The Norfolk County Council (Norwich Northern Distributor Road (A1067 to A47(T))) Order

5.10 Public Transport Local Model Validation Report (LMVR)

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1 Key Summary

1.1.1 The primary aim of the public transport model is to provide:

- Accurate representation of public transport usage in both base and forecast years;
- Changes in costs and demand for public transport to feed into the demand model to assess levels of modal transfer.

1.1.2 The model has been developed from surveys that have been carried out over a number of years, most recently surveys of bus patronage were carried out in 2013. The model represents bus and rail services and patronage in Norwich for a base year of 2012.

1.1.3 The model represents the AM peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and the PM peak hour (17:00-18:00) which are consistent with the highway assignment model.

1.1.4 The model has been very successfully calibrated, but in doing this it was not possible to independently validate the assigned flows as all the available on-board count information was used for calibration. This was judged to be the best use of the available data.

1.1.5 Given the role of the model in the appraisal of the Norwich Northern Distributor Road (NDR), it is considered that the public transport model provides a good representation of base year supply and demand as part of the transport model forecasting system.

2 Introduction

2.1.1 Mott MacDonald (MM) has been appointed by Norfolk County Council (NCC) to assist with the development and appraisal of the Norwich Northern Distributor Road, known as the NDR or referred to as the Scheme.

2.1.2 The Scheme would be a dual carriageway all-purpose strategic distributor road, to be classified as the A1270 Principal Road, which would link the A1067 Fakenham Road near Attlebridge, to the A47 Trunk Road (T) at Postwick. This will be over a length of approximately 20.4km.

2.1.3 The NDR is a project of national significance which requires a Development Consent Order (DCO) under the Planning Act 2008 and this formal planning process began in early 2013. It is currently anticipated that the process will be completed in time for the NDR scheme to start construction in 2015 and to be opened in 2017.

2.1.4 This document is one of a number that support the DCO, each of which has its own unique document number, and should therefore be read in conjunction with the other documentation. The proposed layout of the NDR is shown in the General Arrangement Plans contained in document number 2.6, whilst the full needs case for the NDR is explained in the Statement of Reasons (document 4.1) and the Environmental Statement (document 6.1).

2.1.5 Norfolk County Council (NCC) submitted a Major Scheme Business Case (MSBC) for the Norwich Northern Distributor Road (NDR) to the Department for Transport (DfT) in July 2008. Programme Entry for the scheme was granted in January 2010.

2.1.6 In October 2010 as part of the Government's Comprehensive Spending Review, the DfT reviewed the funding of all major local transport schemes. The outcome of this review was that the NDR was included in a Development Pool of schemes. Despite these schemes offering good value for money the DfT invited scheme promoters to undertake some further analysis and submit improved funding bids. These revised funding bids were submitted in September 2011. Ministerial decisions were made in December 2011 to award funding for NDR.

2.1.7 For that purpose Mott MacDonald updated an existing 2006 VISUM Public Transport Model for the September 2011 submission. The aim of the updating was to produce a VISUM model which could provide inputs into the demand model which was in production-attraction format so that the overall modelling

approach complied with the WebTAG guidance. This resulted in the re-building of the base year matrices using origin and destination interview data collected in 2009 for bus and rail services in Norwich. At the same time further enhancements were introduced into the modelling including the development of a more refined zoning system, and the revision of the public transport services. The base year of 2006 was retained during the September 2011 updating.

2.1.8 This report was prepared as part of the DCO submission. For this the public transport model was updated to a 2012 base which complied with the current DfT guidance.

2.1.9 The required 2012 modelling system consisted of three main elements:

- A highway assignment model developed in SATURN software
- A public transport model developed in VISUM software
- A demand model using the DIADEM software

2.1.10 This report details the updating of the VISUM Public Transport (PT) model to 2012, the revision of the public transport services along with their timetables and presents the model calibration achieved following the guidelines contained in WebTAG.

2.1.11 The structure of the report is as follows:

- Chapter 3 details public transport data collection
- Chapter 4 explains supply and assignment model development
- Chapter 5 contains information on matrix calibration using matrix estimation
- Chapter 6 reports model validation results
- Chapter 7 provides conclusions on the 2012 base PT model and
- Appendices contain information on bus surveys and fares
- A glossary and bibliography are included at the end

3 Public Transport Data Collection

3.1 Background

3.1.1 The transport model components were to be brought up to date by rebasing the model to 2012. Whilst the highway surveys were conducted during the autumn of 2012, public transport data was collected in May 2013. It was considered that there would be very little difference between patronage in autumn 2012 and spring 2013, especially for bus data. This was supported by NTEM v6.2 public transport forecasts for Norfolk which are very similar for 2012 and 2013. Any differences would statistically insignificant and would not have any effect on the forecasts for NDR.

3.1.2 The public transport data collection in 2013 comprised the following:

- Bus monitoring counts
- The updating of the bus services running in or around Norwich
- The collection of the timetables of the bus services identified above
- Checking and confirming that rail services remain similar

3.1.3 The gathered information formed the necessary dataset that enabled the model to be calibrated so that the updated 2012 model represented the bus and rail network operation as closely as possible. No further rail patronage information was collected for 2012 PT model rebasing. This was done on the basis that the NDR would have very little impact on rail travel or be affected by that mode as the rail network serves only a limited number of radial routes in the Norwich area.

3.2 Bus Monitoring Counts

3.2.1 Counts of bus passengers were undertaken on an annual basis on a cordon of sites around Norwich until 2008 by the Public Transport Unit (PTU) of NCC. These were one day counts of buses and bus occupancy counts undertaken on on-board buses. However, due to budget constraints the bus monitoring counts were stopped in 2008.

3.2.2 To support the 2012 PT model update and the model calibration exercise a series of on-board bus counts were commissioned and undertaken in May 2013. These replicated the historic sites that were previously surveyed up to

2008 by NCC, and they covered bus stops on a cordon inside the A140/A1042 outer ring road. Several stands at Castle Meadow which are not on above cordon were also surveyed. They are shown in Figure 3.1 below and include the following locations:

- Thorpe Road
- Bracondale
- Long John Hill
- Newmarket Road
- Hall Road
- Constitution Hill
- Plumstead Road
- Bowthorpe Road
- The Avenues
- Earlham Road
- Dereham Road
- Drayton Road
- Aylsham Road
- Catton Grove Road
- Sprowston Road
- Ipswich Road
- Unthank Road
- Castle Meadow – Stands B, E, P, R and W

3.2.3 Each bus stop was surveyed in the AM peak, interpeak and PM peak periods as follows for a total of 9 hours:

- AM Peak 07:30 – 09:30
- Interpeak 10:00 – 12:00 and 13:00 – 15:00
- PM Peak 15:30 – 18:30

3.2.4 Surveys were completed within a single week. Each site was surveyed for one weekday within this week except Castle Meadow stands B, E, P, R and W which were surveyed for the whole week. The counts at Castle Meadow provided day to day variability of bus patronage which was required for the subsequent matrix estimation, and the location of Castle Meadow was chosen because it was noted that many of the bus services included in the updated 2012 model stopped at that location. Survey dates are given below in Table 3.1.

Table 3.1: Survey Dates

Count site(s)	Date
Thorpe Road, Bracondale, Plumstead Road, Castle Meadow	13th May 2013
Long John Hill, Newmarket Road, Hall Road, The Avenue, Ipswich Road, Castle Meadow	14th May 2013
Bowthorpe Road, Earlham Road, Dereham Road, Unthank Road, Castle Meadow	15Th May 2013
Constitution Hill, Catton Grove, Sprowston Road, Castle Meadow	16Th May 2013
Drayton Road, Aylsham Road, Castle Meadow	17Th May 2013

Notes: For each site both inbound and outbound surveys were carried out on the same day.

3.2.5 Patronage counts were undertaken by enumerators boarding the bus services at the survey bus stops. This was done for both directions of travel on each scheduled bus, but excluding Park & Ride buses as these were dealt with separately within the highway assignment model. The following information was gathered for each bus:

- Time of arrival
- Bus service number
- Bus operator
- Bus type
- Number of passenger boarding and alighting
- Number of on-board through-stop passengers (excluding alighting and boarding passengers)

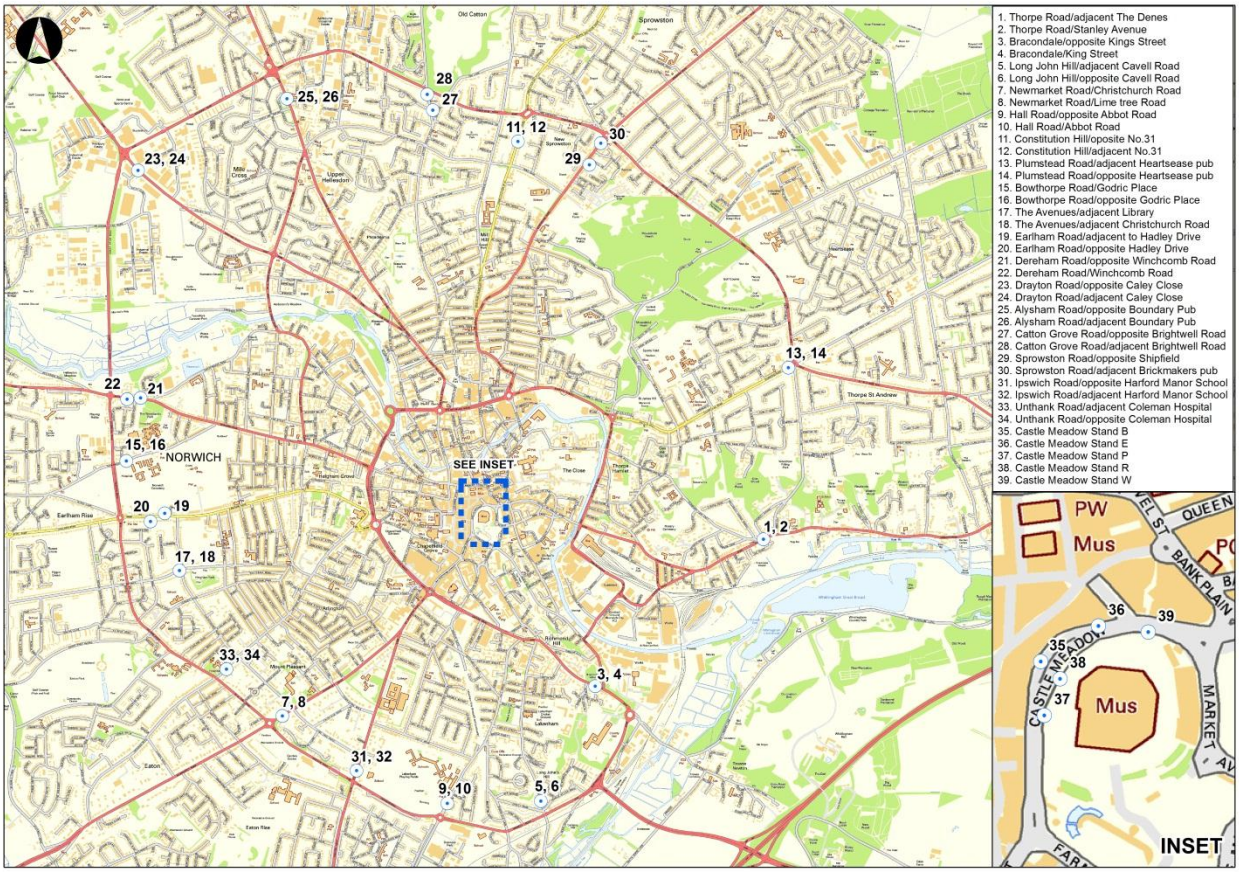
3.2.6 Any buses not stopping (or those that the enumerators were unable to board) were also recorded on the survey sheets with the time, service number, bus type and operator, along with a comment stating that the bus did not stop. The numbers of passengers on board were estimated taking into account the bus type (i.e. double decker, single decker, coach, small bus and bendy bus) and their maximum seating capacities along with the rough enumerator's estimates on the bus. The following maximum capacities were assumed (see Table 3.2).

Table 3.2: Assumed maximum seating capacity

Bus Type	Maximum Seating Capacity
Double Deck	67
Single Deck	42
Coach	47
Small Bus	33

3.2.7 Details of the surveyed bus stop locations and services that pass through these bus stops are included in Appendix A, which also contains summary survey data of the bus on-board through passenger counts.

Figure 3.1: Bus Monitoring Count Locations



3.3 Bus and Rail Service and Timetable Information Collection

3.3.1 There have been significant changes to bus routes and timetables since 2006, and the updated PT model uses February 2013 service and timetables provided by the NCC (http://www.travelineeastanglia.org.uk). Bus timetables also provided up to date information on bus stops. The February 2013 data set was examined for changes from autumn 2012 and other than minor changes in service timings, the timetable used is also considered to represent the 2012 base.

3.3.2 The modelled rail services were compared with the latest timetables and were shown to be very similar, with only minor changes in service timings. Therefore the model is representative of the rail service in the 2012 base.

3.4 Bus and Rail Fares

3.4.1 Bus and rail fares by distance stages for 2006 were available from the 2006 PT model. Real growth in bus and rail fares between 2006 and 2012 was obtained from Railways: fares statistics, "*Standard Note: SN/SG/6384, House of Commons Library, 2013*".

3.4.2 Values of time were obtained from WebTAG 3.5.6 October 2012.

3.4.3 More details on the use of real growth in PT fares and value of time can be found in Section 4.

4 Supply and Assignment Development

4.1 Overview of the Model

4.1.1 Supply and assignment model development is similar to what was reported in the 2011 Public Transport Local Model Validation Report (Norfolk County Council, 2011). There are no changes to modelling time periods or the extent of the model.

4.1.2 The public transport model has been developed to represent the following time periods which are consistent with the highway assignment model.

- AM peak hour - 8:00 am to 9:00 am
- Average interpeak hour - 10:00 am to 4:00 pm
- PM peak hour - 5:00 pm to 6:00 pm

4.1.3 The public transport model represents a base year of 2012. The network structure, rail and bus service patterns and demand are all representative of this year. The demand in the model reflects an average 2012 October weekday.

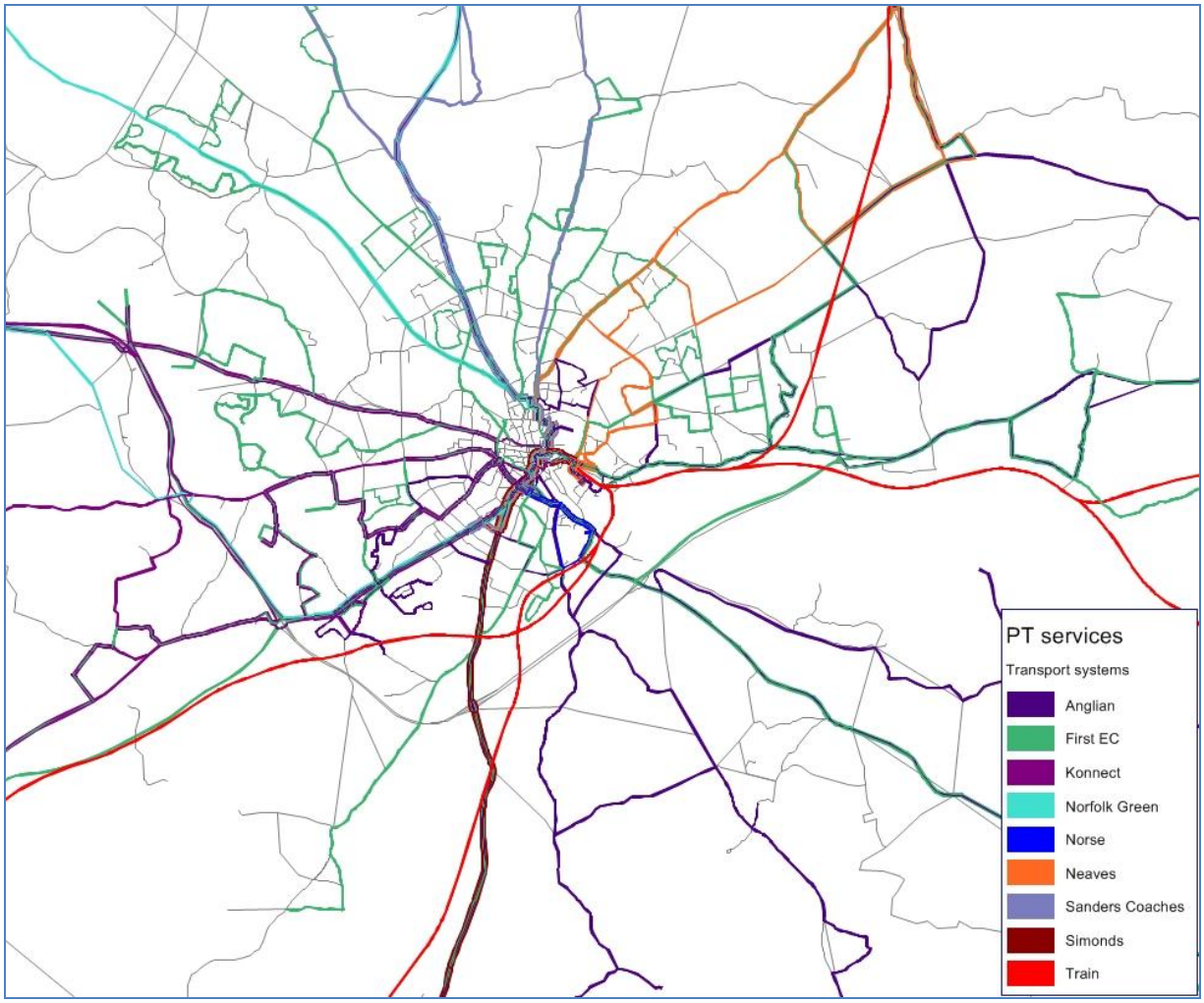
4.1.4 Information on bus service provision in terms of services operating, routeing, frequency, stopping patterns, and journey times were obtained from the service providers/NCC via the information published on-line (http://www.travelineeastanglia.org.uk). A review of the services included in the model was undertaken, and where required these were added/amended as appropriate. The following main bus operators were identified and included in the updated 2012 model:

- EC/First
- Anglian
- Konnect
- Norfolk Green
- Norse
- Neaves
- Sanders Coaches
- Simonds

4.1.5 All timetables relating to the above individual services for each operator were coded into the model between 07:00 and 19:00.

4.1.6 The above changes ensured that bus service network and timetables were representative of the 2012 base service conditions. The rail network was already representative of the base service pattern. Figure 4.1 shows the extent of the public transport network.

Figure 4.1: Extent of the Bus and Rail Network in the Detailed Model Area



4.1.7 The zoning system in the public transport model is consistent with the zoning system used in the highway assignment model. The zoning system has been updated from the zoning system in the 2006 model to include several additional zones mainly representing developments in appropriate detail. The

updated 2012 VISUM PT model contains 413 zones in total. More details on zones can be found in Highway Local Model Validation Report (Mott MacDonald, 2013).

4.2 Assignment Details

4.2.1 The assignment model uses a timetable- (or schedule) based assignment process. This allows fares to be included in the assignment procedure. The Generalised Journey Time (GJT in minutes) of the assignment algorithm, which informs the path search mechanism for the most attractive path for each OD pair, takes the following form:

GJT = (IVT) + 2*(AT) + 2*(ET) + 2*(WT) + 2*(OWT) + 2*(TWT) + TF + Fare

4.2.2 Where

- IVT - in-vehicle time
- AT and ET - access and egress time
- WT - walking time
- OWT and TWT - origin and transfer waiting time
- TF = 7.5 - Transfer penalty (minutes) per number of transfers

4.2.3 As the GJT calculation includes fares, appropriate values of time and fare coefficients were required. Model operates in units of generalised time hence the fare coefficient is the time equivalent (in minutes) of a £1 fare. Values of time were calculated from WebTAG Unit 3.5.6 October 2012 and appropriate fare coefficients calculated. Value of times (VOT) in 2010 prices and fare coefficients can be found in Table 4.1 below for the assignment user classes that were retained from the previous 2006 model, i.e. Commuting, Employers' Business and Other.

Table 4.1: Value of time and corresponding fare coefficient by user class

User class	Perceived value of time (£/hr 2010 prices)		2012 fare coefficient (min/£)
	2010	2012	
Employers' business	21.69	21.70	2.77
Commuting	6.46	6.46	9.29
Other	5.71	5.71	10.51

Source: WebTAG unit 3.5.6 October 2012

4.2.4 Real growth in bus and rail fares between 2006 and 2012 were first calculated using data collected from Railways: fares statistics, "*Standard Note: SN/SG/6384, House of Commons Library, 2013",* and can be found in Table 4.2 below. 2006 distance based fares were then uplifted to 2012 level by applying real growth in fare. Since above fares are still in 2002 prices these were then uplifted to 2010 prices by applying growth in the retail price index between 2002 and 2010 which is 26.9% (RPI from Table A3, SN/SG/6384, House of Commons Library 2013). Distance based PT fares for the First and Anglian bus operators and rail are given in Appendix B, noting that the same First fares were also used for the remaining bus operators given the lack of available 2012 information.

Table 4.2: Real Growth in PT Fares between 2006 and 2012

Year	PT fare index	
	Bus fare	Rail fare
2006	126	131
2012	144	150
Real growth 2006 to 2012	14.3%	14.5%

Source: Table A4, SN/SG/6384, House of Commons Library 2013, 1987=100

5 Model Calibration

5.1 Overview

5.1.1 No new PT matrix building exercise was carried out for the 2012 PT model update. However, instead of relying on the validated 2006 PT matrices, the 2012 Present Year Validation (PYV) PT matrices (bus + rail) developed for the Postwick Hub Study were used as "prior" matrices for the 2012 matrix estimation (ME) process which was used for the model updating.

5.1.2 As mentioned in Section 3 on-board bus counts carried out at 17 count locations were used in the matrix estimation process. The Castle Meadow bus stops which were surveyed for the whole week provided the day-to-day variability or a tolerance for the counts used within the ME process.

5.1.3 No rail counts were undertaken in 2012, and therefore the PT matrix calibration excluded rail.

5.2 Matrix Calibration using Matrix Estimation (ME)

5.2.1 The Matrix Estimation (ME) was carried out using VISUM's matrix correction tool TFlowFuzzy. All demand segment matrices were adjusted using the matrix estimation process.

5.2.2 On-board through bus passenger counts for the AM and PM peak hours were directly available from the surveys. On-board through bus passenger counts for the average interpeak hour were derived from the 10:00 - 15:00 and 15:30 - 16:00 data where the latter period was uplifted so that data for the whole hour from 15:00 - 16:00 could be derived.

5.2.3 The ME process used the 2012 Postwick PYV PT matrices as prior matrices, and these were adjusted by TFlowFuzzy to match the May 2013 observed on-board bus through counts. The goodness of fit of the matrix estimation was assessed by comparing the modelled passenger flows against the corresponding observed figures for each modelled time peak hour in the AM, PM and average Inter-peak. WebTAG 3.11.2 indicates that modelled flows should be within 25% of the counts except where observed flows are particularly low (less than 150) for individual links. Moreover it requires at least 85% of the links to have GEH less than 5. As before GEH value of 5 is considered as appropriate maximum limit since this can be applied to any observed flow. All flow comparisons were undertaken at the hourly level.

5.2.4 Table 5.1 provides a summary of the number of individual sites achieving the GEH calibration criteria, and Table 5.2 to Table 5.4 provide detailed comparisons of observed and modelled flows for bus for individual time periods. These indicate that as a result of the matrix calibration process the modelled passenger flows show an excellent match with the observations in all peak hours with GEH statistics well below the recommended value of 5.

Table 5.1: Site Calibration - Summary

Peak	No of Sites	Inbound		Outbound	
		No GEH <5	% GEH <5	No GEH <5	% GEH <5
AM 08:00-09:00*	16	16	100	16	100
Average IP 10:00-16:00	17	17	100	17	100
PM 17:00-18:00	17	17	100	17	100

Notes: *Observed passenger counts were not available for one of the sites in the AM peak due to an incident

Table 5.2: Bus Passenger Flow Calibration – AM Peak Hour 08:00-09:00

Location	Inbound						Outbound					
	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met
Thorpe Rd	213	207	6	-3%	0.41	1	143	136	7	-5%	0.55	1
Bracondale	312	305	7	-2%	0.38	1	107	107	0	0%	0.02	1
Long John Hill	34	33	1	-1%	0.09	1	1	0	1	-100%	1.41	1
Hall Rd	67	61	6	-9%	0.75	1	16	17	1	6%	0.25	1
Ipswich Rd	146	151	5	3%	0.41	1	14	15	1	7%	0.26	1
Newmarket Rd	316	303	13	-4%	0.72	1	101	104	3	3%	0.30	1
Unthank Rd	75	78	3	4%	0.37	1	74	69	5	-6%	0.53	1
The Avenue	2	4	2	100%	1.15	1	1	2	1	100%	0.82	1
Earlham Rd*	-	-	-	-	-	-	-	-	-	-	-	-
Bowthorpe Rd	53	53	1	1%	0.07	1	28	29	1	4%	0.19	1
Dereham Rd	181	183	3	1%	0.19	1	75	74	1	-1%	0.09	1
Drayton Rd	137	135	2	-1%	0.17	1	26	27	1	4%	0.19	1
Aylsham Rd	159	142	17	-11%	1.39	1	26	27	1	4%	0.19	1
Catton Grove Rd	36	37	1	3%	0.17	1	5	7	2	40%	0.82	1
Constitution Hill	118	109	9	-7%	0.80	1	14	10	4	-29%	1.15	1
Sprowston Rd	50	53	3	6%	0.42	1	35	36	1	4%	0.21	1
Plumstead Rd	83	81	2	-2%	0.22	1	35	35	0	0%	0.00	1
Total	1979	1935	44	-2%	1.00	1	699	695	4	-1%	0.16	1

Notes: *No data was available at this site for AM peak due to an incident

Table 5.3: Bus Passenger Flow Calibration – Average Interpeak hour 10:00-16:00

Location	Inbound						Outbound					
	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met
Thorpe Rd	91	89	2	-2%	0.17	1	100	99	1	-1%	0.11	1
Bracondale	127	127	0	0%	0.01	1	187	185	2	-1%	0.13	1
Long John Hill	13	13	0	3%	0.11	1	5	6	1	25%	0.52	1
Hall Rd	26	24	2	-8%	0.42	1	38	35	3	-8%	0.50	1
Ipswich Rd	30	33	3	11%	0.60	1	75	77	2	3%	0.28	1
Newmarket Rd	145	139	6	-4%	0.53	1	147	147	0	0%	0.02	1
Unthank Rd	85	86	1	1%	0.11	1	86	85	1	-1%	0.11	1
The Avenue	3	3	0	-6%	0.11	1	4	4	0	-9%	0.20	1
Earlham Rd	116	116	0	0%	0.04	1	165	164	1	-1%	0.10	1
Bowthorpe Rd	74	72	2	-2%	0.21	1	121	117	4	-3%	0.35	1
Dereham Rd	114	115	1	1%	0.11	1	147	146	1	-1%	0.11	1
Drayton Rd	69	69	0	0%	0.01	1	74	74	0	-1%	0.05	1
Aylsham Rd	103	88	15	-14%	1.51	1	151	150	1	-1%	0.11	1
Catton Grove Rd	21	22	1	5%	0.22	1	26	28	2	7%	0.35	1
Constitution Hill	73	66	7	-10%	0.87	1	59	52	7	-12%	0.94	1
Sprowston Rd	67	69	2	4%	0.30	1	60	62	2	4%	0.29	1
Plumstead Rd	59	57	2	-3%	0.20	1	68	68	0	0%	0.02	1
Total	1213	1188	25	-2%	0.73	1	1514	1499	15	-1%	0.37	1

Table 5.4: Bus Passenger Flow Calibration – PM Peak hour 17:00-18:00

Location	Inbound						Outbound					
	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met	Observed	Modelled	Abs. Diff	% Diff (M-O)/O	GEH	GEH Criteria met
Thorpe Rd	192	176	16	-8%	1.18	1	203	197	6	-3%	0.42	1
Bracondale	73	73	0	0%	0.03	1	314	307	7	-2%	0.38	1
Long John Hill	21	19	2	-10%	0.45	1	11	13	3	24%	0.73	1
Hall Rd	16	13	3	-19%	0.79	1	39	36	3	-8%	0.49	1
Ipswich Rd	13	15	2	15%	0.53	1	195	197	3	1%	0.18	1
Newmarket Rd	76	80	4	6%	0.48	1	128	130	2	2%	0.18	1
Unthank Rd	113	107	6	-5%	0.57	1	82	81	1	-1%	0.11	1
The Avenue	1	2	1	100%	0.82	1	3	4	1	33%	0.53	1
Earlham Rd	91	91	0	0%	0.00	1	99	102	3	3%	0.30	1
Bowthorpe Rd	27	27	0	0%	0.00	1	192	183	9	-5%	0.68	1
Dereham Rd	70	69	1	-2%	0.15	1	235	231	4	-2%	0.28	1
Drayton Rd	62	61	1	-2%	0.16	1	140	137	3	-2%	0.25	1
Aylsham Rd	32	29	3	-9%	0.50	1	92	94	2	2%	0.21	1
Catton Grove Rd	7	8	1	14%	0.37	1	57	58	1	2%	0.13	1
Constitution Hill	3	4	1	33%	0.53	1	91	81	10	-11%	1.08	1
Sprowston Rd	19	21	2	11%	0.45	1	51	54	3	6%	0.41	1
Plumstead Rd	11	13	2	18%	0.58	1	82	81	1	-1%	0.11	1
Total	827	808	19	-2%	0.67	1	2013	1986	27	-1%	0.61	1

5.3 Impacts of the ME process

5.3.1 The impacts of matrix estimation on the structure of the matrix were investigated by looking at sectoral changes (see Figure 5.1) in the matrix and changes in the trip length distributions. The sector system used here is consistent with the sector system used in highway model validation checks.

5.3.2 Sectoral changes to the matrix in each time period are presented in Table 5.5 to Table 5.10. These include absolute change and GEH. The overall change in demand from the ME process is a reduction in the 2012 modelled demand of 18% in the AM peak hour, 0% in the inter peak hour and 14% in the PM peak hour.

5.3.3 The comparisons indicate that in the peak hour time periods the impact of matrix estimation is to decrease the size of the matrix and thus the prior matrices had overestimated PT demand in the peak hours. The key impact is to modify trips between a few sector movements and this is consistent in the time periods. Overall, those movements most impacted upon by matrix estimation are not key movements in respect to the proposed NDR.

Figure 5.1: Sectors for Matrix Comparisons

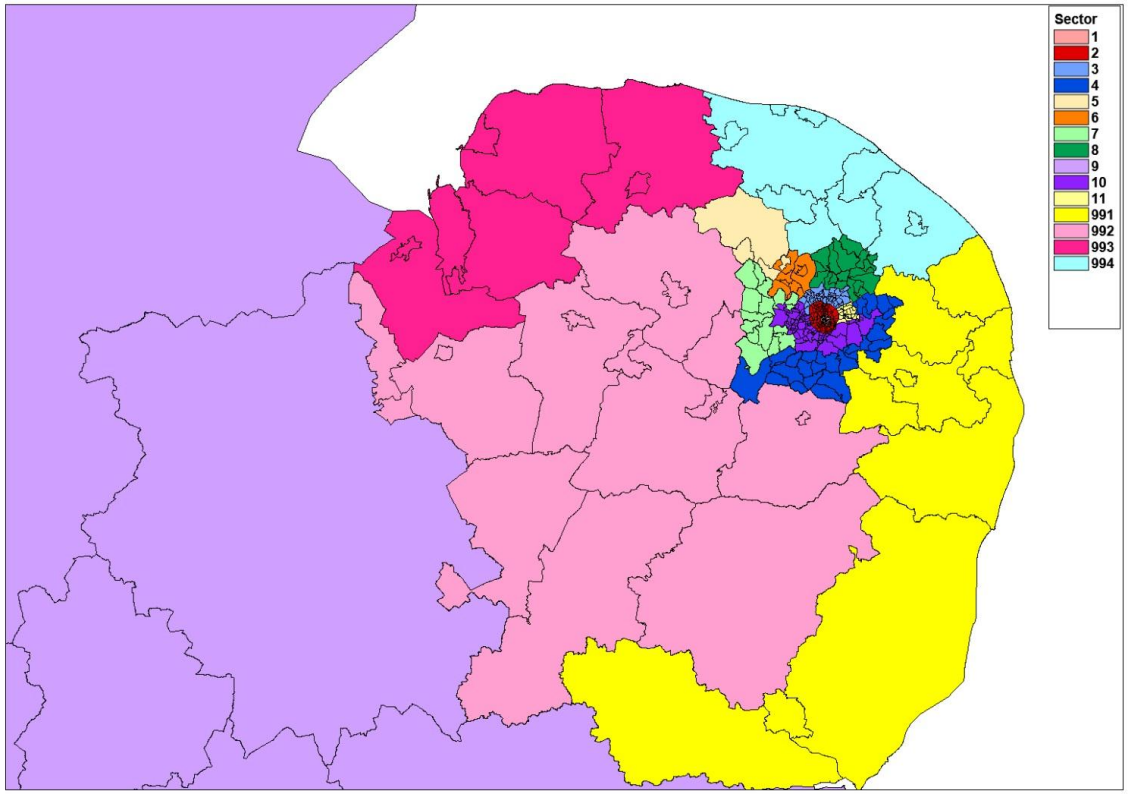


Table 5.5: Impact of Matrix Estimation AM Peak – Absolute Change

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994	Total
1	0	-18	-54	-13	-1	-18	-17	-24	0	-76	-4	-9	-7	-1	-9	-250
2	-69	-33	-58	-9	-1	-22	-14	-6	0	-79	0	-34	-15	-1	-52	-393
3	-81	-29	-3	0	0	0	-2	0	0	-6	1	0	-3	-2	0	-126
4	-42	-10	-1	0	0	0	0	0	0	-2	0	-1	-1	0	0	-59
5	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2
6	-21	-6	0	0	0	0	0	0	0	-1	0	0	0	0	0	-30
7	20	4	-1	0	0	0	0	0	0	-2	1	2	-1	0	0	21
8	-88	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	-92
9	0	0	0	0	0	-5	0	0	0	-2	0	0	0	0	0	-7
10	-208	-83	-8	-1	0	-3	-3	-2	0	-9	0	-1	-5	0	-6	-330
11	-9	0	-3	0	0	0	0	0	0	-2	0	0	0	0	0	-15
991	-8	-70	-2	0	0	0	-1	0	0	-2	0	0	0	0	-8	-91
992	-24	-55	-3	-1	0	0	-2	-1	0	-17	-3	0	-1	0	-5	-113
993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
994	-21	-19	-1	0	0	0	-1	0	0	-2	-1	0	-2	0	0	-46
Total	-552	-323	-134	-25	-3	-49	-41	-33	0	-201	-5	-43	-36	-4	-82	-1532

Table 5.6: Impact of Matrix Estimation AM Peak – GEH

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994
1	0.0	1.0	7.2	2.5	1.1	4.4	3.5	4.3	0.0	6.1	0.6	1.8	1.7	0.9	3.4
2	1.8	1.8	7.9	1.7	1.4	4.6	3.1	1.5	0.0	4.6	0.0	3.4	1.8	0.6	7.1
3	4.5	3.4	1.1	0.0	0.0	0.1	1.1	0.0	0.0	1.5	0.4	0.2	1.3	1.4	0.4
4	3.8	1.8	1.1	0.0	0.1	0.2	0.3	0.0	0.1	0.3	0.1	0.3	0.2	0.1	0.4
5	0.4	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.1	0.0	0.1	0.0	0.0
6	2.0	1.1	0.0	0.0	0.0	0.0	0.3	0.1	0.2	0.8	0.2	0.0	0.3	0.0	0.7
7	1.9	0.6	0.8	0.3	0.0	0.1	0.0	0.1	0.0	0.4	0.4	0.7	0.7	0.0	0.4
8	9.2	1.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.3	0.0	0.0
9	0.0	0.0	0.0	0.2	0.3	2.7	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
10	8.6	5.1	2.6	0.2	0.4	1.9	0.8	1.3	0.1	0.9	0.1	0.3	1.3	0.3	2.9
11	0.7	0.0	1.4	0.2	0.1	0.2	0.3	0.2	0.0	0.6	0.0	0.0	0.1	0.1	0.2
991	0.7	4.1	1.1	0.1	0.4	0.3	0.7	0.1	0.0	0.7	0.1	0.0	0.0	0.1	3.2
992	3.8	4.7	2.0	0.2	0.4	0.9	1.0	0.8	0.0	2.8	0.8	0.1	0.3	0.3	2.4
993	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
994	5.0	2.9	0.5	0.3	0.1	0.4	0.7	0.0	0.0	1.3	0.5	0.2	0.9	0.0	0.1

Table 5.7: Impact of Matrix Estimation Interpeak – Absolute Change

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994	Total
1	0	-4	1	-9	0	7	3	-25	0	78	-1	7	-7	0	-5	45
2	3	0	-2	-4	0	3	1	-1	1	50	0	7	-14	0	2	46
3	7	6	3	0	0	0	4	0	0	14	0	1	-2	0	0	34
4	-23	-7	0	0	0	0	0	0	0	0	0	0	0	0	0	-31
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
7	8	4	2	0	0	0	0	0	0	1	0	1	0	0	0	17
8	-17	0	1	0	0	0	0	0	0	1	0	0	0	0	0	-15
9	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	4
10	0	7	3	0	0	0	-1	0	0	1	0	0	-6	0	0	5
11	12	5	1	0	0	0	0	0	0	3	0	1	0	0	0	22
991	-4	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	-4
992	-16	-45	-2	-2	0	-1	-2	-1	0	-12	-5	-1	-1	0	-3	-91
993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
994	-4	-6	0	0	0	0	0	0	-1	-1	0	0	0	0	0	-12
Total	-34	-38	6	-14	0	11	7	-27	0	136	-7	15	-32	0	-5	21

Table 5.8: Impact of Matrix Estimation Interpeak – GEH

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994
1	0.0	0.2	0.1	1.2	0.2	1.1	0.5	3.6	0.0	4.3	0.1	1.0	1.7	0.2	1.6
2	0.1	0.0	0.2	0.9	0.2	0.7	0.3	0.4	0.1	3.4	0.1	0.7	1.6	0.1	0.3
3	0.6	0.8	1.1	0.2	0.0	0.2	1.9	0.0	0.0	3.4	0.2	0.6	1.0	0.0	0.0
4	3.8	1.7	0.1	0.0	0.0	0.1	0.1	0.0	0.4	0.0	0.2	0.0	0.0	0.1	0.1
5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0
6	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.1	0.6	0.0	0.0
7	1.3	0.8	1.1	0.2	0.1	0.2	0.0	0.5	0.1	0.3	0.2	0.5	0.2	0.0	0.2
8	2.5	0.0	0.7	0.0	0.0	0.2	0.8	0.0	0.7	0.4	0.0	0.0	0.2	0.0	0.0
9	0.0	0.1	0.0	0.2	0.0	0.3	0.1	0.0	0.0	0.6	0.0	0.1	0.0	0.0	0.4
10	0.0	0.5	0.8	0.0	0.2	0.2	0.1	0.2	0.2	0.1	0.0	0.1	1.3	0.1	0.0
11	1.4	0.9	0.6	0.0	0.0	0.2	0.3	0.0	0.0	0.9	0.0	0.4	0.0	0.0	0.0
991	0.6	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1
992	4.0	5.6	1.6	0.6	0.4	1.1	1.1	1.2	0.0	2.9	2.4	0.3	0.2	0.3	2.0
993	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0
994	1.3	1.0	0.2	0.1	0.0	0.1	0.1	0.0	0.4	0.3	0.0	0.1	0.2	0.1	0.0

Table 5.9: Impact of Matrix Estimation PM Peak – Absolute Change

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994	Total
1	-7	-160	-21	-6	0	3	-18	-56	0	20	4	19	-13	1	-15	-249
2	-35	-49	-15	-4	0	3	-6	-2	-29	13	4	4	-26	0	-22	-166
3	-40	-36	-3	-1	0	0	-1	0	0	-6	-3	-1	-2	0	0	-93
4	-10	-8	0	-3	0	0	0	0	0	-3	0	-1	0	0	0	-25
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	-3	0	0	0	0	0	0	0	-3	-1	0	0	0	0	0	-8
7	-17	-12	-2	0	0	0	-7	0	0	-3	0	-1	-1	0	0	-46
8	-18	-4	0	-1	0	0	0	-10	0	-1	0	0	0	0	-3	-37
9	0	-44	0	0	0	0	0	0	0	-1	0	0	0	0	-1	-47
10	-57	-15	-3	-3	0	-1	-3	1	-2	-16	-2	-2	-4	0	-1	-106
11	6	19	2	0	0	0	0	0	0	3	0	2	4	0	0	37
991	-4	-10	0	-1	0	0	-1	0	0	0	0	-5	-1	0	0	-22
992	-4	-24	0	-1	0	-1	-1	1	0	-5	0	-2	-1	0	-1	-39
993	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
994	-7	-32	0	0	0	0	0	-2	0	-4	0	-3	-3	0	-1	-52
Total	-195	-374	-41	-21	-2	3	-38	-69	-35	-3	4	12	-49	1	-46	-853

Table 5.10: Impact of Matrix Estimation PM Peak – GEH

Sector	1	2	3	4	5	6	7	8	9	10	11	991	992	993	994
1	1.1	5.4	1.4	0.6	0.3	0.3	2.4	6.6	0.1	0.9	0.4	1.9	2.0	0.6	4.0
2	2.1	3.0	2.0	0.7	0.3	0.4	1.1	0.8	2.0	0.8	0.6	0.3	2.6	0.1	3.7
3	5.9	5.7	1.1	0.9	0.1	0.2	1.0	0.2	0.0	2.1	1.5	0.7	1.6	0.1	0.6
4	2.1	1.7	0.0	0.6	0.0	0.1	0.0	0.2	0.1	0.6	0.3	0.4	0.1	0.1	0.3
5	0.2	0.2	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.1
6	0.7	0.1	0.2	0.1	0.1	0.1	0.2	0.0	2.2	0.3	0.1	0.1	0.3	0.0	0.2
7	3.9	3.3	1.4	0.4	0.1	0.4	1.0	0.2	0.1	1.1	0.5	0.7	0.6	0.0	0.7
8	3.7	1.2	0.2	0.3	0.1	0.0	0.1	1.2	0.0	0.8	0.0	0.2	0.5	0.0	0.7
9	0.0	2.6	0.0	0.2	0.1	0.3	0.0	0.2	0.0	0.3	0.0	0.2	0.2	0.0	0.4
10	4.7	0.9	0.8	0.7	0.3	0.6	0.8	1.0	1.2	1.6	0.6	0.7	0.7	0.0	0.8
11	1.1	2.7	1.0	0.1	0.1	0.4	0.3	0.0	0.0	1.1	0.2	1.2	1.2	0.2	0.2
991	1.0	1.1	0.1	0.4	0.0	0.1	0.5	0.1	0.0	0.1	0.1	0.8	0.4	0.0	0.4
992	1.2	3.0	0.0	0.4	0.4	0.8	0.5	0.8	0.1	1.4	0.2	0.8	0.4	0.1	0.6
993	0.3	0.2	0.4	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.0
994	2.8	4.8	0.4	0.3	0.0	0.5	0.2	0.6	0.2	2.1	0.2	1.3	1.9	0.0	0.4

5.3.4 Changes in trip length distribution as a result of matrix estimation are shown in Figure 5.2 to Figure 5.10 by purpose and time period. The comparisons indicate that the 2012 matrix estimation process resulted in small increases in both short and long distance trips and a small reduction in medium distance trips, and this is consistent across all journey purposes and time periods.

Figure 5.2: Comparison of Trip Length Distribution – Commute AM Peak

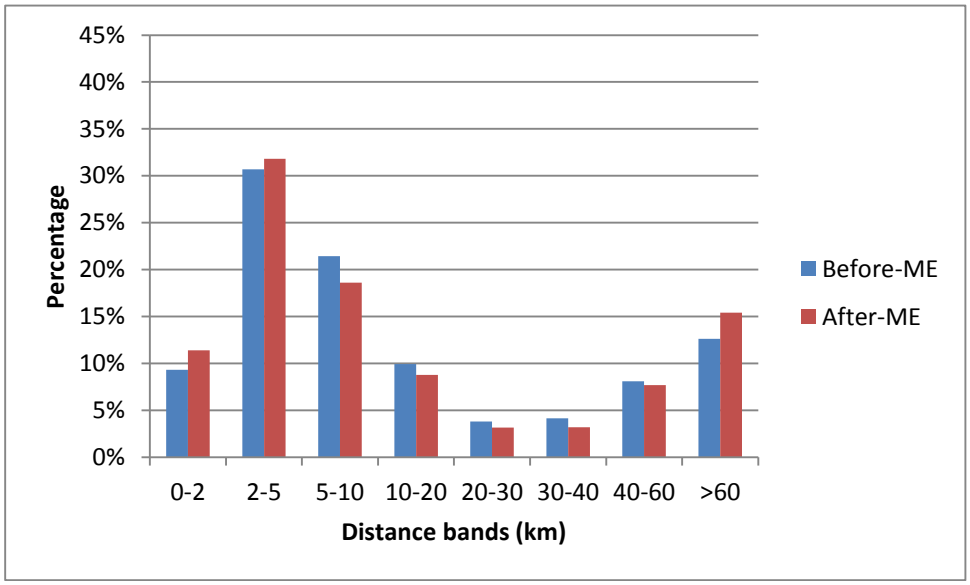


Figure 5.3: Comparison of Trip Length Distribution – Employers Business AM Peak

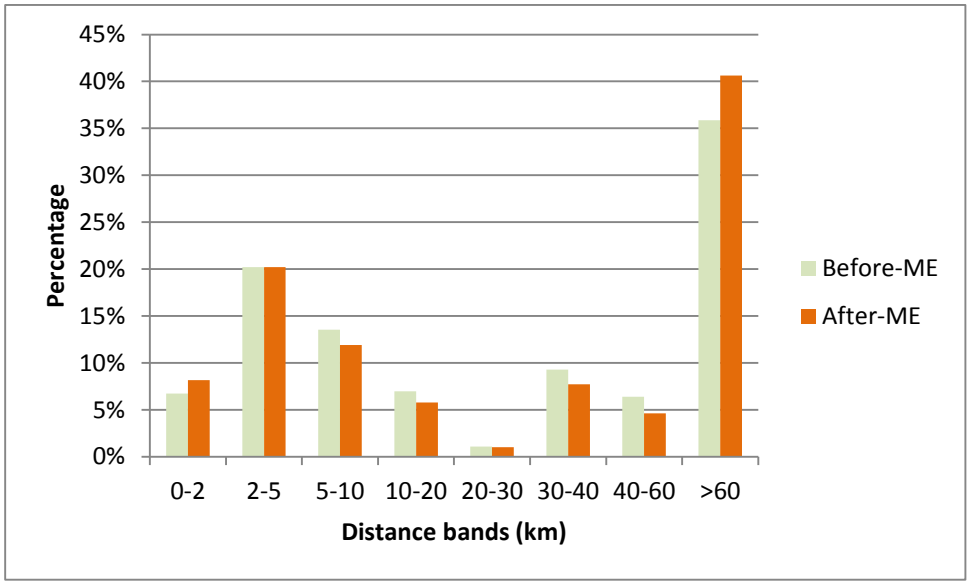


Figure 5.4: Comparison of Trip Length Distribution – Other AM Peak

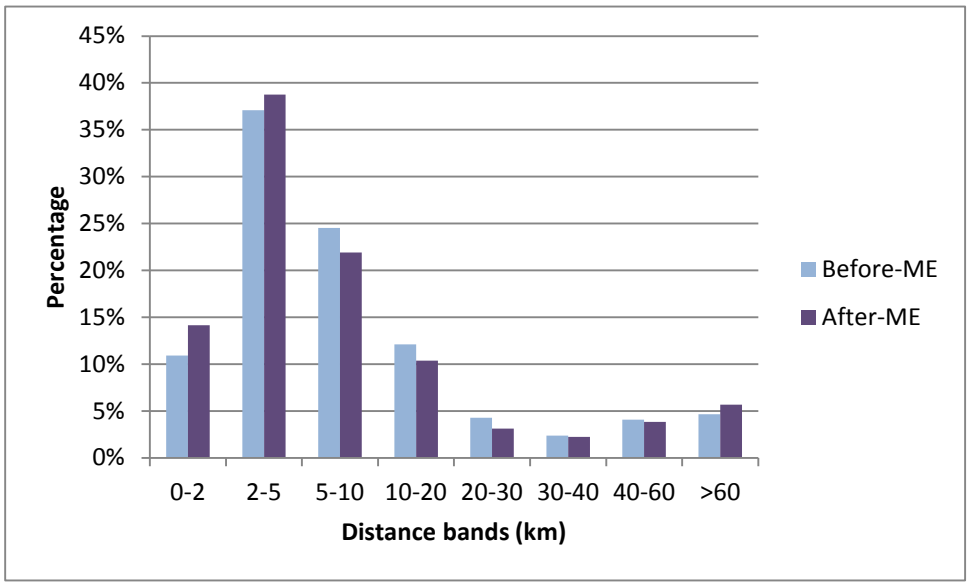


Figure 5.5: Comparison of Trip Length Distribution – Commute Interpeak

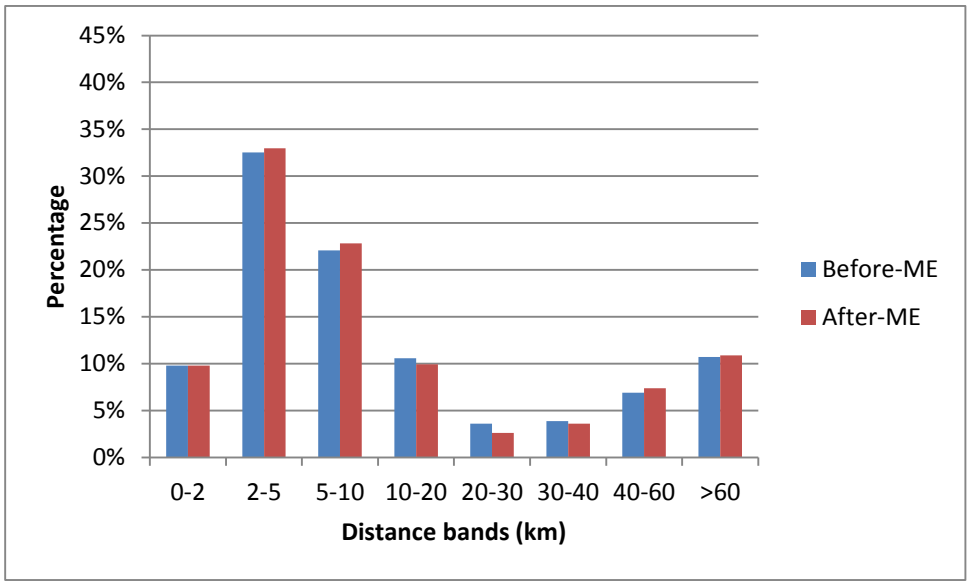


Figure 5.6: Comparison of Trip Length Distribution – Employers Business Interpeak

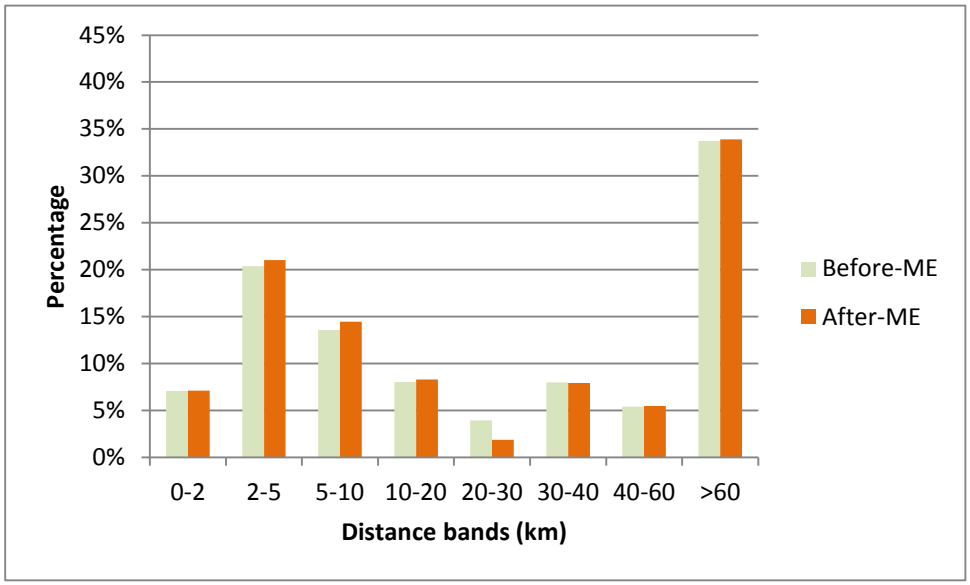


Figure 5.7: Comparison of Trip Length Distribution – Other Interpeak

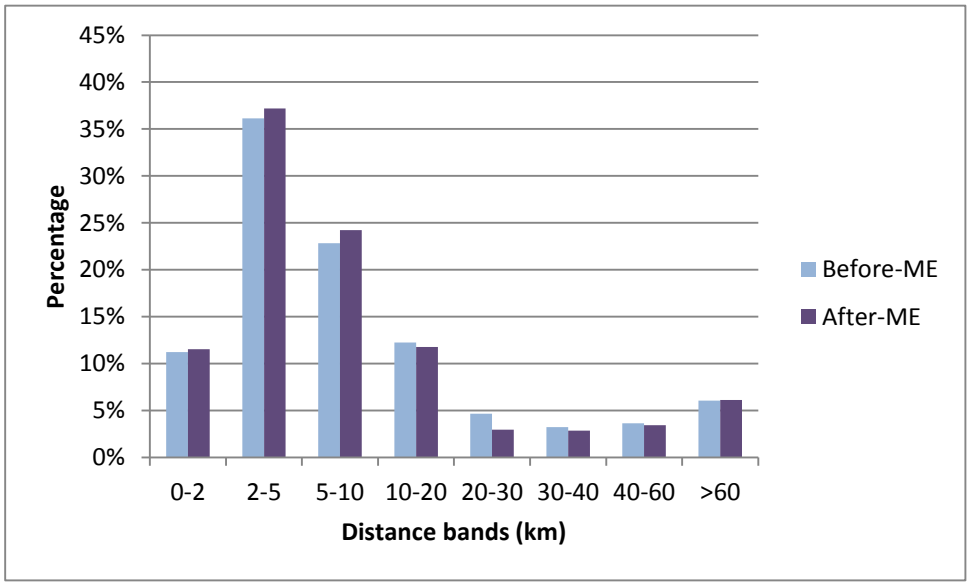


Figure 5.8: Comparison of Trip Length Distribution – Commute PM Peak

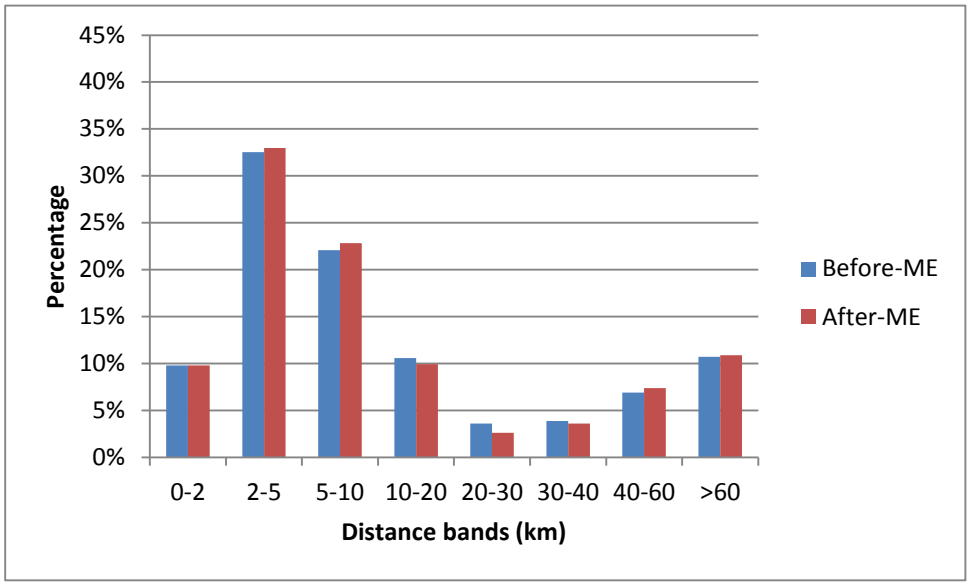


Figure 5.9: Comparison of Trip Length Distribution – Employers Business PM Peak

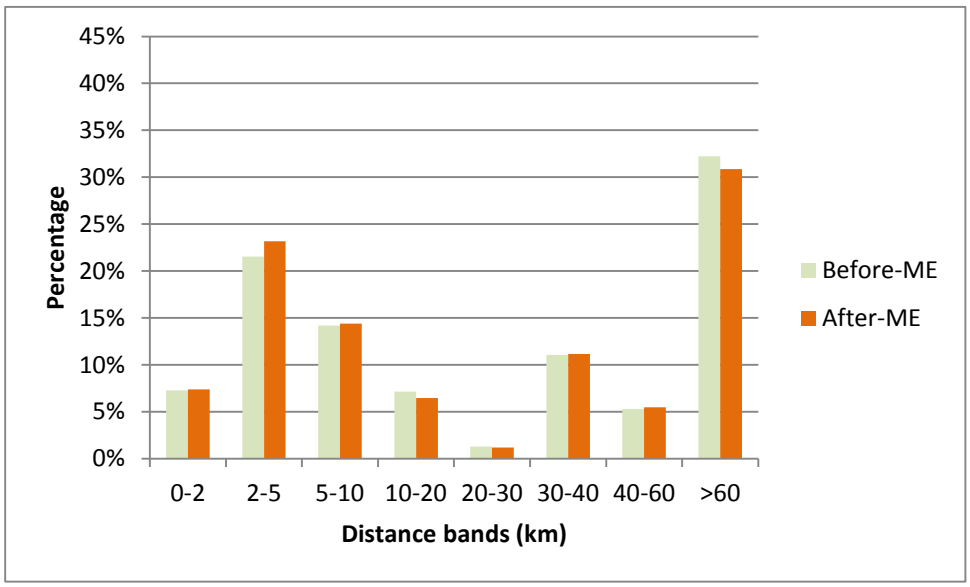
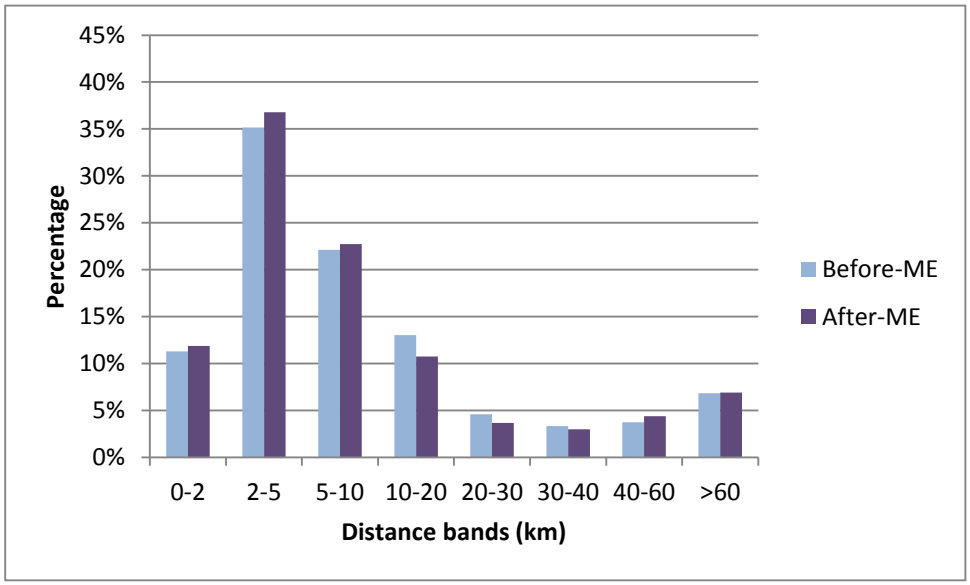


Figure 5.10: Comparison of Trip Length Distribution – Other PM Peak



6 Model Validation

6.1 Introduction

6.1.1 WebTAG Unit 3.11.2 outlines the validation criteria for public transport assignment models. The guideline suggests that there are three checks required:

- Validation of trip matrix
- Network and services validation; and
- Assignment validation

6.2 Validation of Trip Matrix

6.2.1 NCC no longer collates public transport patronage information. It was therefore not possible to carry out trip matrix validation on PT patronage at peak hour or 24 hour level. In addition, Electronic Ticket Machine (ETM) data was not available. Whilst manual counts had been carried out for updating the model it was considered that using all of these in the calibration was a better use of the data and would produce a better model than reserving some of the data for validation. Given the primary focus of the NDR appraisal is on using traffic data from the highway model, this approach was considered to be acceptable. In addition, the results from the demand modelling show a small level of mode switch with the modelling framework, so that any uncertainty in the PT model forecasts would have an insignificant effect on NDR forecasts.

6.3 Network and Service Validation

6.3.1 A number of checks have been carried out on the network and representation of services:

- The routeing for each service included in the model has been checked against routeing included in the timetables by plotting each service.
- A comparison between observed and modelled journey time for each service was undertaken.

6.3.2 These checks indicated that modelled service routeings and journey times were in line with observed timetable information.

6.3.3 Network and service validation also involved in looking at level of patronage on each of the service. Patronage graphs in Figure 6.1 to Figure 6.3 indicate an accurate representation of service patterns.

6.4 Assignment Validation

6.4.1 A series of sense checks were carried out on the assignment to ensure that model was working appropriately. All of these checks indicated that the assignment routines were working as expected. These included:

- A check of assignment statistics to ensure trips from all origins and destinations were assigned in all peaks.
- A visual check of routeing to ensure that sensible assignment routes were used.
- A check to ensure that majority of demand was assigned to a public transport service i.e. there were very small amount of walk only movements in all peaks. Table 6.1 below indicate that walk only trips is a very small proportion of total trips in each peak.
- A check to see that all services had demand assigned to them.

Table 6.1: Percentage of walk only PT trips

	AM	IP	PM
Total with trips with a ride	6,672	4,870	5,270
Trips without ride (walk only trips)	160	96	103
% of walk only trips	2.4%	2.0%	2.%

Figure 6.1: Patronage plots for AM peak

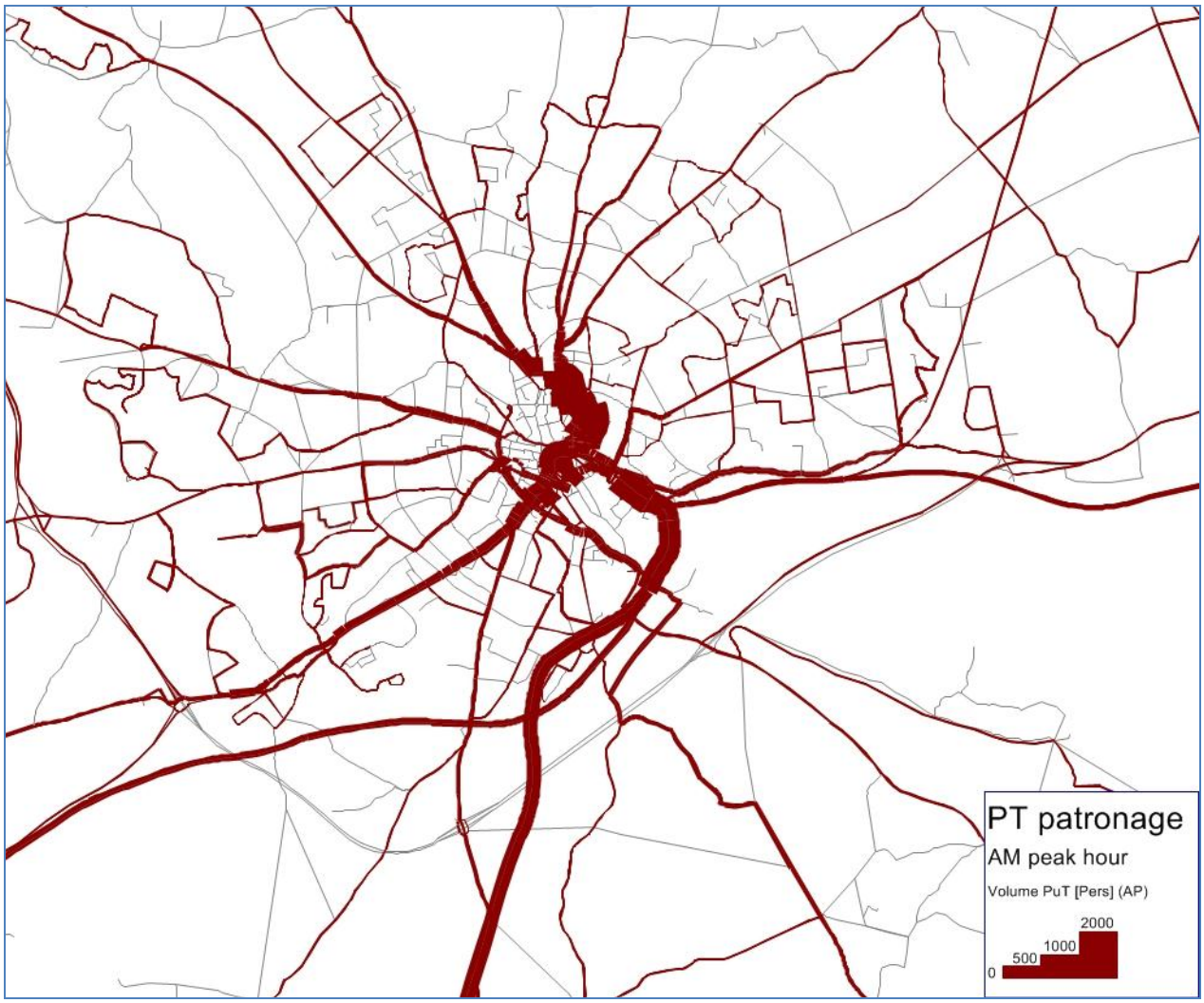


Figure 6.2: Patronage plots for interpeak

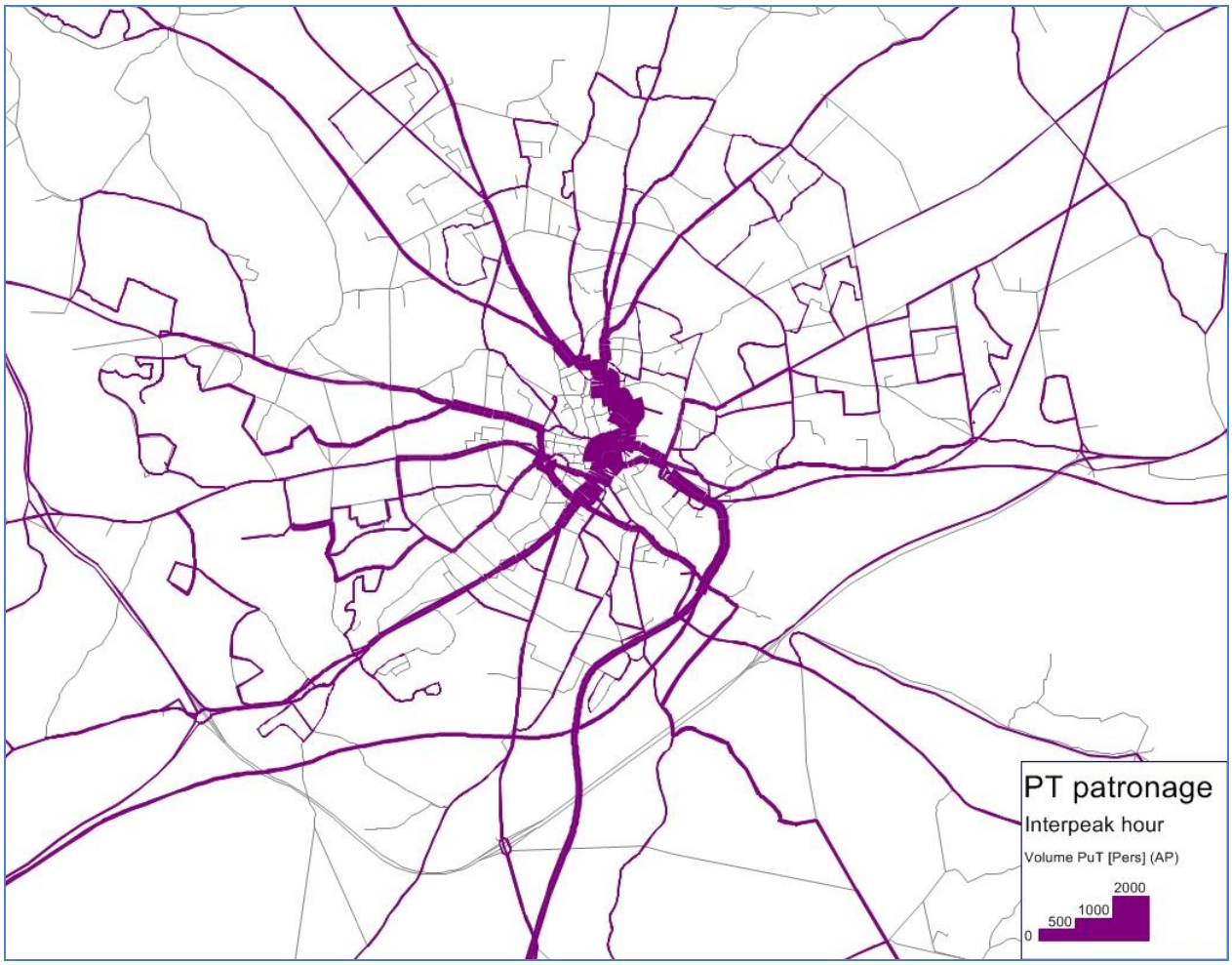
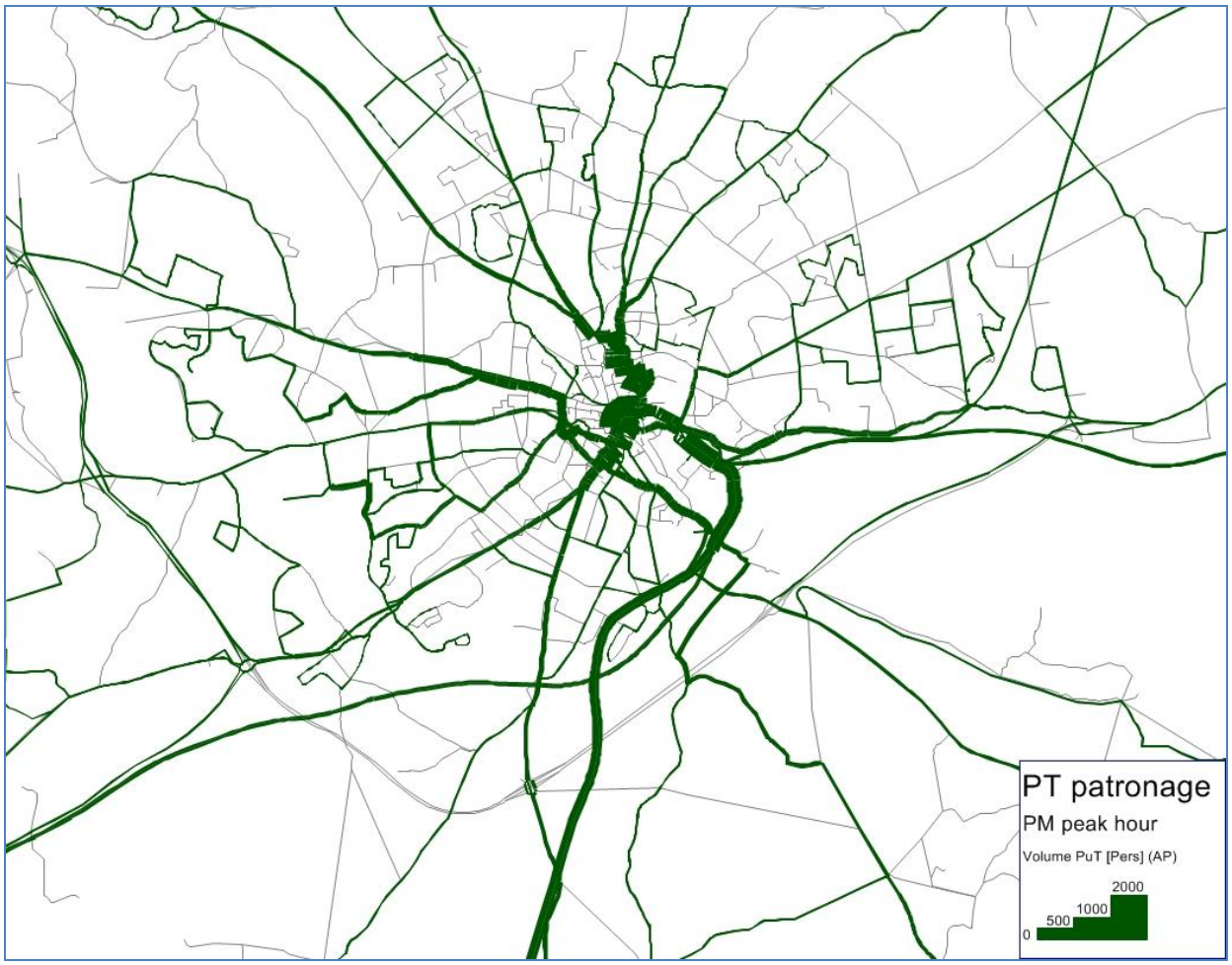


Figure 6.3: Patronage plots for PM peak



6.5 PT flow validation

6.5.1 No independent PT flow validation was undertaken during the development of the 2012 public transport model. The 2012 bus dataset captured all bus trips into Norwich from outside of the urban area and a significant proportion of trips from the suburbs into the city centre and cross city trips. However this was used for the 2012 matrix calibration, as it was considered that the benefits of using this data in calibration to provide a better representation of public transport movements was more important than using it in independent validation. For the purposes of the assessment of the NDR Scheme this is considered acceptable as the public transport modelling has very little influence on the highway traffic forecasts.

7 Appendices

7.1 Appendix A: Bus Survey Information

Table 7.1: Bus Stop Details at Survey Locations

ID Number	Bus Stop	Direction In/Out of cordon	Services to be Surveyed (non-Park and Ride ONLY)
1	Thorpe Road/adjacent The Denes	In	14, 14A, 15, 15A, X47, A47, 123, 124
2	Thorpe Road/Stanley Avenue	Out	14, 14A, 15, 15A, X47, A47, 123, 124
3	Bracondale/opposite Kings Street	In	X2, 001, 100, 146, 570, 587, 588
4	Bracondale/King Street	Out	X2, 001, 100, 146, 570, 587, 588
5	Long John Hill/adjacent Cavell Road	In	004, 31, 100
6	Long John Hill/opposite Cavell Road	Out	004, 31
7	Newmarket Road/Christchurch Road	In	6, X6, 11A, 13, 14, 15, 14A, 15A, 121, 999
8	Newmarket Road/Lime Tree Road	Out	6, X6, 11A, 13, 14, 15, 14A, 15A, 121, 999
9	Hall Road/opposite Abbot Road	In	36
10	Hall Road/Abbot Road	Out	36, 004
11	Constitution Hill/opposite No.31	In	13, 13C, 55, 210
12	Constitution Hill/adjacent No.31	Out	13, 13C, 55, 210, T2
13	Plumstead Road/adjacent Heartsease pub	In	13C, 23, 23A, 24, 24A, 32
14	Plumstead Road/opposite Heartsease pub	Out	23, 23A, 24, 24A, 32
15	Bowthorpe Road/Godric Place	In	21, 22
16	Bowthorpe Road/opposite Godric Place	Out	21, 22
17	The Avenues/adjacent Library	In	999
18	The Avenues/adjacent Christchurch Road	Out	999
19	Earlham Road/adjacent to Fairhaven Court	In	3, 4, 15, 25A
20	Earlham Road/opposite Hadley Drive	Out	3, 4, 15, 25A
21	Dereham Road/opposite Winchcomb Road	In	5, 23, 23A, 24, 24A
22	Dereham Road/Winchcomb Road	Out	5, 23, 23A, 24, 24A
23	Drayton Road/opposite Caley Close	In	28, 29, 29A, 29B, X29
24	Drayton Road/adjacent Caley Close	Out	28, 29, 29A, 29B, X29
25	Aylsham Road/opposite Boundary pub	In	25, 36, 37, 38, 44A, X44, T2
26	Aylsham Road/adjacent Boundary pub	Out	002, 36, 37, 38, 44A, X44, 45, CH4
27	Catton Grove Road/opposite Brightwell Road	In	21, 22
28	Catton Grove Road/adjacent Brightwell Road	Out	21, 22
29	Sprowston Road/opposite Shipfield	In	11, 11A, 36
30	Sprowston Road/adjacent Brickmakers pub	Out	11, 11A, 36
31	Ipswich Road/opposite Harford Manor Sch	In	003, 1, 2, 10A, 36, 37, 122
32	Ipswich Road/adjacent Harford Manor Sch	Out	003, 2, 10A, 37, 122
33	Unthank Road/adjacent Colman Hospital	In	25

ID Number	Bus Stop	Direction In/Out of cordon	Services to be Surveyed (non-Park and Ride ONLY)
34	Unthank Road/opposite Colman Hospital	Out	25
35	Castle Meadow Stand B	N/A	1, 2, 121, 122, 123, 124, 999, A47, X47
36	Castle Meadow Stand E	N/A	25, 25A, 31, 36, 37, 38, 44A, 45, X44
37	Castle Meadow Stand P	N/A	1, 2, 5A, 10A, 25, 25A, 32, 36, 37, 38, 45, 55, 210
38	Castle Meadow Stand R	N/A	11, 11A, 121, 122, 123, 124, 999, A47, X47
39	Castle Meadow Stand W	N/A	13, 14, 14A, 15, 15A, 28, 29, 29A, 29B, CH4

Table 7.2: Details of Bus Services

Bus Service	Operator	Approximate Frequency	Destination
001	Anglian	60 mins	Norwich City Centre - Surlingham
002	Konect Bus	20 mins	Norwich Bus Station - Sheringham
003	Anglian	120 mins	Norwich City Centre - Harleston
004	Anglian	60 mins	Norwich Bus Station – Harleston/Hempnell Green/Topcroft
1	Simonds	120 mins	Norwich Rail Station - Diss
2	Simonds	60 mins	Norwich Rail Station – Roydon (Diss)
3	Konect Bus	60 mins	Norwich Bus Station - Shipdham
4	Konect Bus	60 mins	Norwich Bus Station – Swanton Morley/Dereham
6	Konect Bus	60 mins	Norwich Bus Station - Ashill
10A	Semmence	3 / day	Norwich City Centre - East Harling
11, 11A	First Norwich	10 mins	Sprowston - Norwich University Hospital
13	First Norwich	15 mins (AM Peak) / 30 mins thereafter	Attleborough - Spixworth
14, 14A	First Norwich	15 mins (AM Peak) / 30 mins thereafter	Silfield - Wroxham
15	First Norwich	30 mins (AM Peak) / 60 mins thereafter	Blofield Heath – Wymondham
15A	First Norwich	35 mins (AM Peak) / 60 mins thereafter	Wymondham - Lingwood
21	First Norwich	15 mins (AM Peak) / 30 mins thereafter	Old Catton – Norwich University Hospital
22	First Norwich	30 mins	Old Catton – University of East Anglia
23, 23A	First Norwich	15 mins	Heartsease – New Costessey
24, 24A	First Norwich	15 mins	Thorpe St Andrew – Queens Hill
25, 25A	First Norwich	8 mins	Norwich Rail Station – University of East Anglia
28	First Norwich	20 mins	Norwich City Centre – Thorpe Marriott
29, 29A, 29B	First Norwich	60 mins	Norwich City Centre - Taverham
31	First Norwich	1 / day	Norwich Circular

Bus Service	Operator	Approximate Frequency	Destination
32	Neaves	4 / day	Norwich City Centre - Sprowston
36	First Norwich	15 mins (AM Peak) / 30 mins thereafter	Long Stratton – Horsford
37	First Norwich	30 mins	Hellesdon – Mulbarton
38	First Norwich	30 mins	Norwich City Centre – Old Catton
44	Sanders Coaches	30 mins (AM Peak) / 60 mins thereafter	Norwich – Sheringham / Holt
44A	Sanders Coaches	60 mins	Norwich Bus Station - Aylsham
45	Sanders Coaches	120 mins	Norwich City Centre - Holt
55	Sanders Coaches	5 in AM Peak / 60 mins thereafter	Norwich Bus Station – North Walsham
100	Norfolk County	20 mins	Norwich City Centre - County Hall
121	Anglian	30 mins	Norwich Rail Station - Eaton
122	Anglian	60 mins	Norwich City Centre - Cringleford
123	Anglian	15 mins (AM Peak) / 30 mins thereafter	Norwich City Centre – Wroxham
124	Anglian	60 mins	Norwich City Centre – Pilson Green
146	Anglian	30 mins	Norwich City Centre – Lowestoft
210	Sanders Coaches	6 / day	Norwich Bus Station – North Walsham
445	Sanders Coaches	4 / day	Norwich – Sheringham
570	Anglian	120 mins	Norwich City Centre – Thurlton
587	Anglian	30 mins	Norwich City Centre – Poringland
588	Anglian	30 mins	Norwich City Centre – Bungay/Halesworth
999	Anglian	30 mins	Eaton Park – Gertrude Road
A47	Anglian	60 mins	Norwich Bus Station - Gorleston
CH4	Norfolk Green	1 / day	Norwich City Centre - Cromer
T2	Norfolk Green	3 / day	Hellesdon – Sprowston
X2	First Norwich	30 mins	Norwich City Centre – Lowestoft
X6	Konect Bus	60 mins	Norwich Bus Station - Attleborough
X29	Norfolk Green	30 mins (AM Peak) / 60 mins thereafter	Norwich Bus Station - Fakenham
X41	Sanders Coaches	3 / day	Norwich – Sheringham
X44	Sanders Coaches	30 mins	Norwich Bus Station – Sheringham
X47	Anglian	60 mins	Norwich Bus Station - Gorleston

Table 7.3: Summary Bus Passenger Data at Survey Sites

Site	Location	07:30-08:00	08:00-09:00	09:00-09:30	10:00-11:00	11:00-12:00	13:00-14:00	14:00-15:00	15:30-16:00	16:00-17:00	17:00-18:00	18:00-18:30
Site 1	Thorpe Road Inbound	109	213	59	143	107	89	58	28	113	192	42
Site 2	Thorpe Road Outbound	59	143	57	56	82	153	107	52	193	203	60
Site 3	Bracondale Inbound	147	312	128	226	175	123	81	15	69	73	14
Site 4	Bracondale Outbound	26	107	23	58	89	260	237	145	221	314	120
Site 5	Long John Hill Inbound	0	34	0	32	21	11	0	0	0	21	0
Site 6	Long John Hill Outbound	0	1	0	11	3	11	0	0	0	11	0
Site 7	Newmarket Road Inbound	104	316	144	345	82	111	109	40	158	76	22
Site 8	Newmarket Road Outbound	70	101	23	80	136	197	133	94	253	128	78
Site 9	Hall Road Inbound	0	67	17	25	8	19	12	34	18	16	1
Site 10	Hall Road Outbound	0	16	20	0	30	30	31	50	34	39	21
Site 11	Constitution Hill Inbound	36	118	21	157	71	90	19	14	31	3	0
Site 12	Constitution Hill Outbound	3	14	4	35	35	49	32	73	128	91	64
Site 13	Plumstead Road Inbound	33	83	8	87	76	44	32	27	18	11	7
Site 14	Plumstead Road Outbound	16	35	30	39	66	66	68	50	89	82	38
Site 15	Bowthorpe Road Inbound	48	53	47	93	97	69	55	28	44	27	7
Site 16	Bowthorpe Road Outbound	17	28	15	38	77	118	150	111	139	192	55
Site 17	The Avenues Inbound	0	2	4	4	3	5	4	0	2	1	0
Site 18	The Avenues Outbound	0	1	0	0	0	7	5	5	6	3	0
Site 19	Earlham Road Inbound*	46	-	-	89	113	111	117	74	79	91	48
Site 20	Earlham Road Outbound*	34	-	-	83	127	144	178	147	123	99	78
Site 21	Dereham Road Inbound	132	181	60	173	194	83	76	22	59	70	53
Site 22	Dereham Road Outbound	23	75	8	102	150	174	113	99	180	235	90
Site 23	Drayton Road Inbound	106	137	25	98	92	19	27	55	39	62	17

Site	Location	07:30-08:00	08:00-09:00	09:00-09:30	10:00-11:00	11:00-12:00	13:00-14:00	14:00-15:00	15:30-16:00	16:00-17:00	17:00-18:00	18:00-18:30
Site 24	Drayton Road Outbound	38	26	14	26	55	94	114	42	156	140	38
Site 25	Aylesham Road Inbound	33	159	33	139	150	93	73	30	60	32	4
Site 26	Aylesham Road Outbound	0	26	11	76	117	115	124	163	149	92	44
Site 27	Catton Grove Inbound	33	36	11	26	27	17	9	13	14	7	7
Site 28	Catton Grove Outbound	3	5	4	8	22	42	33	13	64	57	19
Site 29	Sprowston Road Inbound	30	50	45	69	57	55	29	62	32	19	2
Site 30	Sprowston Road Outbound	9	35	6	47	41	24	78	55	66	51	62
Site 31	Ipswich Road Inbound	39	146	0	42	32	45	18	6	5	13	3
Site 32	Ipswich Road Outbound	10	14	0	52	77	59	68	59	85	195	15
Site 33	Unthank Road Inbound	7	75	23	39	52	124	74	68	77	113	64
Site 34	Unthank Road Outbound	20	74	30	106	74	72	77	51	113	82	38

Notes: *Data not available for the period from 08:00 to 09:30 due to an accident

Table 7.4: Average weekday bus passenger data at Castle Meadows sites

Site	Location	07:30-08:00	08:00-09:00	09:00-09:30	10:00-11:00	11:00-12:00	13:00-14:00	14:00-15:00	15:30-16:00	16:00-17:00	17:00-18:00	18:00-18:30
Site 35	Stand B	5	27	5	25	29	31	34	14	43	43	21
Site 36	Stand E	59	67	38	101	165	200	193	274	357	245	147
Site 37	Stand P	160	199	93	138	110	70	69	39	54	53	29
Site 38	Stand R	92	122	42	86	53	46	41	42	40	26	10
Site 39	Stand W	62	103	46	73	57	41	29	35	37	57	30

7.2 Appendix B: Fares

Table 7.5: Distance Based Rail Fares

Distance (km)	2012 fare in 2010 prices(£)
10	1.74
20	3.48
30	5.22
40	6.96
50	8.70
60	10.44
70	12.18
80	13.92
90	15.66
100	17.40
110	19.14
120	20.88
130	22.62
140	24.37
150	26.11
160	27.85
170	29.59
180	31.33
190	33.07
200	34.81

Table 7.6: Distance Based Bus Fares

First and other operators		Anglian	
Distance (km)	2012 fare in 2010 prices (£)	Distance (km)	2012 fare in 2010 prices (£)
1	1.16	1	0.73
2	1.60	2	1.31
3	1.74	3	1.60
4	2.03	4	1.89
5	2.18	5	2.03
7	2.32	6	2.18
8	2.47	7	2.32
10	2.62	8	2.47
13	2.76	10	2.62
16	2.91	12	2.76
20	3.05	14	2.91
26	3.20	16	3.05
		19	3.20
		23	3.34
		27	3.49

8 Glossary

Assignment	A process of loading a trip matrix onto routes through a network that accounts for travel costs on the network in identifying the optimum route choice for every trip
Calibration	A process of adjusting the model input data or model parameters to improve the model and its validation
Convergence	An equilibrium between model outputs, in assignment between the flows and travel costs and in demand models between the demand and the costs from the supply model
Cost matrix	A table of travel costs for journeys that may include travel time, operating costs and charges such as tolls or fares
Cruise speeds	Average travel speed along a network link
Demand model	See variable demand model
Demand segment	Travel demand is divided into a number of segments for the purposes of applying different demand modelling procedures. The division is usually by trip purpose and whether the trips are home-based or non-home-based
Generalised cost	A combination of time and money costs (operating costs and charges) that are expressed in time or money units which are used to represent the total travel costs for a journey within the assignment or demand models
Journey purpose	Trips are divided into different travel purposes, usually work (or commute), employers' business and other. These trip purposes have different generalised costs applied and different demand model responses
Matrix estimation	A process used to adjust an initial or 'prior' matrix so that the resulting assignment of the adjusted matrix matches count data as closely as possible
Network	A mathematical representation of a transport network in a supply-side assignment model, either a highway network which represents vehicle travel, or a public transport network that represents bus and rail services
Reference trip matrix	A forecast reference matrix based on applying growth from national (or other) datasets, but before the application of adjustments due to the impact of how travel costs will change with growth in travel
User classes	Trips are aggregated into several user classes for the purposes of assignment. These usually represent different types of vehicle (e.g. car, HGV) and different trip purposes
Trip matrix	A table representing travel in a model area between land areas or zones
Validation	A process of comparing the model data with independent data
Variable demand modelling	A model that forecasts changes in travel behaviour such as trip frequency, choice of mode, time of travel and trip distribution
Zone	An area of land or development which is used in a transport model to aggregate individual households or commercial premises into a manageable number of units that can be used to represent journey patterns in the study area. Usually the zone size will be relatively small in the study area, but progressively larger further away from it.

9 Bibliography

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