRs. These include assessment of the percentage of airport flows that represent air passengers and commuting splits. Further information on the basis of these assessments is provided in chapter 5 of this report.

Stage 7: Calculated MRE by Flow.

We combined data on flow types, GJT elasticities and Late Time Multipliers in order to calculate MRE values for each flow by ticket type (full, reduced and seasonal).

Stage 8: Calculated MRE by Service Code.

Data at the flow level was taken from our analysis and analysed further in order to calculate MREs at the service code level. We checked and ensured internal consistency between MREs calculated at the flow level - and MREs calculated at the service code level.

Stage 9: Calculated MRE and NR Payment Rate at Service Group.

Service codes were mapped to service groups and MREs and NRPRs were calculated at the service group level. We undertook internal consistency checks to ensure that data at the service group level was consistent with data at service code level.

We set out more detail on Stages 7-9 in section 5.3, including the process for adjusting our sample to ensure that it reflected the full population of flows.

The values for the different parameters used in our analysis are described in Chapter 5.

3.4 ITS analysis: development of parameter estimates

ITS and MVA were commissioned by ATOC to produce updated estimates of key parameters for PDFH version 5.1, including the parameters that drive MRE estimates: delay (or late time) multipliers and generalised journey time elasticities. ITS and Halcrow worked closely, as part of the integrated project team for this study, to ensure consistency of our analysis and correct interpretation of the ITS/MVA findings.

The key features of the review were:

- The MVA/ITS team considers it was the most extensive review ever undertaken specifically as part of a PDFH update.
- It constitutes the most comprehensive review of UK evidence relating to the values travellers place upon variables used to denote travel time variability.
- For the first time, it includes evidence on directly estimated reliability elasticities.
- In arriving at their recommendations, ITS/MVA compared the directly estimated late time elasticities with those implied by the current PDFH procedure and the late time penalties and GJT elasticities input to it.
- ITS/MVA conducted further investigation and addressed issues raised by the Peer Review Group and the Steering Group, and these influenced the recommendations made.

Given the evidence that emerged, ITS/MVA felt that on balance the current approach using late time multipliers driven off the GJT elasticity should be retained – rather than a direct elasticity based approach. A key reason for this is that the current approach retains slightly more differentiation between markets.

The recommended delay (late time) multipliers, which were used for Option 4 and subsequently revised before final approval of the parameter value for PDFH 5.1, were:

- 3.0 for London Inter-urban (>20 miles) non-commuting
- 3.4 for Non-London Inter-urban (>20 miles) non-commuting
- 2.3 for Non-London Regional flows (<20 miles) non-commuting
- 2.3 for LSE Inner and Outer Suburban non-commuting
- 3.9 for London and Non-London Inter-urban (>20 miles) flows commuting
- 3.0 for Non-London Regional flows < 20 miles commuting
- 3.0 for LSE Outer Suburban commuting
- 3.0 for LSE Inner Suburban commuting
- 6.0 for Airports.

These estimates were to be used in conjunction with the revised GJT elasticities:

- Rest of Country to/from London -1.35
- South East to/from London -1.25
- London TCA -0.90
- Non London > 20 miles -1.20
- Non London < 20 miles -1.10
- Airports Outbound -1.50
- Airport Inbound -1.00

We explain in later Chapters (particularly Chapter 5) how the segmentation that ITS/MVA used, and the resulting parameters, were incorporated into this study. Importantly, the segmentation identifies that passenger behaviour varies according to three dimensions:

- Journey purpose – defined in the ITS/MVA study in terms of commuting/non-commuting, but also noting that ticket type can be used as a partial proxy for this;
- Flow distance; and
- Geographic market segments (London, South-East England, rest of Great Britain and airports).

3.5 Stakeholder engagement on methodology

As part of our work we have maintained stakeholder engagement throughout Phase A. The stakeholder engagement includes a wide array of stakeholders, but can be broadly split between train

operating companies (TOCs), Network Rail and other stakeholders. Other stakeholders include Association for Train Operating Companies (ATOC), Department for Transport (DfT), Transport Scotland, Rail Freight Operators Association and Transport for London.

We have engaged with stakeholders on the following key elements of our work:

- Timeline and deliverables for the Phase A study;
- Phase A method, including inviting stakeholders to comment on our proposed approach;
- Any adjustment to base data that may have been required;
- Provision of data where the core data was outside of the LENNON dataset;
- Non TOC specific study findings;
- TOC specific study findings.

To ensure the widest possible engagement, we have used two workshops to engage at industry wide level, and a number of individual sessions to engage with TOCs and NR contacts.

3.5.1 Workshops

Workshop 1: 6 December 2012

Halcrow and ITS delivered an industry-wide workshop to introduce the study on 6 December 2012. At this workshop we presented the following material:

- An overview of the Halcrow and ITS team;
- A description of the scope of work;
- Update on ITS work to date;
- An outline method to calculate MREs and NRPR for further consultation with stakeholders. During this workshop we explicitly invited stakeholder feedback on our approach to engagement;
- A description of our engagement plans with stakeholders;
- An outline of the timeframe for the delivery of Phase A and how this fits with Phase B;
- Governance and quality assurance procedures to be adopted during the study;
- A brief description of our work plan and timeline for Phase B.

Workshop 2: 21 January 2013

The purpose of the second workshop was to update stakeholders on progress on Phase A of our work. The workshop also outlined our proposed methodology for Phase B of the study. We presented material on the following topics at the workshop:

- A further update on ITS and work on updating parameters, specifically the Late Time Multipliers and GJT elasticities;

- Outline of the general findings of the study to date;
- Description of the approach intended for Phase B, and;
- Update on stakeholder engagement.

Both workshops were a forum for discussion for any issues related to Phase A or Phase B of our work.

3.5.2 Detailed engagement with stakeholders on our method

As part of our engagement with stakeholders, we developed a questionnaire that was issued to all 22 TOCs. In all, 19 TOCs responded. The purpose of this questionnaire was to engage with TOCs on key aspects of our method and availability of information that would then enable us to focus our work for the remainder of the Phase A exercise. We asked the following questions:

1. Do your passengers use any operator specific tickets that represent revenue and journeys not captured within LENNON (i.e. settled outside of RSP)? If yes, please provide high-level details and availability of alternative data sources that would provide this data;
2. Does your revenue include travel on London or PTE travelcard /zonal products that is contained within LENNON, but not at a geographically recognised flow level? If yes, please indicate the approximate proportion of revenue (or demand) that is aggregated in this way, and the availability of possible data sources that may provide disaggregation;
3. Are you aware of any non-marginal revenue or journeys contained within LENNON (classified as product types that could be considered to be “Full” Reduced” or “Season”) that should be excluded from our analysis? If yes, please provide high level details;
4. Was your franchise /network affected by any significant disruption, structural timetable change or service group remapping during 2011/12? If yes, please provide details;
5. Do your services provide a direct connection with an International Airport? If yes, would you be able to provide evidence that indicates the aggregate split between air passengers or other travellers (e.g. commuters) using these airport flows?
6. Please provide any additional comments on the method for calculation of MREs, or exceptions that you believe may be material for your own TOC. Please support your comments with evidence (including data sources where appropriate) wherever possible.

The following table shows a summary of the responses to our questionnaire from TOCs that responded, for each of the questions above.

Figure 3.4: Materiality of data from TOCs to our analysis

	1. Non – LENNON Data	2. LENNON includes Travel on London or PTE travelcards – if so, what %?	3. Non-Marginal Data to be Excluded from our Analysis	4. Network Affected by Disruption / Structural Changes	5. Airport Connection
1	5%	5%	0%	Y	Y
2	0%	0%	0%	Y	Y
3	25%	0%	0%	N	Y
4	5%	25%	0%	Y	Y
5	0%	1%	0%	N	Y
6	0%	5%	0%	Y	Y
7	0%	5%	0%	N	Y
8	99%	0%	0%	Y	Y
9	0%	0%	0%	Y	Y
10	1%	30%	0%	N	N
11	5%	5%	0%	N	Y
12	0%	10%	0%	Y	N
13	5%	15%	0%	Y	Y
14	5%	40%	0%	Y	N
15	5%	5%	0%	Y	Y
16	2%	3%	0%	N	Y
17	0%	0%	0%	Y	N
18	0%	3%	2%	Y	Y
19	100%	25%	0%	Y	N

The colour coding provides an indication of the importance of the information provided for the development/application of our method. Green indicates the information is not material. On the other end of the spectrum, bright red indicates that the information provided to us was very material to our analysis. Colours in between reflect the relative materiality of the data being provided.

We received some minor feedback on our overall method from the TOCs. This was considered, but did not materially affect the final method used to estimate the MREs and NRPRs.

Our later engagement process to develop and validate the reference case model scenario and Option 5 is described in Chapter 5. Our detailed engagement at TOC specific level is discussed in the Appendices to this report.

4 Data sources and uses

4.1 Introduction

Data for our study was extracted for the railway year 2011/12, the last full year prior to the study commencement. The primary data sources were LENNON and Moira: the use of these sources is described below.

4.2 Demand & revenue data (LENNON)

The primary source of revenue and journey data that forms the basis of the MRE calculation is based on extracts from the "Earnings by Fiscal Year" table in LENNON, provided by ATOC. A separate extract was made for each TOC using the "Carrier Profit Centre Code" as a filter to restrict the results to the correct TOC for the Financial Year 2012. The following columns were extracted:

- Origin Code
- Destination Code
- Service Code
- Primary Product Group Code
- Adjusted Earnings Sterling
- Operating Journeys.

The data was transferred into the SQL Server database for further processing. Total Earnings and Journeys for each Carrier Profit Centre were also queried from LENNON and used to check that all the detailed data was successfully loaded.

The Primary product group was used to classify the revenue and journeys into the ticket type required for the analysis – i.e. Full, Reduced and Season. The table below shows the mapping used.

Table 4.1: Product groups and Moira types

Primary Product Group	Product Group Description	Moira Type
0	No Group	N/A
N/A	N/A	N/A
PG01	FIRST FULL	Full
PG02	FIRST REDUCED (PRIMARY)	Reduced
PG03	FIRST REDUCED ADVANCE PURCHASE	Reduced
PG04	FIRST SEASON TICKET	Season
PG05	STANDARD FULL	Full
PG06	STANDARD REDUCED	Reduced
PG07	STANDARD REDUCED ADVANCE PURCHSE	Reduced
PG08	STANDARD SEASON TICKET	Season
PG09	OTHER	N/A
PG99	NON SPECIFIC PPG	N/A

The LENNON data was processed as described in section 3.3. For some TOCs additional revenue and journey data was used to augment the LENNON dataset where there were material additional revenue streams.

The revenue and journeys were used to calculate the yield that forms the input to the MRE calculation for each flow. The number of journeys for each flow is then used in the model to aggregate the data from individual flows to the service code and service group levels within the model.

4.3 GJT and distance data (MOIRA)

ORR supplied us with Generalised Journey Times (GJTs) by ticket type, and distances from the 8 regional Moira version 1 models for the timetable period November 2011, which represented the mid-point of the study year. We considered that use of Moira version 1 (rather than version 2) would produce more robust results, given industry concerns over the representations of some journey data in Moira 2. We identified unique station origin and destination pairs from these datasets. Where the same origin destination pair exists in more than one regional model the minimum GJT and distances are used, assuming that passengers will usually take the shortest route.

We mapped LENNON flows onto Moira flows: each LENNON location code was given a default equivalent Moira location which could then be overridden on a TOC-by-TOC basis, either for all occurrences of that location, or for a specific location pair.

We used the flow distances for the classification of flows into the required flow types. We used the GJT directly in the MRE calculation.

4.4 Other data sources

Where the stakeholder engagement process identified any issues then individual TOCs were asked to provide additional data to inform the process. Some of the additional data provided was:

- More detailed LENNON data to inform adjustments for specific flows/service groups;
- Additional Revenue and Journey data to augment LENNON;
- LENNON location coding information to inform classification of PTE entries in LENNON to suitable flow types and durations;
- Earnings and revenue adjustment quantities to correct misallocations in LENNON;

Details of TOC-specific enhancements/adjustments to the data are set out in the detailed technical appendices to this report.

4.5 Data security and confidentiality

Halcrow has ensured data security and confidentiality by implementing a closed process that has included:

- Using Halcrow's secure electronic file sharing system, Sharepoint, to share all sensitive information with TOCs, NR and ORR;
- Where we have stored confidential data on our servers we have limited access to the project team only;
- Explicit approval from TOCs for any data that has been shared with NR has been obtained;
- All confidential paper material is stored securely and there are separate locked bins for the disposal of confidential material;
- We have used staff experienced with dealing with data confidentiality procedures and who are used to handling clients' confidential information;
- Access to the office premises is strictly restricted to current staff and pre-notified visitors.

For this project we have taken data security and confidentiality very seriously. We have maintained an audit trail to all data requests and where we have circulated information to stakeholders.

4.6 Our internal assurance and review processes

4.6.1 Quality assurance

Halcrow's project management processes are governed by Halcrow Integrated Management System (PRISM). PRISM has been steadily developed and implemented to provide efficient planning and cost control, and operates fully computerised systems to ensure that all projects are planned and programmed on the basis of resources, budget and time elements and to account for data confidentiality and security. The PRISM system is a proven integrated management system which includes:

- Quality Management System registered to BS EN ISO 9001:2000.
- PRISM takes account of the fact that each commission is unique and demands an individually planned approach to its management.
- Management systems in place for a commission reflect the scale of commercial and health and safety risks.
- Halcrow Group Limited employs dedicated business system auditors who carry out quarterly internal audits of all areas of the company;
- Internal Audit Reports include any actions on non-compliances.

The PRISM system requires an explicit internal review of all deliverables produced for a client. This review requires a three-tier sign off process of the deliverable as follows:

- The deliverable is initially reviewed by the author;
- it is then reviewed by the project lead. The project lead may identify further actions that require resolution prior to submitting the deliverable to the project manager. A formal process exists for managing these actions to resolution. Once the project lead is happy with the deliverable it is passed to the project manager;
- it is finally reviewed and if the project manager is happy with the deliverable and resolution of any outstanding actions he would sign off the deliverable.

This process ensures that the quality of deliverables to the client follow a rigorous internal process prior to final delivery. Compliance is taken extremely seriously. Our procedures are auditable and transparent and are designed to ensure that the output we deliver fully meets requirements and can be shown to have been carried out by qualified staff. Halcrow has adhered to this process for the deliverables within this study,

4.6.2 Peer review

In addition to the PRISM requirements Halcrow has undertaken an independent internal audit of the calculations to ensure they have been undertaken correctly and any assumptions made are reasonable.

PRISM also requires a nominated technical advisor to:

- Ensure that the technical approach is and remains applicable;
- that technically the project remains on track;
- any issues raised in assessments of the approach have been considered and auctioned, and;
- that the agreed approach is being followed and /or adapted where necessary.

5 Model runs: developing the reference case model

5.1 Introduction

Section 2.4 explains the timeline on the development of the reference case. We refer to the reference case scenario as Option 4 in our analysis. Option 5 is the final set of model runs that we undertook. Option 4 and Option 5 are identical in all areas except for the final Late Time Multipliers and GJT elasticity values used. Therefore the comments that follow relate equally to the reference case and Option 5 unless explicitly stated otherwise. The rest of this Chapter explains:

- the key assumptions and inputs that we used to produce results for the reference case;
- the detailed steps in our calculations for the reference case; and;
- the engagement/validation process we carried out with stakeholders, to finalise the reference case results.

5.2 Market segmentation and key assumptions

In order to implement the approach described in Chapter 3, we used market segmentation consistent with both the 2005 AEA study, and the ITS/MVA recommendations. As explained in Chapter 3, the segmentation follows three dimensions, each of which affect passenger behaviour.

We also applied some key assumptions to define the reference case, in consultation with ORR and NR. We carried out sensitivity testing around key assumptions for the reference case, which is explained in Chapter 7.

The detailed segmentation that we applied for the reference case is set out below.

5.2.1 Ticket types

The first dimension of the segmentation is ticket type, as a proxy for journey purpose, which are split between three types of ticket as shown in the table below.

Table 5.1: Ticket types

Name	Description
T_F	Full
T_R	Reduced
T_S	Season

5.2.1 Geographic market segments

The second dimension we used for segmentation was geographic market segments, based on station origin and destination, using the following station types:

Table 5.2: Station types

Name	Description
S_LN	London
S_SE	South East
S_OSE	Outside Southeast
S_AP	Airports

These station OD definitions were used to create flow types as follows, using a matrix of station OD pairs:

Table 5.3: Origin to destination mapping to flow type

Origin	Destination	Flow Type
S_LN	S_LN	London TCA
S_LN	S_SE	London to South East
S_LN	S_OSE	London to Outside LSE
S_LN	S_AP	Airports*
S_SE	S_LN	South East to London
S_SE	S_SE	South East to South East
S_SE	S_OSE	South East to Outside LSE
S_SE	S_AP	Airports *
S_OSE	S_LN	Outside LSE to London
S_OSE	S_SE	Outside LSE to South East
S_OSE	S_OSE	Outside LSE to Outside LSE
S_OSE	S_AP	Airports *
S_AP	S_LN	Airports *
S_AP	S_SE	Airports *
S_AP	S_OSE	Airports *
S_AP	S_AP	Airports *

* For all airport flows, non airport passenger % is considered while allocating the flow type.

5.2.2 Distance bounds

The third dimension we used for segmentation was station-to-station distance bounds. ITS/MVA analysis showed that there is a difference in passenger behaviour for flows defined by the threshold of 20 miles.

5.2.3 Commuting and non-commuting splits

In order to complete the segmentation by journey purpose, we then split flows into commuting and non-commuting passengers. The commuting non-commuting splits are shown below in table 5.4.

Table 5.4: Proportions of commuting demand by ticket type and flow type (*source: Halcrow Analysis Based on PDFH v5)*

Description	Commuting F	Commuting R	Commuting S
London Travelcard area	51%	46%	78%
South East: to /from London	40%	23%	91%

South East: Non-London	48%	21%	72%
Outside of Southeast to/from TCA	11%	6%	59%
Non-London	36%	17%	72%
Airports	10%	17%	85%

The commuting percentage splits above are derived from the ticket type to journey purpose mapping tables contained in chapter B0.3 of PDFH v5, which at the time was the most current available data. The following table shows the data sources for calculating commuting percentages for each market segmentation which are used in our model.

Table 5.5: Table references in PDFH v5 for calculating commuting percentages

Market Segmentation (Commuting%)	Table References in PDFH v5
London Travelcard area	Table B0.1 (Within the London Travelcard Area)
South East: to /from London	Table B0.2 Rest of South East to/from London Travelcard Area
South East: Non-London	Table B0.3 Within the South East (excl London Travelcard Area)
Outside of Southeast to/from TCA	Table B0.4 Outside South East to/from London (<100 miles); Table B0.5 Outside South East to/from London (100+ miles)
Non-London	Table B0.6 Outside South East <20 miles (excl within PTE areas); Table B0.7 Outside South East 20-100 miles; Table B0.8 Outside South East 100+ miles
Airports	Table B0.9 To/From Airports

An example of how we have applied the calculation is provided below. We begin by taking a reference table from PDFH v5. One is provided below to illustrate the process:

Table 5.6: Example of ticket type to journey purpose mapping table from PDFH v5 (August 2009) (Table B0.2 Rest of South East to/from London Travelcard Area)

	Anytime	Off peak	Season	Total
Commuting	4.1	7.6	52.1	**63.8**
Business	3.5	6.7	2.4	**12.6**
Leisure	2.7	18.2	2.7	**23.6**
Total	**10.3**	**32.5**	**57.2**	**100**

We categorised business and leisure purpose as non-commuting. “Anytime”, “Off-Peak” and “Season” are considered as “Full Tickets”, “Reduced Tickets” and “Season Tickets” respectively. Using this categorisation, we derived the commuting percentages for South East: to /from London by ticket types which is shown in the Table 5.4 above.

Recognising that travel using Oyster PAYG is classified in the LENNON ticket sales data as ‘Reduced’ fares, a bespoke adjustment

factor has been applied to London Travelcard Area reduced flows (a 30% uplift).

Since the commuting percentages for Outside of Southeast to/from TCA and Non-London cannot be referenced by a single table from PDFH v5, we have assessed what the relevant percentage should be. The commuting percentages for Outside of Southeast to/from TCA flows are calculated as the weighted average of commuting percentages for Outside South East to/from London (<100 miles) and Outside South East to/from London (100+ miles) as contained in PDFH v5. Similarly, the commuting percentages for Non-London flow type are calculated as the weighted average of commuting percentages for Outside South East <20 miles (excluding within PTE areas), Outside South East 20-100 miles and Outside South East 100+ miles from PDFH v5. The weightings are derived from the journeys of the relevant flow types in Lennon for all TOCs. It should be noted that commuting percentages are not used in Option 1 scenario (AEA 2005 delay multipliers and PDFH 5.0 elasticities).

5.2.4 Generalised Journey Time Elasticities and Late Time Multipliers

The overall Late Time Multiplier and generalised journey time elasticity values that we used by market segment are shown below:

Table 5.7: ITS recommended Late Time Multipliers (Option 4)

	Less than 20 miles		>20 miles	
Flow type	Commuting	Non commuting	Commuting	Non commuting
London TCA	3.0	2.3	3.9	3
London to South East	3.0	2.3	3.9	3.4
South East to London	3.0	2.3	3.9	3.4
South East to South East	3.0	2.3	3.9	3.4
London to Outside LSE	3.0	2.3	3.9	3.0
Outside LSE to London	3.0	2.3	3.9	3.0
Outside LSE to South East	3.0	2.3	3.9	3.4
South East to Outside LSE	3.0	2.3	3.9	3.4
Outside LSE to Outside LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

Source: PDFHv5 1 Reliability Review v3.2

Table 5.8: ITS recommended Elasticities (Option 4)

	Less than 20 miles			>20 miles		
Flow Type	Full	Reduced	Season	Full	Reduced	Season
London TCA	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9
London to South East	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
South East to London	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
South East to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
London to Outside LSE	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to London	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
South East to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Outside LSE to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Airports*	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25

** Airport elasticities are assumed to be the arithmetic average between the airport inbound elasticity and airport outbound elasticity due to the lack of detailed information on airport flows in Lennon.*

** Elasticities are assumed to be same for commuting and non-commuting flow types.*

Source: PDFHv5 1 Reliability Review v3.2

Table 5.9: ITS recommended Late Time Multipliers (Option 5)

	Less than 20 miles		>20 miles	
Flow type	**Commuting**	**Non commuting**	**Commuting**	**Non commuting**
London TCA	2.5	2.3	2.5	2.3
London to South East	2.5	2.3	2.5	2.3
South East to London	2.5	2.3	2.5	2.3
South East to South East	3.0	2.3	3.9	3.4
London to Outside LSE	2.5	3.0	2.5	3.0
Outside LSE to London	2.5	3.0	2.5	3.0
Outside LSE to South East	3.0	2.3	3.9	3.4
South East to Outside LSE	3.0	2.3	3.9	3.4
Outside LSE to Outside LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

Source: PDFHv5 1 Reliability Review v3.2

Table 5.10: ITS recommended Elasticities (Option 5)

	Less than 20 miles			>20 miles		
Flow Type	**Full**	**Reduced**	**Season**	**Full**	**Reduced**	**Season**
London TCA	-0.9	-0.9	-0.81	-0.9	-0.9	-0.81
London to South East	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
South East to London	-1.25	-1.25	-1.125	-1.25	-1.25	-1.125
South East to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
London to Outside LSE	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to London	-1.35	-1.35	-1.215	-1.35	-1.35	-1.215
Outside LSE to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
South East to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Outside LSE to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Airports*	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25

5.2.5 Airport demand

In order to apply the specific Late Time Multiplier and GJT elasticity parameters for Airport demand, it is necessary to define the proportion of flows to or from airport stations that are not air passengers / or airport workers, as shown in the table below.

Table 5.11: Proportions of demand to/from Airport stations that are not Airport users

Airport Station	% non air passengers
Birmingham Intl	50%

Airport Station	% non air passengers
Gatwick Airport	25%
Heathrow Exp 4	5%
Heathrow Airport	5%
Heathrow Exp 5	5%
Heathrow Exp 123	5%
Liverpool S Pwy	50%
Luton Airport Pwy	25%
Manchester Airport	5%
Prestwick Int Ap	5%
Southend Airport	5%
Stansted Airport	5%
Teesside Airport	5%
Heathrow BR	5%

Source: Halcrow Analysis/Assumptions

5.3 Implementing our model: calculation process

We set out more detail below on Stages 7-9 described in section 3.5. These are the more detailed steps that we undertook in these stages:

1. Calculated the MREs for the mapped top 90% revenue flows for all three ticket types Full, Reduced and Season;
2. calculated MREs for the unmapped but allocated top 90% revenue flows for all ticket types. Unmapped allocated top 90% revenue flows are the top 90% revenue flows which cannot be directly mapped in Moira, but allocated using a default flow type which we have assigned based on our knowledge/experience;
3. took the weighted average MREs for the top 90% of the mapped flows which belong to a service code, in order to calculate the sample top 90% mapped service code level MRE;
4. took the weighted average MREs for the top 90% unmapped allocated flows which belong to a service code, in order to calculate the sample top 90% unmapped allocated service code level MRE;
5. calculated the sample service code level MREs as the weighted average of the sample top 90% mapped service code MREs and the sample top 90% unmapped allocated service code MREs. We then applied adjustment factors to sample service code MREs in order to calculate the final service code MREs at the population level. This involves “tail adjustment” that reflect the flows excluded from the sample flows for each service code. The ratio of the total revenue per journey and the sample revenue per journey is calculated for each service code/ticket type, and then it is multiplied on the sample service code MRE to give a final service code MRE. (In effect this moves the MREs from being

calculated on the basis of 90% of the data as we extracted, to being calculated on 100% of the data using a proxy adjustment)

6. multiplied the service code MREs with service code total journeys per day to calculate NRPRs at service code level;
7. mapped service codes to service groups and calculated the NRPRs as a sum of service code NRPRs. MREs at service group level are calculated using service group NRPRs divided by total journeys at the service group level.

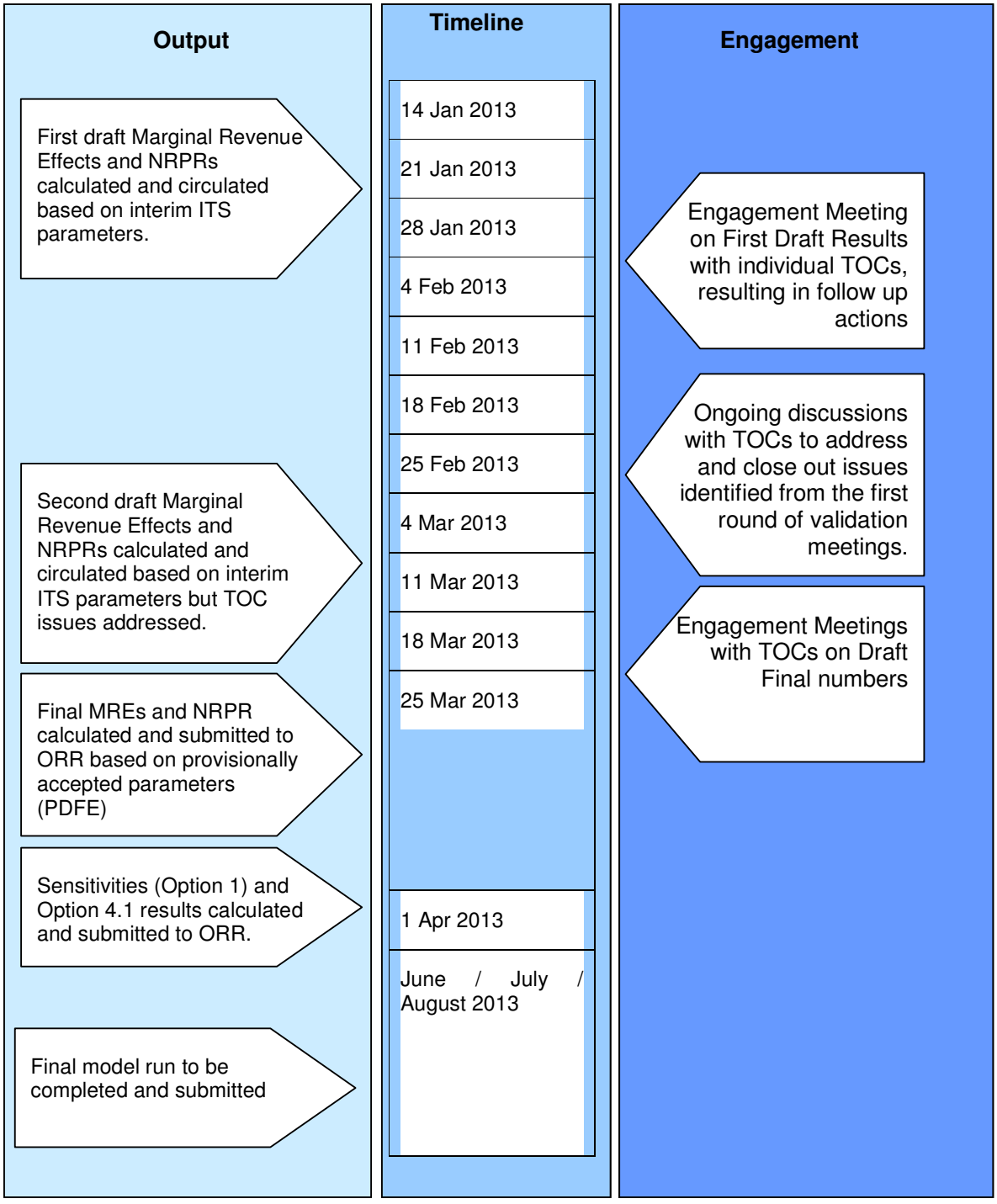
5.4 Stakeholder engagement and validation

5.4.1 Engagement with TOCs

A key element of our work has been to engage with TOCs and NR at individual level in order to discuss and validate the calculations from the Phase A study.

The engagement process with individual TOCs started shortly after our initial workshop in December with a focus on engagement on the method of calculation. This is discussed in more detail in section 3.5. This was followed by an extensive and detailed engagement with all TOCs to discuss the outputs from our modelling exercise. The timeline of engagement with individual TOCs for this element of engagement and how this fits into the final calculated NRPRs and MREs is shown below:

Figure 5.1: Engagement timeline



As the above graphic illustrates, we have maintained extensive engagement with TOCs throughout the period – for TOCs who were willing to engage in the process. For validation, this was done immediately after key outputs were produced - by arranging a validation meeting with each TOC. During these meetings we discussed our findings with TOCs and sought to obtain clarification

or additional information where we had identified either anomalous data or counter-intuitive results. These meetings therefore served as an important sense check to our work. The output from these meetings were actions either on the TOC or Halcrow, to be closed out, based on materiality, prior to issue of the next round of outputs.

The engagement process during Phase A produced a number of actions for Halcrow, recorded and monitored through a comprehensive issues log (see Appendix 8 to this report). In total 146 actions on Halcrow were produced as a result of engagement with TOCs on method and validation of results. Of these, 136 were fully resolved with the remainder of the engagement issues not considered to be material.

5.4.1.1 Modifications made as a result of engagement with TOCs

The specific modifications made after discussions with TOCs related to data processing rather than our overall approach or method. We explain and address the specific changes in the TOC-specific appendices at the end of this report.

A summary of the changes that were made to our analysis as a result of the engagement process are shown below:

- Revised mappings for some flows taking account of TOC specific feedback;
- identification and provision of additional data provided by TOCs that was held outside of LENNON;
- changes due to the use of Travelcard data where appropriate;
- confirmation and revision where appropriate of Airport flows;
- discussion of unmapped flows and any revisions to the base data post these discussions;
- changes to base data where the TOC advised and evidenced an alternative view to that contained in LENNON;
- adjustments to our base data where TOCs advised that multimodal tickets are used and provided supporting evidence to add to our base data;
- adjustments to data to ensure full and reduced tickets were treated appropriately;
- treatment of journeys made by British Transport Police;
- revised approach to commuting split away from a 50/50 split;
- revised approach to Peak Off-Peak allocations, based on further analysis.

5.4.2 Engagement with NR

A level of engagement has been maintained with Network Rail throughout Phase A of the study with members of the NR regulation team. We also undertook engagement with NR individual route managers and teams. The purpose of these meetings was to explain our approach and present the calculated NRPR by service code for the different TOCs. During our meetings we described the process that has been applied by Halcrow in calculating the revised

NRPR and noted any concerns from individual route managers / teams. Although the process was useful to inform NR route managers of our approach and discuss the rates, the process in itself did not alter our calculated NRPR for the different TOCs.

6 Summary of Results [non-confidential figures]

6.1 Introduction

We have produced detailed results for each TOC, for each model scenario, using the method and processes described in Chapter 3. These results were provided to the relevant TOC, using the secure Sharepoint document management system (see Chapter 4.5 for more details). ORR has also been provided with access to all detailed results and the models we have created for each TOC to allow ORR to run any sensitivities they require. We provided NR with as much detail as possible on the results of our calculations, including estimates of Network Rail Payment Rates (NRPRs) for all service groups.

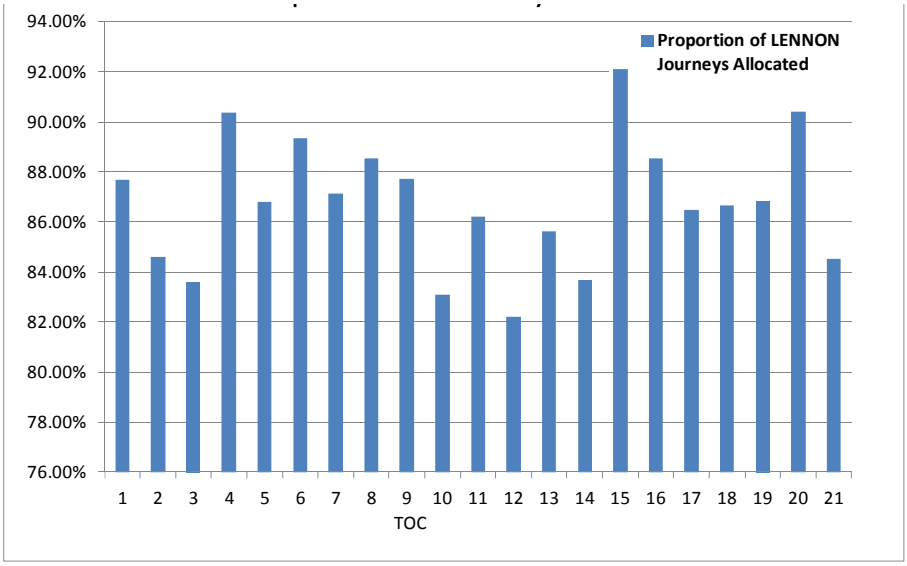
The rest of this Chapter provides some summary information rather than comment on individual TOC results as this is confidential information. Confidential results are summarised in the appendices to this report, which have been provided to ORR.

6.2 Summary of revenue and journeys

6.2.1 Journeys

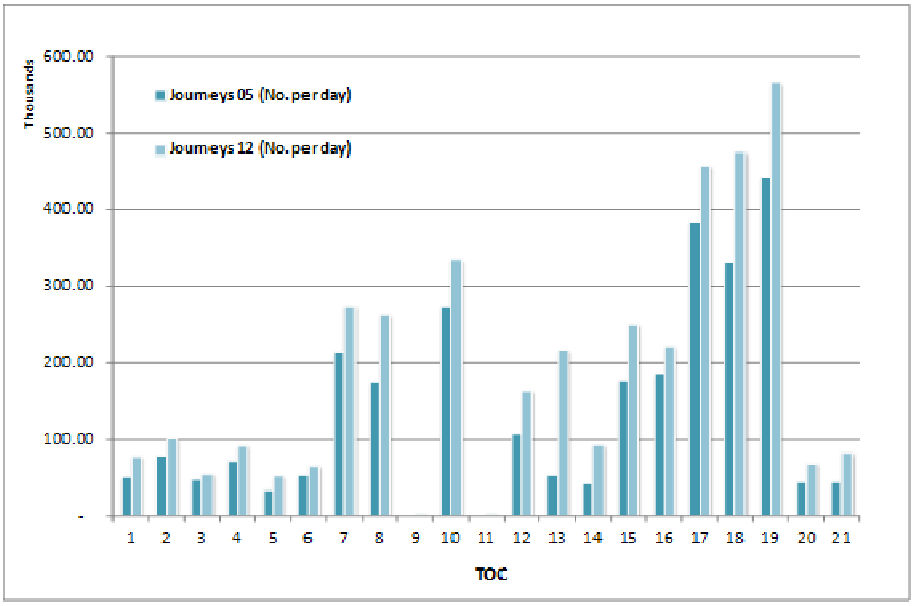
We have been able to allocate more than 80% of all LENNON journeys for all TOCs. The chart below shows the allocation:

Figure 6.1: Proportion of LENNON journeys allocated



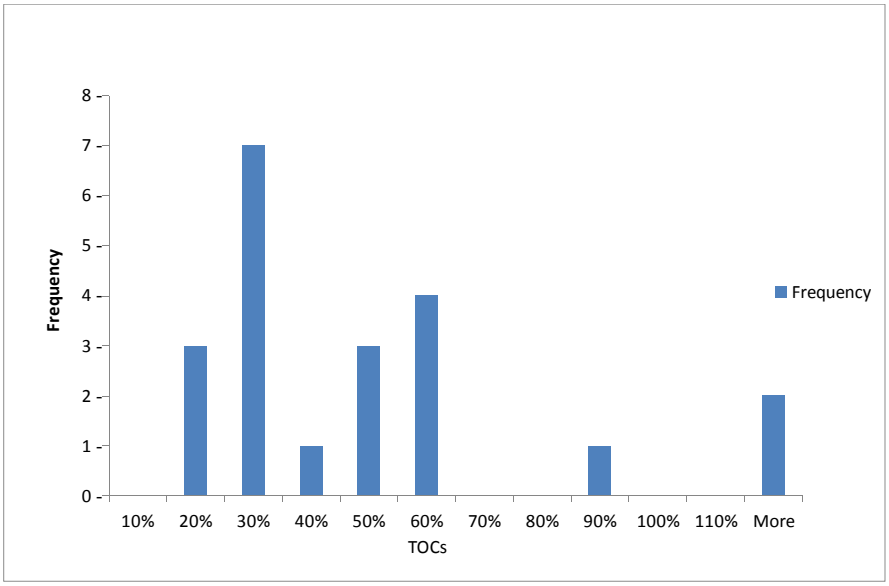
The total number of journeys between 2005 and 2012 has generally increased for each TOC. The total number of journeys for all service groups between 2005 and 2012 has increased from 2.8 million passenger journeys per day to 4 million passenger journeys per day. This represents an increase of 39%. The variance of journeys by TOCs between these periods is illustrated below:

Figure 6.2: Number of journeys per day by TOC based on 2012 service group. Comparison of 2012 with 2005.



Clearly growth rates for different TOCs and service groups vary and this is expected. The data is further impacted by some changes in flows, in some instances flows have been removed whilst in others flows have been added since 2012. The percentage variances in the numbers of journeys by TOC for the TOC as a whole are further illustrated in the chart below:

Figure 6.3: Frequency of variance bands for journeys per day, 2005 compared to 2012 for TOCs



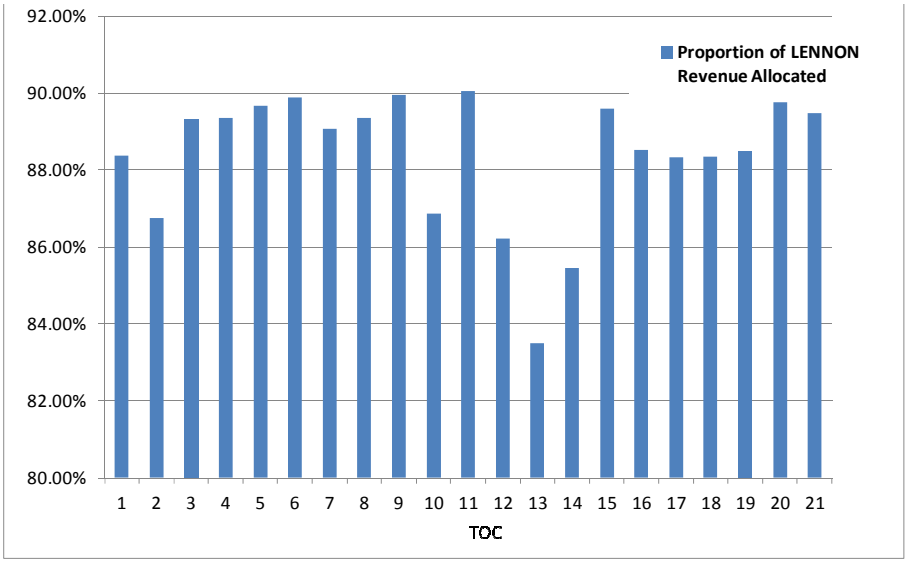
The graph shows that for two TOCs, the percentage variance of total journeys per day between 2005 and 2012 exceeds 100%, one TOC where the percentage variance exceeds 90%, whilst the mode value

is a percentage variance of more than 30% in journeys compared to 2005. No TOC has seen a reduction in journeys compared to 2005.

6.2.2 Revenues

Similar to journeys, we have been able to allocate and thus include a high percentage of LENNON revenues. This is illustrated in the chart below:

Figure 6.4: Proportion of LENNON revenues allocated



The proportion of LENNON revenue that we could allocate directly varies by TOC for several reasons, including the complexity of operations. However, the primary reason for variations in this proportion between TOCs was the integrity of the LENNON data - i.e. the way the LENNON data was coded to geographic locations. For some TOCs, we found that a material proportion of LENNON data did not have a geographic origin or destination, and so required further manual analysis to allocate it to station-to-station flows.

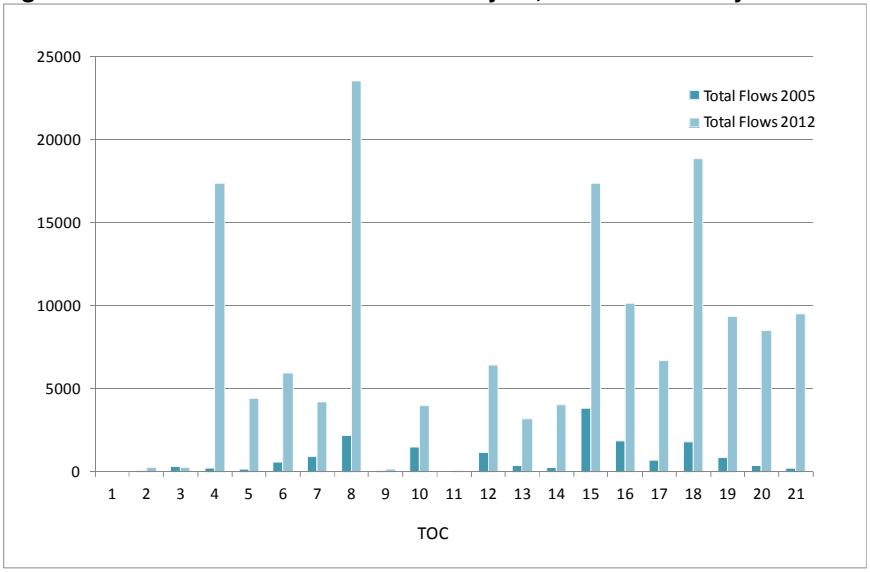
As for the allocation of journeys, for all TOCs we have been able to allocate more than 80% of LENNON revenue data.

6.3 Summary of service code, flow and Late Time Multiplier comparison to 05 study

6.3.1 Flow comparison

Our approach to this study has been to extract the top 90% of revenues from the LENNON system (and any Non-LENNON data provided by TOCs): we have sought to include at least 80% of journeys and revenues in calculating the MRE and NRPRs once the process of mapping raw LENNON data to geographic ODs was complete. This has resulted in a significantly greater number of flows included in our analysis compared to the 2005 AEA analysis for almost all TOCs. The chart below illustrates this for the different TOCs we analysed:

Figure 6.5: Number of flows used in analysis, 2012 vs. 2005 by TOC



6.3.2 Service code comparison

The number of service codes we have included in the 2012 study is 316. This represents a 7% increase on the 295 service codes included in the 2005 study. The difference appears to be primarily due to a change in the structure of the industry and additional service codes introduced between 2005 and 2012.

6.3.3 Late Time Multiplier

The relevant Late Time Multipliers used for our calculation of MREs and NRPR are shown in the table below. This table is shown for comparison with the 2005 AEA study Late Time Multipliers data:

Table 6.1: ITS recommended Late Time Multipliers Option 4

ITS recommended Late Time Multipliers source: PDFHv5 1 Reliability Review v3.2 (09 May 2013)				
	Suburban (less than 20 miles)		**Inter-urban (>20 miles)**	
Flow type	**Commuting**	**Non-commuting**	**Commuting**	**Non-commuting**
London TCA	3.0	2.3	3.9	2.3
South East to/from London	3.0	2.3	3.9	3.4
South East to South East	3.0	2.3	3.9	3.4
London to/from outside LSE	3.0	2.3	3.9	3.0
Non LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

Table 6.2: ITS recommended Late Time Multipliers Option 5

ITS recommended Late Time Multipliers source: PDFHv5 1 Reliability Review v3.2 (09 May 2013)				
	Suburban (less than 20 miles)		Inter-urban (>20 miles)	
Flow type	Commuting	Non-commuting	Commuting	Non-commuting
London TCA	2.5	2.3	2.5	2.3
South East to/from London	2.5	2.3	2.5	2.3
South East to South East	3.0	2.3	3.9	3.4
London to/from outside LSE	2.5	3.0	2.5	3.0
Non LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

The values for the 2005 study are shown below:

Table 6.3: 2005 AEA Late Time Multipliers

2005 AEA Late Time Multipliers source: page 5 of AEA report			
Flow Type	Full Ticket	Reduced Ticket	Season Ticket
Airports	6.5	6.5	6.5
LDHS	6.05	4.21	4.56
Others	2.5	2.5	2.5
LDHS = Long-distance high-speed			

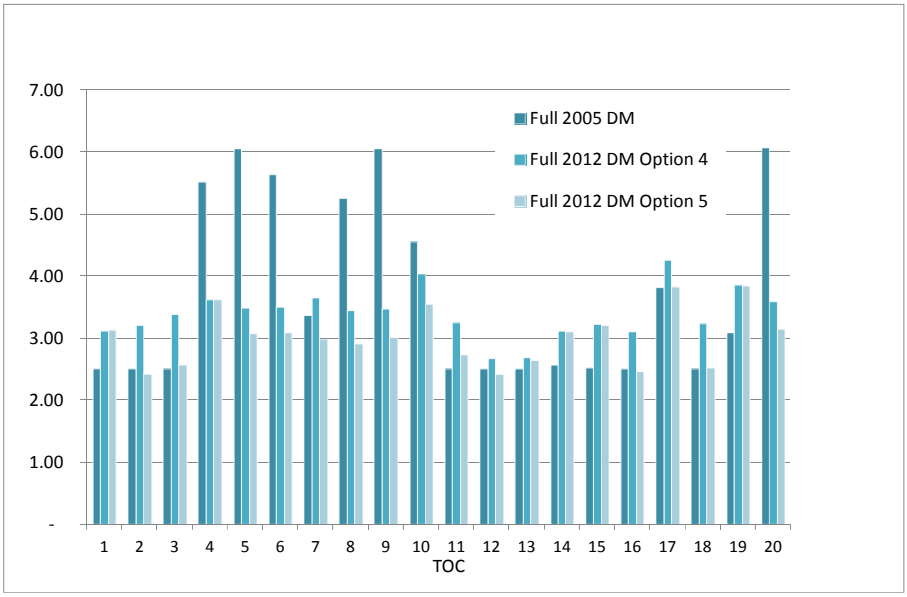
The key points to note between the Late Time Multipliers for the two study periods are as follows:

- The 2005 study is based on Late Time Multipliers by ticket type, whilst the segmentation used for our study is based on distance segmentation;
- the types of flows used are more extensive in our study;
- the variance between ticket types is much less in our study compared to 2005;

More comment on the revised Late Time Multipliers and other elements of ITS work are provided in Chapter 3 above.

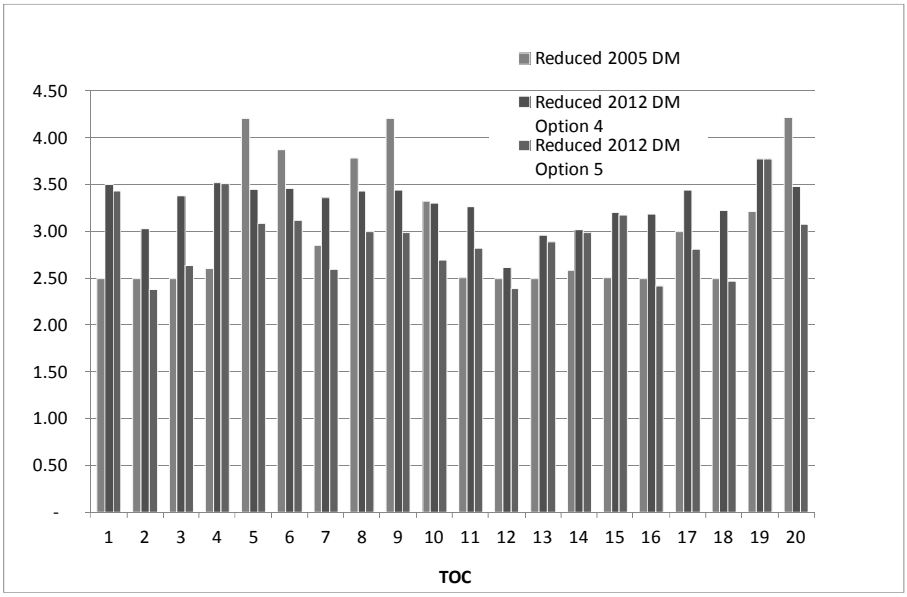
We have undertaken some analysis of the relative weighted average Late Time Multipliers by ticket types between 2005 and 2012. The charts below show the difference by ticket types:

Figure 6.6: Weighted average Late Time Multipliers for full tickets, 2005 vs. 2012



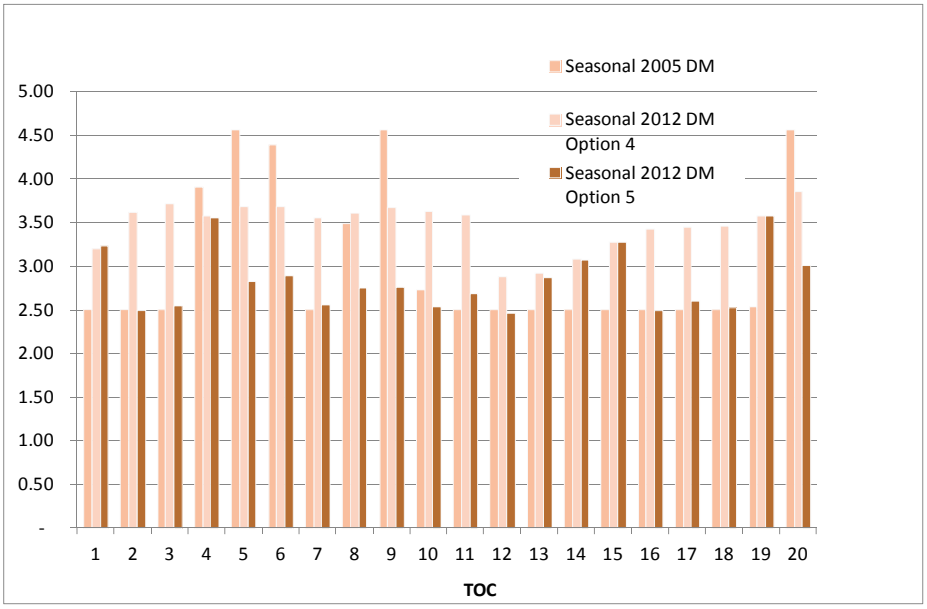
Note: In order to maintain the relevance of comparison we have removed data for one TOC which had no journeys in 2005.

Figure 6.7: Weighted average Late Time Multipliers for reduced tickets, 2005 vs. 2012



Note: In order to maintain the relevance of comparison we have removed data for one TOC which had no journeys in 2005.

Figure 6.8: Weighted average Late Time Multipliers for season tickets, 2005 vs. 2012



Note: In order to maintain the relevance of comparison we have removed data for one TOC which had no journeys in 2005.

The weighted average delay multipliers have reduced between the 2005 AEA study and the current review due to the reduced value of multipliers being assigned to flows on average. This is evident from tables 6.1, 6.2 and 6.3 above.

A further observation is that the variance between average late time multipliers for each ticket type is now much lower than the variances in 2005.

7 Further model runs: sensitivity testing

7.1 Introduction

This Chapter sets out our assumptions used for further model runs requested by ORR and NR. These further model runs represented sensitivity tests around the reference case, by applying alternative combinations of parameters, in order to understand the effect of varying these parameters on estimated MREs and NRPRs.

7.2 Reference case model, Option 4

Option 4 is the reference case model. Option 4 was based on the most recent draft GJT elasticities and late time multipliers proposed for inclusion in the updated PDFH at the time of running the models.

The estimates for Late Time Multipliers and GJT Elasticities used for Option 4 are described in full in Chapter 5 and but repeated here for completeness and for ease of comparison:

Table 7.1: ITS recommended Late Time Multipliers

	Suburban (less than 20 miles)		Inter urban (>20 miles)	
Flow type	Commuting	Non commuting	Commuting	Non commuting
London TCA	3.0	2.3	3.9	3
London to South East	3.0	2.3	3.9	3.4
South East to London	3.0	2.3	3.9	3.4
South East to South East	3.0	2.3	3.9	3.4
London to Outside LSE	3.0	2.3	3.9	3.4
Outside LSE to London	3.0	2.3	3.9	3.0
Outside LSE to South East	3.0	2.3	3.9	3.0
South East to Outside LSE	3.0	2.3	3.9	3.4
Outside LSE to Outside LSE	3.0	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

Source: PDFHv5 1 Reliability Review v3.2

Table 7.2: ITS recommended elasticities*

	Suburban (less than 20 miles)			Inter urban (>20 miles)		
Flow Type	Full	Reduced	Season	Full	Reduced	Season
London TCA	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9
London to South East	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
South East to London	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25
South East to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
London to Outside LSE	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to London	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
South East to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Outside LSE to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Airports*	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25

Source: PDFHv5 1 Reliability Review v3.2

** Airport elasticities are assumed to be the arithmetic average between the airport inbound elasticity and airport outbound elasticity due to the lack of detailed information on airport flows in LENNON.*

** Elasticities are assumed to be same for commuting and non-commuting flow types.*

7.3 Option 4.1

Option 4.1 is a variance on Option 4. It uses the same values as Option 4 but the 2005 AEA values for London and the South East for suburban commuting. The table below illustrates this with the variance highlighted in yellow:

Table 7.3: Late Time Multipliers used for Option 4.1

	Suburban (less than 20 miles)		Inter urban (>20 miles)	
Flow Type	**Commuting**	**Non commuting**	**Commuting**	**Non commuting**
London TCA	2.5	2.3	3.9	3
London to South East	2.5	2.3	3.9	3.4
South East to London	2.5	2.3	3.9	3.4
South East to South East	2.5	2.3	3.9	3.4
London to Outside LSE	3	2.3	3.9	3.4
Outside LSE to London	3	2.3	3.9	3.0
Outside LSE to South East	3	2.3	3.9	3.0
South East to Outside LSE	3	2.3	3.9	3.4
Outside LSE to Outside LSE	3	2.3	3.9	3.4
Airports	6.0	6.0	6.0	6.0

Table 7.4: Elasticities* used for Option 4.1

	Suburban (less than 20 miles)			Inter urban (>20 miles)		
Flow Type	**Full**	**Reduced**	**Season**	**Full**	**Reduced**	**Season**
London TCA	-0.8	-0.8	-0.8	-0.9	-0.9	-0.9
London to South East	-0.9	-0.9	-0.7	-1.25	-1.25	-1.25
South East to London	-0.8	-0.8	-0.7	-1.25	-1.25	-1.25
South East to South East	-1	-1	-0.9	-1.2	-1.2	-1.2
London to Outside LSE	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to London	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35
Outside LSE to South East	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
South East to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Outside LSE to Outside LSE	-1.1	-1.1	-1.1	-1.2	-1.2	-1.2
Airports*	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25

** Airport elasticities are assumed to be the arithmetic average between the airport inbound elasticity and airport outbound elasticity due to the lack of detailed information on airport flows in LENNON.*

** Elasticities are assumed to be same for commuting and non-commuting flow types.*

We note that ORR has used the Option 4 payment rates in its June 2013 draft determination calculations. Examples include the schedule 4 access charge supplemental income and the schedule 8 freight operator payment rate.

7.4 Option 1

The sensitivity analysis we have undertaken for Option 1 uses the 2005 AEA study values for both the elasticities and Late Time Multipliers. These values are provided below:

Table 7.5: 2005 AEA Late Time Multipliers

Flow Type	Full	Reduced Ticket	Season Ticket
Airports	6.5	6.5	6.5
LDHS	6.05	4.21	4.56
Others	2.5	2.5	2.5

Source: page 5 of AEA report

LDHS = Long-distance high-speed

Table 7.6: 2005 AEA GJT Elasticities

Flow Type	Full	Reduced Ticket	Season Ticket
London TCA	-0.8	-0.8	-0.7
London to South East*	-0.82	-0.82	-0.72
South East to London*	-0.82	-0.82	-0.72
South East to South East	-1	-1	-0.9
London to Outside LSE	-0.9	-0.9	-0.9
Outside LSE to London	-0.9	-0.9	-0.9
Outside LSE to South East	-0.9	-0.9	-0.9
South East to Outside LSE	-0.9	-0.9	-0.9
Outside LSE to Outside LSE	-0.9	-0.9	-0.9
Airports	-1.25	-1.25	-1.25

Source: PDFH 5.0, Chapter B4, Journey Time, Frequency and Interchange

** The elasticities for South East to/from London are derived from the elasticities for South East to London and the elasticities for South East from London using weightings as 80/20.*

It should be noted that we have applied a different segmentation to our analysis for Option 1 compared to Option 4 and Option 4.1, as market segments were defined rather differently in the AEA 2005 study.

8 Technical appendices

Appendices Redacted