sert

South Essex Rapid Transit
Major Scheme Business Case

Appendix 4D
Passenger Demand Forecasting and Analysis

April 2010

Essex County Council THURROCK COUNCIL southend onsea BOROUGH COUNCIL INTERREG IVB BOOSTING ADVANCED PUBLIC TRANSPORT SYSTEMS

A partnership project between Essex County Council, Southend-on-Sea Borough Council and Thurrock Council

Model Forecasting Report

SERT

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1 Introduction

Background to the project

The Thames Gateway is the United Kingdom's largest regeneration area and has been a Government priority for over six years. In South Essex, The Thames Gateway includes parts of the five districts of Basildon, Castle Point, Rochford, Southend-on-Sea and Thurrock, and more than 630,000 people living within Thames Gateway South Essex. This area has an important economic role nationally and regionally, in terms of energy production, manufacturing, and the importation and handling of goods for distribution across the UK. However, it also has important environmental resources such as attractive coastal areas, distinctive estuarial wetlands, popular resorts and open countryside.

Between 2001 and 2021, around 43,000 new homes and 55,000 new jobs will be created. This scale of growth will require intervention in inward investment, business retention and skills development, as well as transportation infrastructure. On this basis, The Thames Gateway South Essex 'Business Plan for Transport' (2005) highlighted the need for sustainable transport infrastructure to support this level of regeneration and named SERT, a rapid transit running through south Essex as a high priority flagship scheme.

Structure of the report

This forecasting report covers the details of the model structure and model runs for the testing of the proposed South Essex Rapid Transit (SERT) scheme.

Following this brief introduction, the report is divided into a further five sections:

- Section 2 describes forecasting approach used to model the forecast effects of the scheme
- Section 3 describes the variable demand modelling approach, including the methodology
- Section 4 describes the mode choice modelling approach, including the methodology
- Section 5 describes the forecast year network development including how the SERT buses were coded
- Section 6 describes the forecast matrix development including how the matrices were factored to account for forecast developments

- Section 7 describes the scheme testing within the mode choice model and summarises the results from the model
- Section 8 presents the summary and conclusions.

2 Forecasting Approach

Initial assessments of the SERT scheme were made by modelling the introduction of SERT using a Mode Choice approach, as outlined in section 4. Further tests using a Variable Demand model were carried out, both to check for any impacts of induced travel, and to present the central case forecasts for the SERT Major Scheme Business Case (MSBC). This approach is detailed section 3.

These 2 models are related to each other, and although they take a different approach to modelling travel choices, they both share consistent inputs, and both models share certain data.

Summary of shared modelling inputs and assumptions

For both the Mode Choice approach, and the Variable Demand approach certain model inputs and assumptions are shared

- Growth factors for future year matrices come from TEMPRO growth factors, with land uses derived from South Essex Transport Land Use Interaction Model (SETLUM). Further details are given in Section 5.
- The opening year for testing was 2013 and the design year was 2028
- Base Year Matrices of 2006 provide base costs and demand
- The same highway network is used for calculation of highway costs
- Both models share the same time priods, vehicle types and trip purposes (albeit that the Mode choice approach adds all purposes together to model at the all purpose level)

The interaction of the 2 approaches is shown in Figure 2-1below.

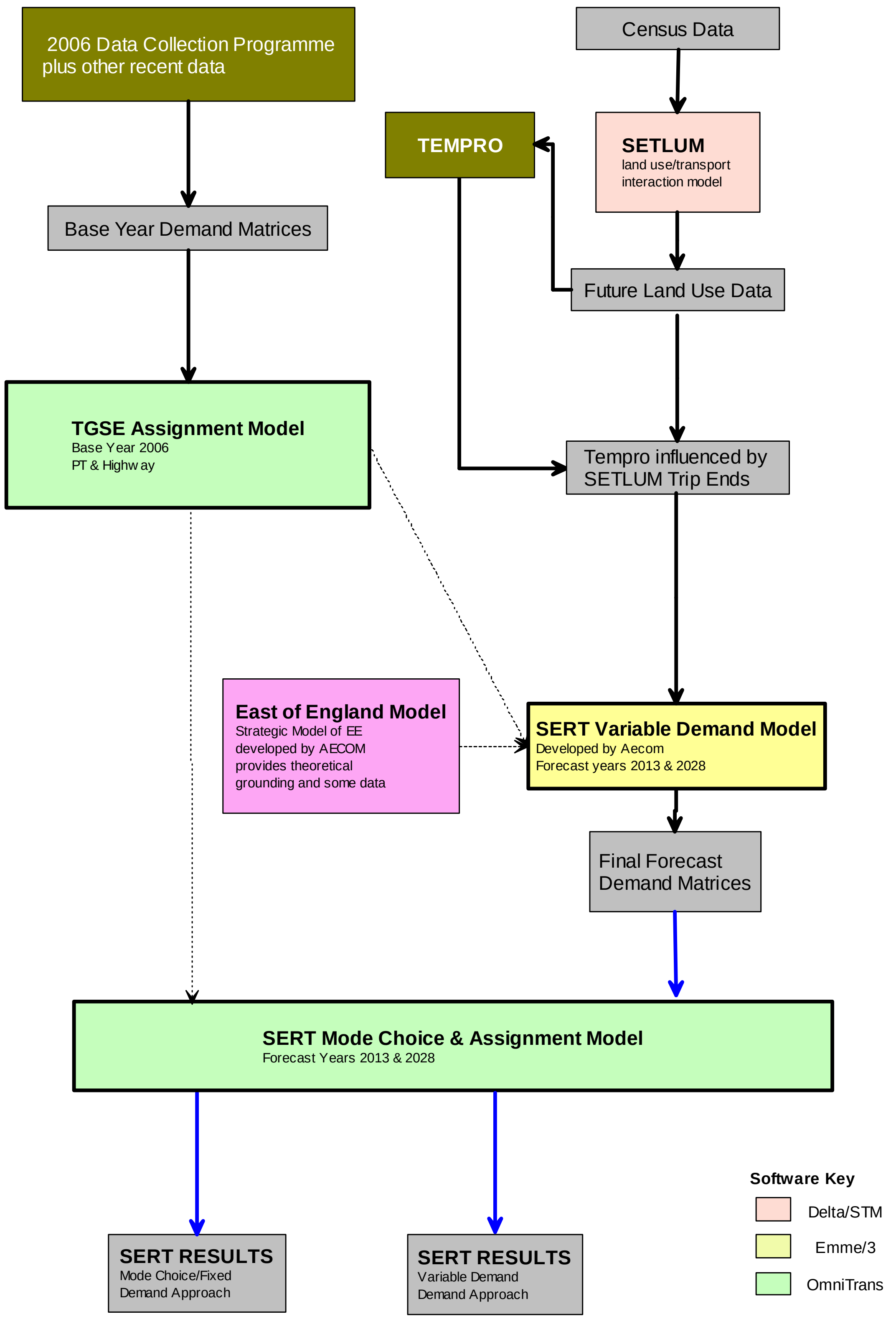


Figure 2-1 Relationship of Forecasting Models

Model Time Periods and Vehicle types

The choice of model time periods is described in Appendix 4E – Local Model Validation Report. These are set out in Table 2-1. Modelled output patronages are presented as average hourly passengers for each period in an average weekday. Average hours were used as the model covers a very large area and peak hours varied across the network.

Modelled Time Periods	
AM Peak	07:00-10:00
Inter-Peak	10:00-16:00
PM Peak	16:00-19:00

Table 2-1 Modelled time periods

The model includes three highway vehicle types, cars, Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs). HGVs are an aggregation of Goods Vehicles and Coaches. In the Public Transport model two main public transport modes are modelled; rail and bus with SERT demand considered part of bus demand.

3 Variable Demand Model

A variable demand model - Thames Gateway Demand Model (TGDM) - has been used test the effects on the scheme of induced travel and to present the central case for the SERT MSBC. WebTag requires that a variable demand assessment is made for all schemes above £5m and that are considered major public transport schemes. A set of preliminary tests to establish whether variable demand assessment needs to be taken to greater detail are recommended.

At the start of the TGSE model development it was recognised that variable demand effects were likely to be required by DfT for the schemes likely to be tested by the model. Therefore a variable demand model was commissioned from AECOM that was based on the successful East of England Demand Model that was built for HA and BAA. This model has been used for Stansted Airport surface access proposals, and a number of other schemes proposed by the HA in the region, including M25 improvements. The model is compliant with DfT's modelling advice in WebTAG Units 3.5.6 and 3.10.1 to 3.10.4, as of March 2009. As with the mode choice model the opening year for testing was 2013 and the design year was 2028.

Thames Gateway Demand Model

Although the variable demand modelling advice given in WebTag is aimed at mainly highway improvements, it does have applicability to public transport schemes. Details of the model are given in Appendix 4D – Demand Model Development Report. A summary of the model is given in the remainder of this chapter.

The key objectives of TGDM are to:

- provide forecasts of changes in travel demand over time, as a result of changes in land-use, economic growth, travel costs and committed transport supply changes;
- provide forecasts of the demand responses of highway and public transport trips to changes to the transport system; and
- ensure that the forecast travel demand and generalised costs of travel are in equilibrium.

Figure 3-1 shows the overall structure of TGDM and the relationships between transport supply (such as highway capacity or new public transport services), planning data and transport demand.

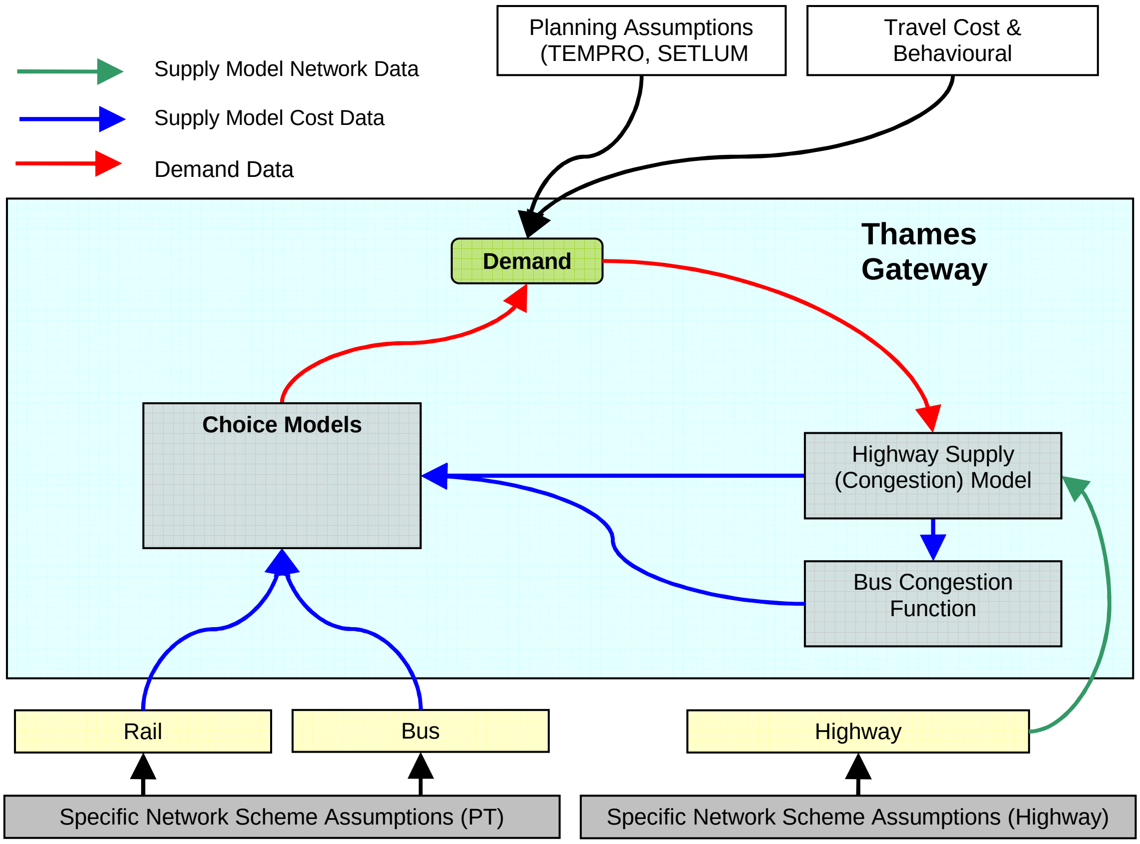


Figure 3-1 Variable Demand Model – overall structure

Choice Hierarchy

The demand model hierarchical choice structure reflects the relative sensitivity of the individual responses. The choice structures are implemented in the following order:

- trip frequency;
- macro time period choice;
- main mode choice;
- trip distribution; and
- public transport mode choice.

In addition, there is a mode choice process to choose between slow modes (walk and cycle) and other modes for home-based work and education trips, which effectively replaces trip frequency for those segments, as these trips are assumed to be doublyconstrained to the population (production) and employment/education (attraction) trip-end forecasts.

Figure 3-2 shows the TGDM choice structure, within which the choice processes are ordered in accordance with the guidance in WebTAG Unit 3.10.3 Section 1.9.

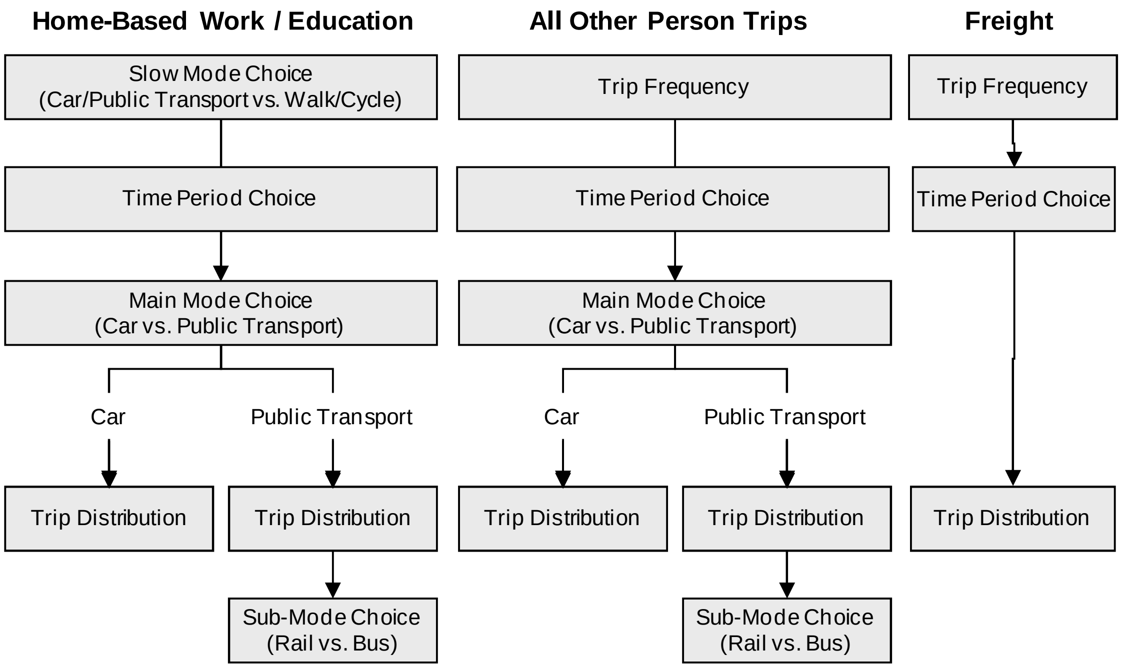


Figure 3-2 TGDM Choice Model Structure

Overall Forecasting Process structure for Variable Demand

A schematic of the variable demand forecasting process is shown in Figure 3-3. This can be compared to the Mode Choice approach which is illustrated in Figure 4-1.

Full details of the Variable Demand Model are given in Appendix 4D – Demand Model Development Report.

Variable Demand Modelling

Variable matrices – changes in generalised cost result in demand matrix changes

Variable demand model replaces logit model for the mode choice

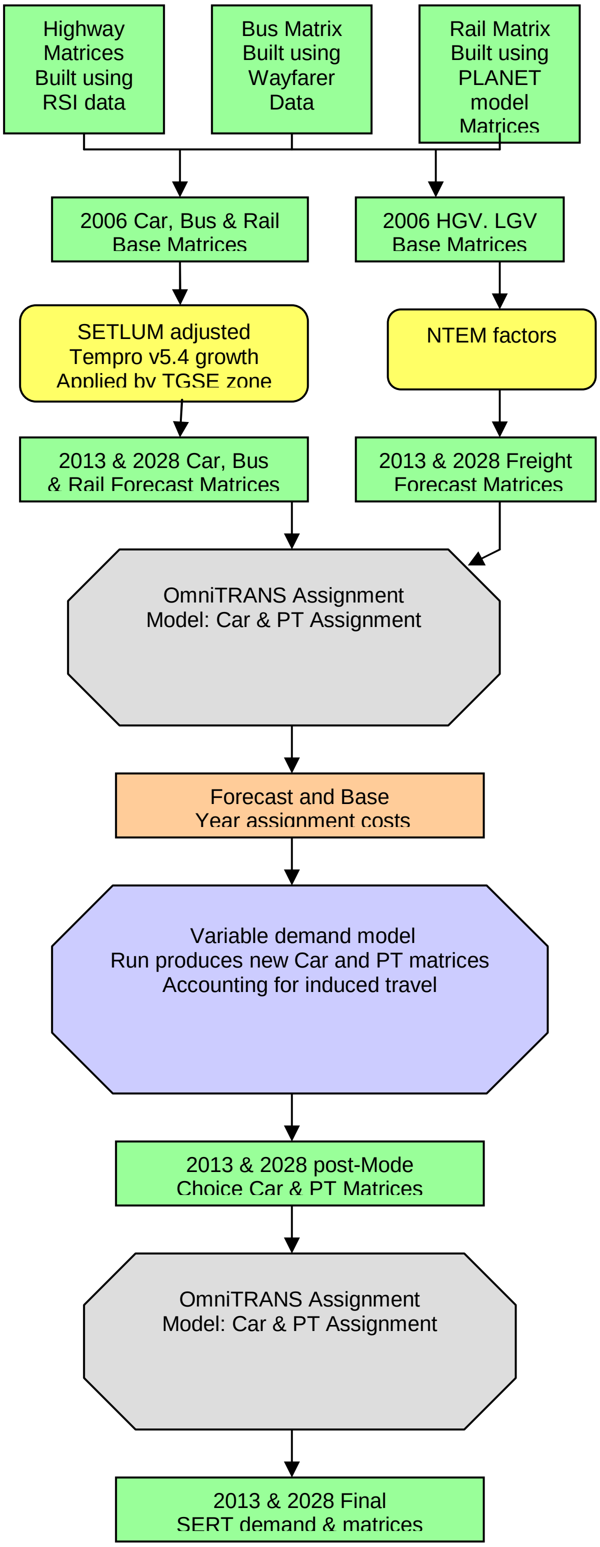


Figure 3-3 Structure of Variable Demand Modelling

4 Mode Choice Model

Introduction

A mode choice model forms the basis of a model where the overall levels of travel demand are fixed, and no account is taken of induced, or suppressed demand as a result of highway congestion. In this model, as with most mode choice models, the cost differences between PT and Car travel are used to calculate which mode travellers would most likely use.

The mode choice model chosen for this scheme was the incremental logit model, which uses the relative change in costs between forecast travel costs by mode and the base costs to generate forecast modal shares. The incremental logit model was chosen as it represented a robust method which would suitably account for changes to travel costs associated with the introduction of SERT to the PT network. The choice of incremental logit also meant that any changes in highway costs caused by any committed schemes in the future such as the Sadlers Farm junction improvements would have an impact on the overall mode choice of any schemes in the future.

Overall Forecasting Process Structure for Mode Choice

A schematic of the model is shown in Figure 4-1

Mode Choice Model

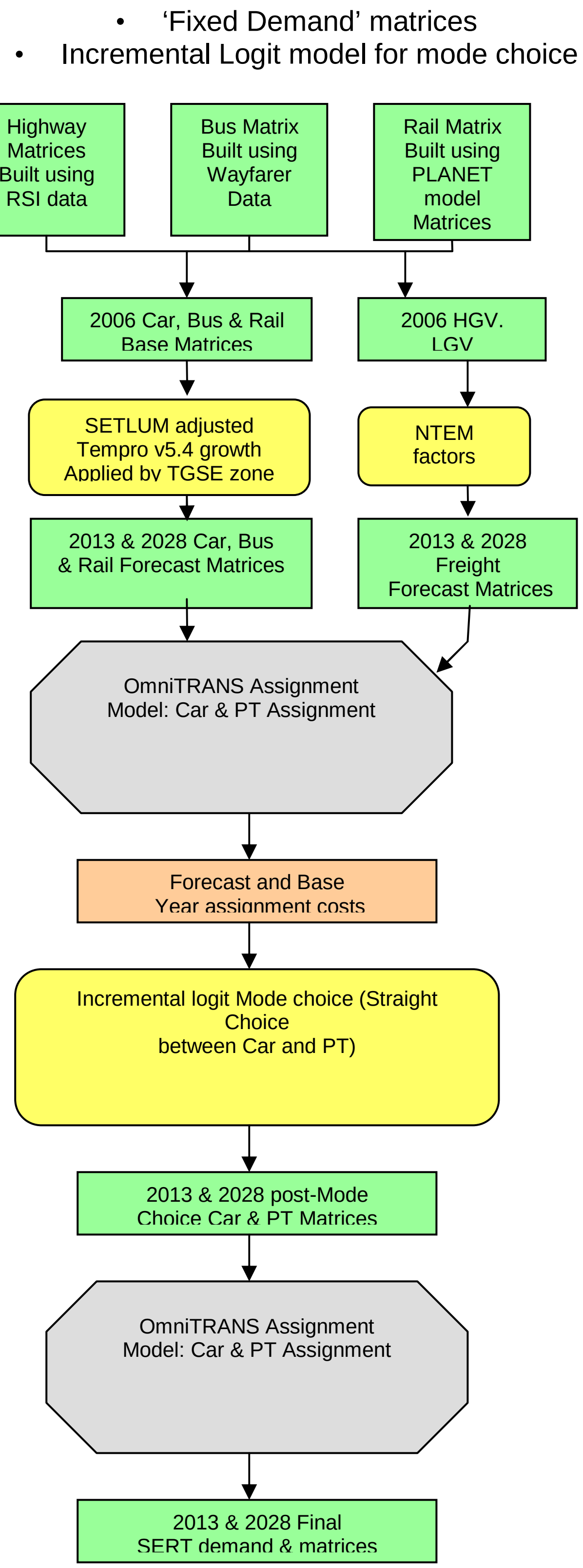


Figure 4-1 Structure of Mode Choice Model

The stages of the modelling process are described below in order:

1. **Forecast matrix development**

The base highway matrices from the validated highway model were used in the highway model. The PT matrices were generated using PLANET data for the rail matrices and wayfarer data provided by the operators. Further details on this process can be found in Appendix 4E – Local Model Validation Report.

2. **Correction for local planning assumptions from SETLUM**

Forecast matrices were generated by growing the base matrices by factors generated using TEMPRO with local planning assumptions for the South Essex area derived from the Land use model SETLUM (Car, Bus, Rail) and National Trip End Model (NTEM) factors for HGV and LGV. Further details of this process are given in Section 6

3. **Highway and PT Assignment**

The forecast highway matrices are then assigned to the forecast highway network and the PT matrices assigned to the forecast PT network.

4. **Extraction of costs from assignment**

The highway and public transport costs are then skimmed from the assigned model for use in the mode choice model.

5. **Logit Model**

The costs skimmed from the assignments are then compiled into generalised cost components for each origin to destination movement. Separate costs are built for highway and public transport. The costs are then compared with those generated in the base model using the incremental logit model and a new set of highway and PT matrices are generated. Only those trips which have a car available to them are run through the mode choice model, those without cars available are assumed to remain captive to public transport.

6. **Re-assignment of post mode choice matrices**

The post mode choice matrices are then assigned to the forecast highway and PT networks respectively.

7. Final SERT demand

The PT assignment is then used as the final mode choice between PT modes and a selected link assignment is used to generate a SERT patronage matrix.

Calibration of demand model

The incremental logit model relies heavily on the lambda coefficient, which decides how sensitive the mode choice is to changes in travelling cost. It is possible to calibrate the mode choice in order that the lambda value and resulting mode choice model accurately predict forecast modal splits.

The process of calibration is carried out by testing the base model for demand elasticities with respect to PT fare levels and using a lambda value which provides the expected/observed elasticity. Equation 1 shows the elasticity equation with respect to PT fare:

$$e = \left(\frac{\log_{10}\left(T^{'}\right) - \log_{10}\left(T^{0}\right)}{\log_{10}\left(C^{'}\right) - \log_{10}\left(C^{0}\right)} \right)$$

Equation 1: PT demand elasticity with respect to PT fare

When the elasticity value is known, in this case it is -0.30, the base model can be run with various elasticity values by time period until the desired elasticity is achieved. This then forms the lambda value for the forecast model. The various lambda values and elasticity values are shown in Table 4-2

Time Period	Calibrated Lambda Value
AM	-0.076
IP	-0.056
PM	-0.060

Table 4-1 Calibrated Lambda Values

Lambda Value	AM Demand Elasticity with respect to PT Fare	IP Demand Elasticity with respect to PT Fare	PM Demand Elasticity with respect to PT Fare
-0.004	-0.02	-0.02	-0.02
-0.008	-0.03	-0.04	-0.04
-0.012	-0.05	-0.06	-0.06
-0.016	-0.06	-0.08	-0.08
-0.020	-0.08	-0.11	-0.10
-0.024	-0.09	-0.13	-0.12
-0.028	-0.11	-0.15	-0.14
-0.032	-0.12	-0.17	-0.16
-0.036	-0.14	-0.19	-0.18
-0.040	-0.16	-0.21	-0.20
-0.044	-0.17	-0.23	-0.22
-0.048	-0.19	-0.26	-0.24
-0.052	-0.20	-0.28	-0.26
-0.056	-0.22	**-0.30**	-0.28
-0.060	-0.24	-0.32	**-0.30**
-0.064	-0.25	-0.34	-0.32
-0.068	-0.27	-0.36	-0.34
-0.072	-0.28	-0.39	-0.37
-0.076	**-0.30**	-0.41	-0.39
-0.080	-0.32	-0.43	-0.41

Table 4-2 Lambda values and resulting model elasticities used in calibration of mode choice model

Realism testing

In order to check that the demand model is behaving realistically various components of the travel cost and time have been changed and the overall demand checked to see that it accords with general experience.

The following elements of cost were changed by +/-10% in the base model:

- Car Fuel Cost
- Car Journey Time
- PT Fare

A summary of the results and the expected results is shown in Table 4-3 to Table 4-5.

Model elasticities were calculated using the Equation 1 shown previously.

PT Model Elasticity with respect to fares					
Time Period	Increase in PT Fares	Original PT Matrix Total	Modified PT Matrix Total	PT Elasticity	Expected Range
AM	+10%	480171	466628	-0.30	-0.2 to -0.4
IP	+10%	200402	194758	-0.30	-0.2 to -0.4
PM	+10%	442185	429641	-0.30	-0.2 to -0.4
AM	-10%	480171	493941	-0.27	-0.2 to -0.4
IP	-10%	200402	206186	-0.27	-0.2 to -0.4
PM	-10%	442185	452450	-0.22	-0.2 to -0.4

Table 4-3 Base Model elasticity with respect to Public Transport Fares

Highway Model elasticity with respect to car journey times					
Time Period	Increase in Car Costs	Original Car Matrix Total	Modified Car Matrix Total	Car Elasticity	Expected Range
AM	1.1	5756774	5748038	-0.02	less than -2.0
IP	1.1	4957582	4954116	-0.01	less than -2.0
PM	1.1	6060225	6053525	-0.01	less than -2.0
AM	0.9	5756774	5766023	-0.02	less than -2.0
IP	0.9	4957582	4961125	-0.01	less than -2.0
PM	0.9	6060225	6067295	-0.01	less than -2.0

Table 4-4 Base Model elasticity with respect to car journey times

Highway Model elasticity with respect to car fuel Costs					
Time Period	Increase in Car Costs	Original Car Matrix Total	Modified Car Matrix Total	Car Elasticity	Expected Range
AM	1.1	5756774	5739674	-0.03	-0.1 to -0.4
IP	1.1	4957582	4950671	-0.01	-0.1 to -0.4
PM	1.1	6060225	6046980	-0.02	-0.1 to -0.4
AM	0.9	5756774	5775942	-0.03	-0.1 to -0.4
IP	0.9	4957582	4964784	-0.01	-0.1 to -0.4
PM	0.9	6060225	6075003	-0.02	-0.1 to -0.4

Table 4-5 Base model elasticity with respect to car fuel costs

The results show that the public transport matrices are sensitive to changes in fare by the expected amount, as are the car matrices with respect to journey time. The car matrices are marginally less sensitive than expected with respect to car fuel costs. For the purposes of testing a public transport scheme like SERT it was decided that the elasticities showed that the model was sufficiently sensitive to the key attributes required of PT fare and car journey times.

Model parameters

The following section outlines the key parameter values from the demand model.

4.1.1 Values of Time

The values of time for the base and forecast years were calculated using guidance from Section 3.5.6 of WebTag and are shown in Table 4-6 below. The value of time was used to convert monetary elements of generalised cost such as PT fare and parking fares into consistent time units for input to the mode choice model. A general value of time was used by combining the 'mode' values of time given in WebTag. This value of time also represents all purposes, as it is at the all-purpose level that the Mode choice model operates at.

Year	Value of Time (Pence per Minute)
2006	14.37
2013	16.45
2028	20.82

Table 4-6 Values of time used in SERT modelling

4.1.2 Vehicle Occupancy

Vehicle occupancy figures were generated using TEMPRO planning data for the study area for the base and forecast years, the occupancy figures are shown in Table 4-7. The vehicle occupancy figures were used to convert the vehicle trips from the highway matrix into people trips for the mode choice (all PT trips are by person).

Year	Vehicle Occupancy (Average Persons per vehicle)
2006	1.39
2013	1.34
2028	1.22

Table 4-7 Average vehicle occupancy used in modelling

4.1.3 Mode Constants

The mode constant for bus was set to 10.0 minutes and the rail mode constant set to 5 minutes to represent the perceived benefits of rail travel over bus travel. Because SERT services represented high quality and high frequency services it was decided to set the mode constant for SERT buses to 5.0 minutes to represent the perceived benefits of travelling on SERT over normal buses in the TGSE area. These mode constants were selected in accordance with WebTag guidelines (unit 3.15.3) and influenced by previous PT studies. The mode constants are shown in Table 4-8

Time Period	Mode Constants (Minutes)		
	Bus	Rail	SERT
AM	10.0	5.0	5.0
IP	10.0	5.0	5.0
PM	10.0	5.0	5.0

Table 4-8 Mode constants used in generating generalised cost of public transport modes

4.1.4 Interchange Penalties

Interchange penalties were set to 5 minutes and the weighting applied to walking and waiting time on all PT modes was set to a factor of 2, all of which are consistent with WebTag and previous studies in the region.

Time Period	Lambda Values
AM	-0.076
IP	-0.056
PM	-0.060

Table 4-9 Mode choice model lambda values by time period

4.1.5 Other Factors

The calculation of generalised cost also used other factors related to public transport travel costs. An interchange penalty is applied to discourage unrealistic service changes to save small amounts of time, and to reflect the inconvenience of changing services. Weighting factors are applied to walking time, and waiting time in order to replicate the disutility of these parts of a PT journey.

Mode Choice Factors	Value
Interchange Penalties	5 Minutes
Walk Weighting	2
Wait time weighting	2

Table 4-10 Mode choice model weighting parameters

5 Forecast Year Network Development

Introduction

The public transport network was coded in conjunction with the existing highway network in the TGSE model. The details of the assumptions made in coding up the network are covered in Appendix 4E – Local Model Validation Report.

Model Features

The model was built using an opening year of 2013 and a design year of 2028

Forecasting Assumptions

5.1.1 Network changes

Between the Do Minimum and Do Something schemes the only changes to the network was the addition of the SERT bus service running at 6 buses per hour in each direction for the following schemes:

- SERT Route 1 – SERT route running between Lakeside and Basildon Eastmayne
- SERT Route 2 – SERT route running between Progress Road and Southend Seafront

The routes were modelled in 2 separate networks for identification of individual route benefits. Details of route coding are given in 5.1.6

Model runs and early sensitivity tests indicated that reductions in patronage to bus services due to SERT are compensated for by overall levels of bus growth. Nor would the patronage on existing routes fall to the extent that would suggest that these services are at risk. Discussions with bus operators had indicated a positive attitude to SERT and we think it unlikely that bus operators will introduce significant changes to their bus services to either compensate for SERT, or to compete with it. Although there may be some changes to bus services after SERT is introduced, it is difficult to anticipate what they might be or if they will be significant. Any local adjustments to bus routes in SERT Route 1 and 2 corridors would supplement SERT, not compete with it. We therefore concluded that for modelling and economic assessment purposes there will be no significant changes to the existing pattern of bus services after the introduction of SERT.

5.1.2 Highway Travel Costs

Parking costs in the model were set to an average from the modelled area of £3.50 per trip per vehicle for all 3 of the modelled periods. This figure was derived using available car park data in the region and represented the average parking fee on a weekday.

Parking charges were only added to movements whose destination zone was considered to be an area which has high levels of parking charges. The areas where parking charges were charged were decided through a combination of analysis of the local paying car parks and local knowledge.

The vehicle operating cost for car travel was calculated using the latest Webtag guidance. The calculated values used in the model are shown in Table 5-1 below:

Year	Vehicle Operating Costs (£ per KM)
2006	0.10981
2013	0.09909
2028	0.08747

Table 5-1 Vehicle operating costs used in generating generalised cost

5.1.3 Committed schemes

A number of schemes were identified as being committed and would be in place by 2013. These schemes were as follows:

- Cuckoo Corner Junction improvement (Funded through the CIF2 Process)
- A13 M25 - Lakeside Widening (M25 increase slip road capacity at J30, exit slips) – Developer funded
- M25 widening between J27 to J30 (Government's Programme of Major Schemes)
- Sadlers Farm Junction improvements (Government's Programme of Major Schemes)

5.1.4 DM and forecast highway network schemes

Plots of the Sadlers Farm junction improvements are shown in Figure 5-1 where the junction has been signalised and a underpass added between the A13 and the A130. Figure 5-2 shows the network coding of the junction improvements to Cuckoo corner where the junction has been re-configured and signalised in order to improve the traffic flow through the junction.

Figure 5-1 Network coding of Sadlers Farm junction improvements

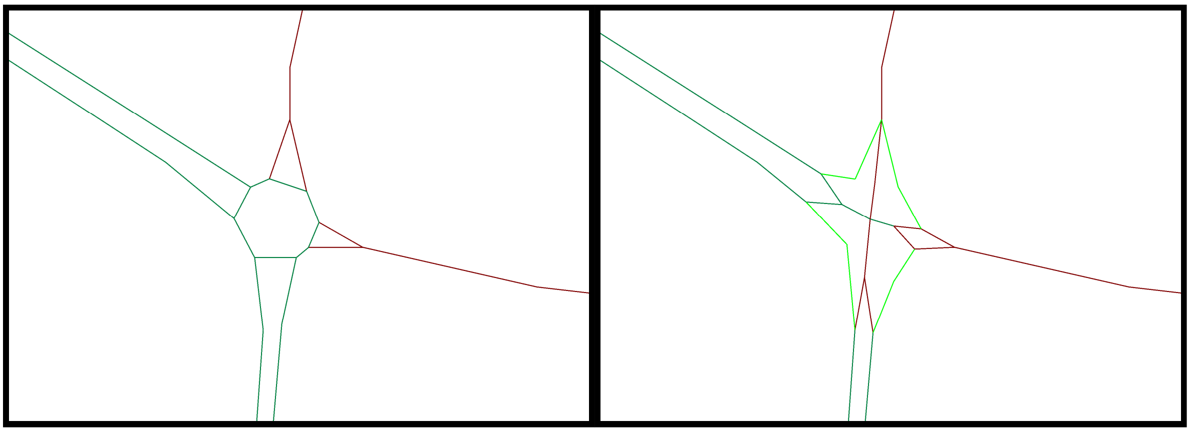


Figure 5-2 Network coding of Cuckoo Corner unction improvement

5.1.5 DM and forecast bus and rail fares

A distance based rail fares table was generated using rail fares data available on national rail websites for C2C and 'One' services.

Distance Travelled (KM)	Fare for by distance travelled
0	£1.75
5	£2.50
10	£3.25
20	£4.75
50	£9.25
100	£16.75
400	£61.75

Table 5-2 Rail Fares table used in TGSE model

Bus fares were calculated using a mixture of survey data from bus services and local knowledge. The fare system used was a £1.50 per boarding up to a maximum fare of £4.50.

It was decided to model SERT bus fares at the same rate as buses in the network at £1.50 per boarding up to a maximum fare of £4.50.

5.1.6 SERT bus routes

SERT routes were coded in the same way as normal bus routes with a fixed timetabled speed, however this speed was quicker than normal buses in order to account for the impact of the priority measures at junctions and bus lanes. SERT buses were coded as running at 30kph except when running along the A13 Stanford-le-Hope Bypass where they ran at 90kph. This average timetabled speed therefore includes the time taken to slow down, stop, pick up/drop off passengers and get back up to speed, and therefore represents a rapid service compared to normal buses in the area.

All SERT routes were high quality and high frequency services and so were coded to run at 6 buses per hour in each direction of the route and had a mode constant of 5 minutes compared to 10 minutes for bus services.

SERT Route 1 travels between Lakeside and Basildon Eastmayne and SERT Route 2 travels between Progress Road and Southend Seafront. Figure 5-4 to Figure 5-6 show the routes coded onto the networks, further details on where the SERT routes follow can be found in the MSBC route description section.

5.1.7 SERT bus stops

Because of the relatively coarse coverage of the models zoning system the SERT stops were coded at locations which best represented general areas where the service might pick up and deposit passengers and not at the exact locations planned. These were generally near key interchange points such as rail stations or near zone centroids.

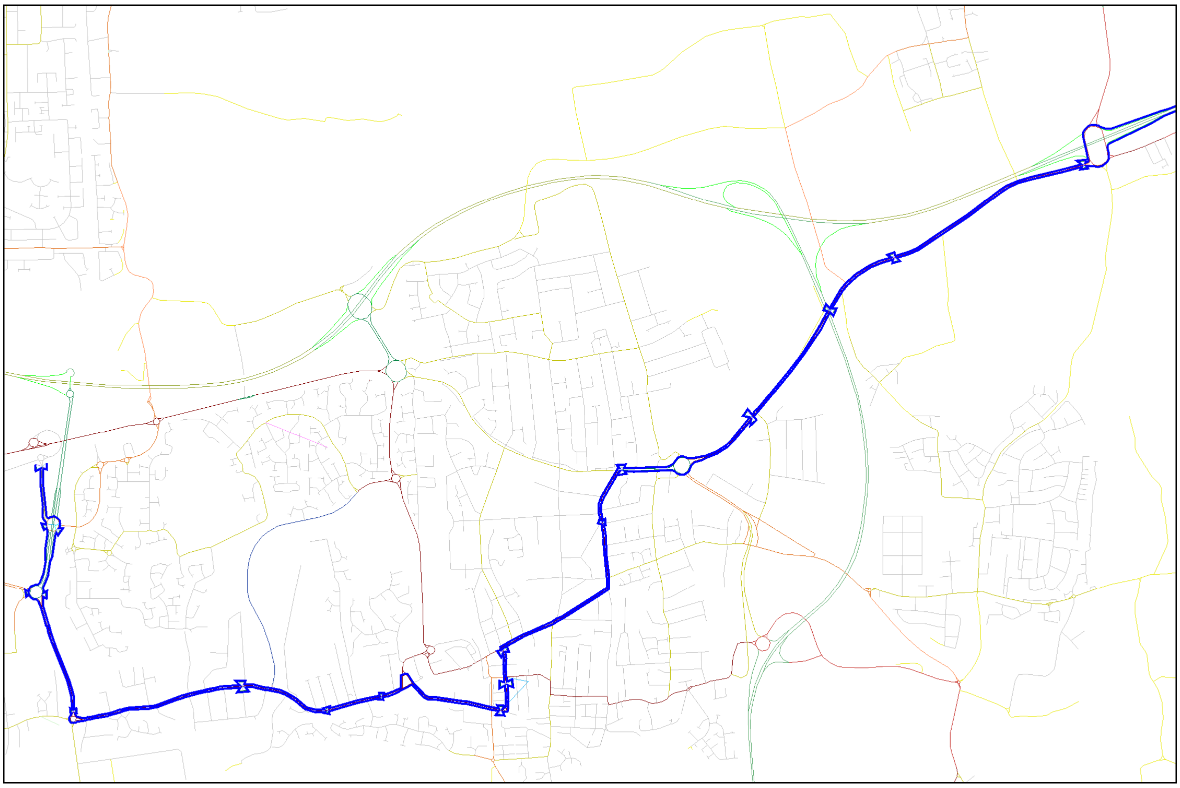


Figure 5-3 Coding of SERT Route 1 on TGSE network

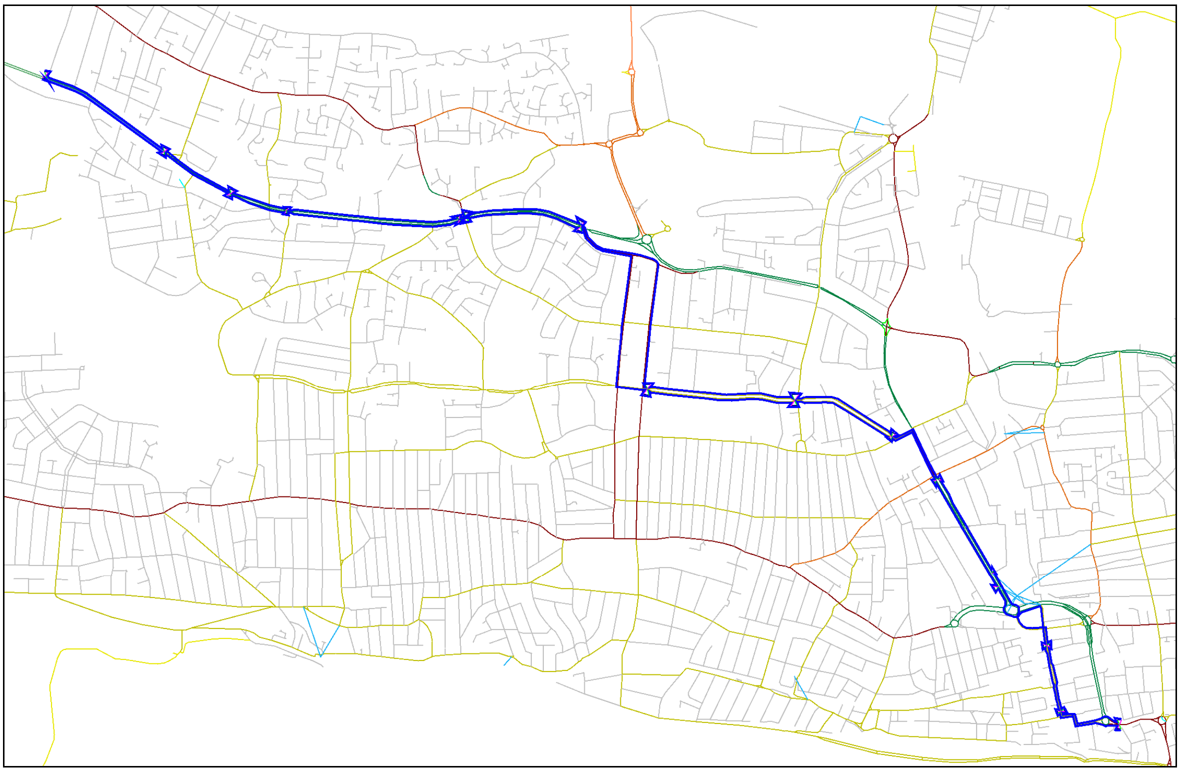


Figure 5-4 Coding of SERT Route 2 on TGSE network

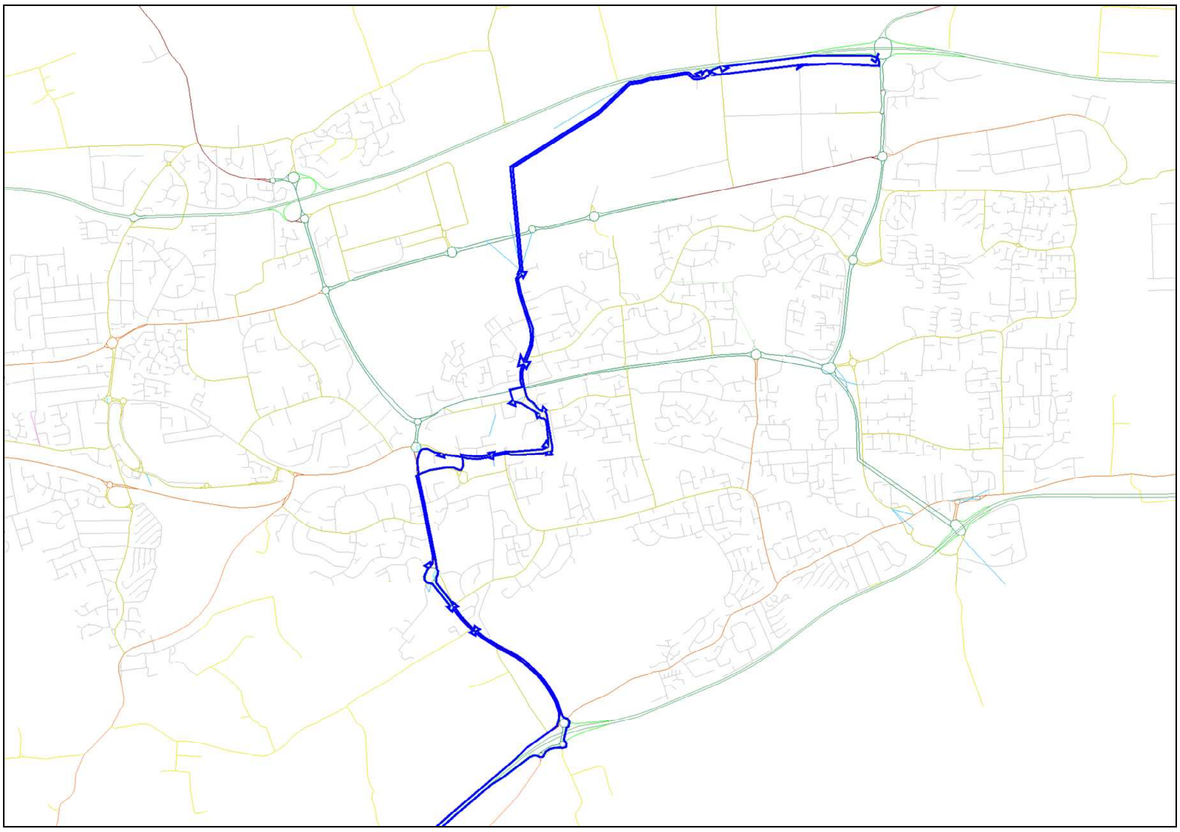


Figure 5-5 Coding of SERT Route 1 in Basildon

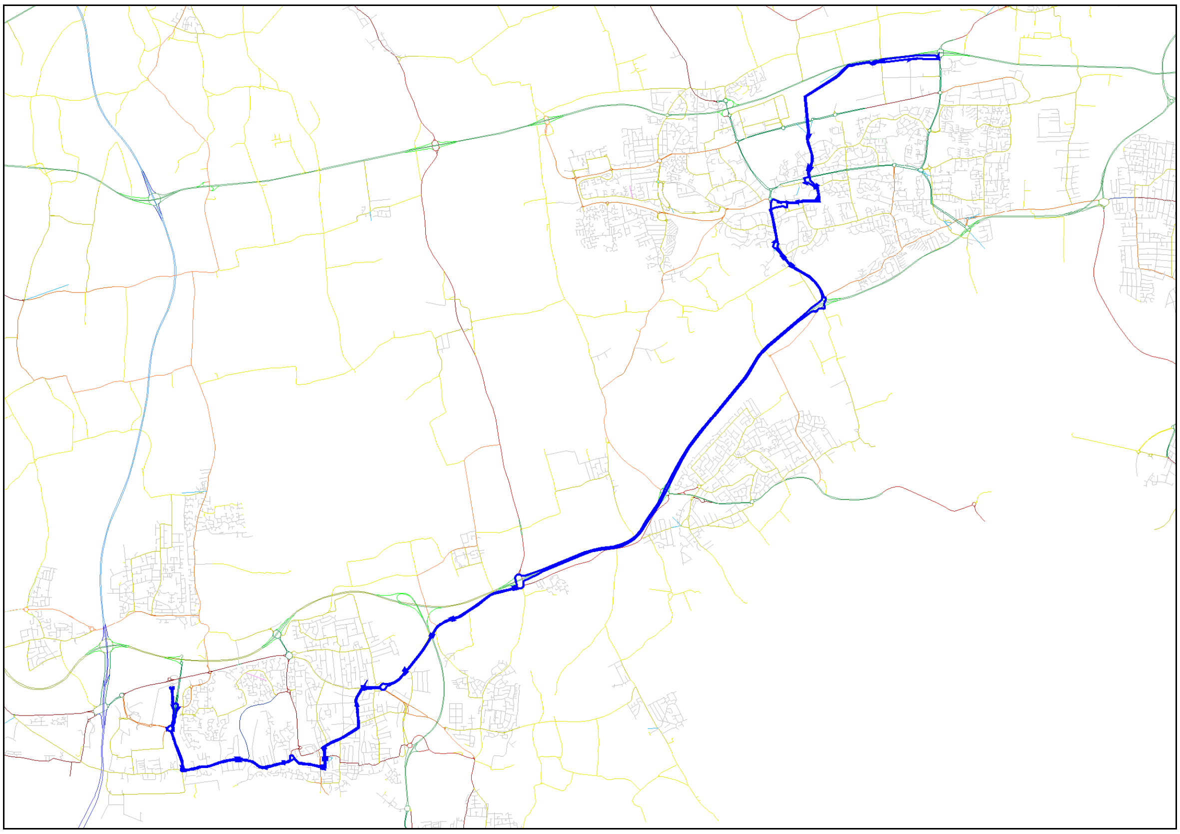


Figure 5-6 Coding of SERT Route 1 in Thurrock

Low Cost Alternative

The low cost alternative represents alternative schemes, following the same routes, where costs are reduced through the removal of priority measures in order to reduce the overall cost of the scheme. The removal of these measures are also likely to reduce the overall benefits of the scheme as well.

The Low cost alternative consisted of the removal of two sets of costs:

- Costs associated with junction improvement measures for the SERT buses

- Costs associated with other measures such as any deterioration in quality of the bus stops, information provision at SERT stops, bus shelter installation, raised kerbs at stops, service reliability resulting from the removal of priority measures, SERT seating at stop and interchange upgrades

To design a low cost alternative, an analysis of junction improvement works, which represent a very large part of SERT implementation costs, was made in the Do Minimum forecast model. Costs of junction priority measures were compared to the modelled delay saved by SERT passengers, to enable a scoring of each separate junction improvement to be made. For the low cost alternative only those junction priority measures with the very highest cost verses delay score were selected, such that junction improvement costs were reduced by 50%. In representing the Low Cost Alternative in the model, SERT running speeds were adjusted to take account of the far less extensive bus priority measures at junctions.

Additionally, to represent the downgrading of quality measures at stops and other infrastructure, the SERT mode constant was changed to 10 minutes – similar to conventional bus services

6 Forecast year matrix development

Matrix development

When using the mode choice approach the matrices in the Do minimum and Do Something scenarios were factored using the same set of factors so that the same future year matrices were used for all future scenarios. These same factors were used to produce 'Reference' demand for the variable demand forecasting.

TEMPRO

The National Trip End Model (NTEM), developed by the DfT, provides the latest DfT forecasts of road traffic growth associated with car ownership, demographic and land use changes. The TEMPRO program has been designed for fast and efficient access to these National Trip End Model projections. The NTEM forecasts are based on information supplied through Local Authority planning projections, regional demographic forecasts, economic forecasts and trip rates derived through the National Travel Survey. TEMPRO 5.4 was released in July 2008 and will remain current up to April 2010; it provides spatial factors for forecast changes of travel demand for private and public transport trips travelling to and from each TEMPRO zone.

TEMPRO takes account of the effects of economic growth; increases in car ownership, decreasing car occupancy, and land use/planning changes. The land use/planning changes are also informed by SETLUM, the land use/transport interaction model used for TGSE and described in the next paragraph. In the context of variable demand forecasting, it is important to note that TEMPRO takes no account of future highway congestion and the increasing generalised cost of private car trips; the main purpose of variable demand models.

SETLUM

The South Essex Transport Land Use Interaction Model (SETLUM) was created as part of the overall modelling approach for Thames Gateway South Essex. SETLUM works through two integrated models, a land use model and a strategic transport model, running in tandem, building up a picture of the demographic and transportation changes through the period 2001-2021.

The land use model represents the United Kingdom using a series of zones. A fully modelled area of 128 zones covers Mid and South Essex, three London Boroughs and areas of North Kent. A further 35 external zones outside the fully modelled area represent the rest of the UK. The transport network is modelled by a strategic transport model using a matrix of the trips between the same zones used in the land use model. Where the land use in a zone changes, (through increased households or the attraction of additional jobs), the number of trips to or from that zone changes.

The model has been used to evaluate differing growth scenarios pivoting around population, job and household growth together with different transport strategies. The model considers a wide variety of inputs for both the land-use and transport models, a more detailed list of these factors includes:

- Job Growth
- Regional development
- Population changes
- Income levels
- Fuel costs
- Journey times
- Car ownership levels
- Public Transport Availability
- Private and Public Transport Costs

Forecast growth assumptions

Forecast public transport and car matrices were factored using TEMPRO factors adjusted to account for local planning assumptions for jobs and households. The jobs and household data was generated using SETLUM.

These growth factors gave new trip ends (totals of trip origins and destinations) for each TGSE zone. Base year matrices were then 'furnessed' to these new trip ends, thereby preserving the underlying travel patterns in the base year matrices derived from observations.

The mode choice model was carried out on car available only as non-car available persons were assumed to be captive to public transport. Separate car available/non-car available factors were generated for the South Essex region using TEMPRO data for the base year, opening year and design year, which are shown in .

Mode	Car Availability	2006 Matrix percentage Splits	2013 Matrix percentage Splits	2028 Matrix percentage Splits
Bus	Car Available	62%	63%	64%
	Non-Car Available	38%	37%	36%
Rail	Car Available	85%	87%	88%
	Non-Car Available	15%	13%	12%

Table 6-1 Car availability factors obtained from TEMPRO used in model

Table 6-2 shows the car, bus and rail matrix totals for each of the base, opening year and design year. The car and rail matrices grow at a far quicker rate than the bus matrices which is consistent with current trends and local knowledge.

Time Period	Vehicle Type	2006	2013	2028	2013 Average Matrix Growth	2028 Average Matrix Growth
AM	Car	5756774	6253140	7039302	1.086	1.223
	Bus	6543	6609	6782	1.010	1.037
	Rail	473629	500495	549005	1.057	1.159
IP	Car	4957582	5412752	6167703	1.092	1.244
	Bus	6139	6307	6880	1.027	1.121
	Rail	194262	202800	221785	1.044	1.142
PM	Car	6060225	6579996	7424003	1.086	1.225
	Bus	5158	5204	5438	1.009	1.054
	Rail	437027	457646	500547	1.047	1.145

Table 6-2 Base and forecast year matrix totals and average growth rates

6.1.1 SETLUM planning assumptions

The SETLUM model was used to adjust the TEMPRO growth factors and account for the local planning data and land use assumptions known by Essex County Council. The employment and housing forecasts provided by SETLUM were only available until 2021, so normal TEMPRO growth was used to growth the 2021 SETLUM adjusted factors to 2028 matrices. Table 6-3 shows the difference in growth between TEMPRO and SETLUM in jobs and households for the regions covered in the SETLUM model for 2013 and Table 6-4 contains the same data for 2021. Whilst most figures are broadly consistent, some regions such as Billericay, Castle Point and Basildon have very different changes in SETLUM compared to TEMPRO. This highlights the importance of using the local data from SETLUM instead of solely using TEMPRO figures.

TEMPRO Region	2013 Growth			
	Jobs		Households	
	SETLUM	TEMPRO	SETLUM	TEMPRO
AVELEY	5.5%	4.2%	-3.4%	8.4%
BARKING AND DAGENHAM	2.5%	3.3%	2.9%	11.6%
BASILDON	-5.4%	6.2%	4.9%	7.2%
BASILDON	8.9%	6.1%	4.7%	6.3%
BENFLEET	5.5%	4.7%	2.7%	4.2%
BEXLEY	2.2%	8.5%	2.9%	3.3%
BEXLEY	2.2%	8.5%	2.9%	4.0%
BILLERICAY	-9.8%	6.6%	2.9%	7.5%
BILLERICAY	3.2%	6.2%	4.0%	5.2%
BOREHAM	-5.2%	5.5%	8.1%	8.7%
BRENTWOOD	3.2%	6.3%	3.1%	5.2%
BRENTWOOD	4.5%	6.8%	3.6%	5.4%
BURNHAM-ON-CROUCH	4.7%	5.2%	4.3%	5.7%
CANVEY ISLAND	-1.8%	4.6%	3.5%	4.6%
CASTLE POINT	24.6%	4.3%	0.9%	5.2%
CHELMSFORD	1.4%	6.0%	9.3%	8.6%
CHELMSFORD	2.1%	6.4%	10.1%	9.0%
DANBURY/LITTLE BADDOW	-5.2%	6.1%	8.1%	7.9%
DARTFORD	2.2%	8.3%	2.9%	3.8%
DODDINGHURST/WYATTS GREEN	-5.1%	6.4%	1.2%	4.8%
GRAYS	11.1%	5.1%	18.5%	11.3%
GREAT AND LITTLE WAKERING	-8.3%	4.9%	7.1%	5.9%
HAVERING	2.6%	8.3%	2.3%	5.0%
HAVERING	2.6%	8.5%	2.3%	4.8%
HOCKLEY	-0.2%	5.2%	3.6%	6.3%
HULLBRIDGE	7.9%	4.9%	3.1%	8.0%
INGATESTONE	-5.1%	7.0%	1.2%	5.3%
LINFORD	-0.2%	4.4%	-4.2%	11.4%
MALDON	4.7%	4.4%	4.3%	4.0%
MALDON	4.7%	5.0%	4.3%	5.1%
MAYLANDSEA	4.7%	4.3%	4.3%	4.2%
RAYLEIGH	11.0%	5.5%	4.9%	5.8%
ROCHFORD	8.3%	4.9%	4.7%	7.0%
ROCHFORD	-4.6%	4.8%	3.2%	6.4%
SOUTH OCKENDON	7.9%	4.7%	-1.2%	8.5%
SOUTH WOODHAM FERRERS	0.6%	6.6%	4.0%	13.4%
SOUTHEND-ON-SEA	6.0%	6.0%	2.7%	3.4%
SOUTHMINSTER	4.7%	4.8%	4.3%	4.4%
STANFORD LE HOPE/ CORRINGHAM	46.1%	4.6%	-5.7%	11.6%
THURROCK	9.4%	5.9%	6.0%	17.1%
TILBURY	-0.8%	4.0%	0.3%	8.4%
WICKFORD	-7.1%	6.0%	6.2%	8.9%
WICKFORD	-12.1%	6.3%	9.2%	13.4%
WICKHAM BISHOPS/GREAT TOTHAM	4.7%	4.5%	4.3%	3.4%
WRITTLE	3.2%	6.2%	10.5%	8.6%

Table 6-3 Comparison of SETLUM and TEMPRO jobs and household data in 2013

TEMPRO Region	2021 Growth			
	Jobs		Households	
	SETLUM	TEMPRO	SETLUM	TEMPRO
AVELEY	10.5%	9.3%	-4.2%	19.4%
BARKING AND DAGENHAM	5.4%	5.5%	6.3%	26.9%
BASILDON	-4.3%	13.3%	11.4%	16.8%
BASILDON	17.8%	12.8%	11.5%	14.7%
BENFLEET	12.0%	10.1%	1.6%	10.3%
BEXLEY	4.6%	12.7%	6.2%	9.3%
BEXLEY	4.6%	13.6%	6.2%	9.3%
BILLERICAY	-13.5%	13.9%	5.0%	17.4%
BILLERICAY	5.4%	13.4%	8.5%	12.0%
BOREHAM	-1.5%	12.3%	16.4%	19.8%
BRENTWOOD	7.0%	13.4%	6.6%	11.7%
BRENTWOOD	8.6%	14.3%	7.8%	12.3%
BURNHAM-ON-CROUCH	10.0%	9.8%	9.3%	12.4%
CANVEY ISLAND	-4.1%	10.0%	13.0%	11.1%
CASTLE POINT	55.5%	9.5%	0.4%	12.5%
CHELMSFORD	3.0%	12.9%	19.9%	19.7%
CHELMSFORD	3.6%	13.6%	21.7%	20.7%
DANBURY/LITTLE BADDOW	-1.5%	13.0%	16.4%	18.0%
DARTFORD	4.6%	13.4%	6.2%	8.8%
DODDINGHURST/WYATTS GREEN	-4.4%	13.4%	2.1%	10.9%
GRAYS	22.8%	11.0%	35.3%	26.4%
GREAT AND LITTLE WAKERING	-5.8%	9.4%	9.8%	13.6%
HAVERING	5.7%	12.3%	5.0%	12.1%
HAVERING	5.7%	13.0%	5.0%	11.8%
HOCKLEY	-2.0%	10.0%	6.7%	14.5%
HULLBRIDGE	20.5%	9.8%	1.3%	18.7%
INGATESTONE	-4.4%	14.4%	2.1%	12.0%
LINFORD	4.6%	9.6%	-8.9%	26.5%
MALDON	10.0%	8.4%	9.3%	8.6%
MALDON	10.0%	9.4%	9.3%	10.9%
MAYLANDSEA	10.0%	8.3%	9.3%	9.0%
RAYLEIGH	19.7%	10.4%	14.1%	13.4%
ROCHFORD	14.3%	9.6%	4.7%	16.3%
ROCHFORD	-5.0%	9.5%	5.9%	14.7%
SOUTH OCKENDON	19.2%	10.2%	9.5%	19.4%
SOUTH WOODHAM FERRERS	7.5%	13.9%	9.5%	31.4%
SOUTHEND-ON-SEA	12.9%	12.9%	5.7%	9.4%
SOUTHMINSTER	10.0%	9.1%	9.3%	9.4%
STANFORD LE HOPE/ CORRINGHAM	100.2%	10.1%	-10.3%	27.1%
THURROCK	22.2%	12.5%	21.1%	40.9%
TILBURY	-1.8%	8.9%	4.1%	19.4%
WICKFORD	-13.9%	12.8%	9.8%	21.0%
WICKFORD	-18.9%	13.6%	17.2%	31.4%
WICKHAM BISHOPS/GREAT TOTHAM	10.0%	8.5%	9.3%	7.2%
WRITTLE	4.4%	13.2%	22.8%	19.8%

Table 6-4 Comparison of SETLUM and TEMPRO jobs and household data in 2021

6.1.2 TEMPRO and SETLUM growth rates

A comparison of TEMPRO growth rates for the whole of Great Britain, the East of England and Essex were made with the SETLUM adjusted TEMPRO growth rates used in the model. A table showing a summary of this comparison is shown in Appendix A and shows that the SETLUM adjusted figures are consistent with those provided by TEMPRO.

6.1.3 LGV and HGV growth

For Light Goods Vehicles and Heavy Goods Vehicles, global factors were applied derived from NTEM vehicle kilometre forecasts. Freight vehicle demand does not contribute to the mode choice model (the assumption being that current freight highway traffic remains on the highway) but freight traffic contributes to highway congestion and therefore highway travel costs.

Table 6-5 shows the LGV and HGV matrix totals and the associated growth for the 2 forecast years. Table 6-6 shows the percentage growth from NTEM for the goods vehicle categories in the model.

Time Period	Vehicle Type	2006	2013	2028	2013 Growth	2028 Growth
AM	HGV	10514	11599	14088	1.103	1.340
	LGV	17531	20865	28637	1.190	1.633
IP	HGV	10558	11647	14146	1.103	1.340
	LGV	15283	18189	24964	1.190	1.633
PM	HGV	7117	7852	9537	1.103	1.340
	LGV	16216	19300	26488	1.190	1.633

Table 6-5 Heavy and Light goods vehicle matrix totals and growth factors

Goods Vehicle Category	Forecast Period	
	2006-2013	2006-2028
Light Goods	19.02%	63.35%
Heavy Goods	10.32%	33.99%

Table 6-6 Growth factors for HGV and LGV traffic generated from NTEM data

7 Scheme testing and results

Introduction

The result of increasing values of time and the introduction of highway improvements in the committed schemes meant that the overall PT mode share dropped in all forecast years compared to the base, as PT costs relative to highway costs increased in the future. In spite of the decreasing PT mode share the SERT patronage performs well in the model. Overall PT shares are shown in Table 7-1 for 2013 and Table 7-2 for 2028. These show that in spite of the general trend of a falling PT mode share across the TGSE area, the introduction of each SERT route increases the overall PT mode share compared to the Do minimum scenario by a small, but noticeable amount.

2013 PT Mode Shares TGSE Area compared to 2006 Base				
Time Period	2006 Base	2013 DM	2013 S1	2013 T1&B1
AM	8.12%	7.68%	7.71%	7.81%
IP	8.20%	7.87%	7.90%	7.92%
PM	5.88%	5.60%	5.62%	5.69%

Table 7-1 Mode shares for Public Transport in 2013 compared to 2006 share

2028 PT Mode Shares TGSE Area compared to 2006 Base				
Time Period	2006 Base	2028 DM	2028 S1	2028 T1&B1
AM	8.12%	7.79%	7.81%	7.93%
IP	8.20%	8.11%	8.14%	8.16%
PM	5.88%	5.72%	5.73%	5.80%

Table 7-2 Mode shares for Public Transport in 2028 compared to 2006 share

Model results

We have presented the central case for SERT using the results of the Variable Demand Model. The results of the Variable Demand Model have also been used for the economic assessment. Tests for the Low Cost Alternative, and Sensitivity Tests have been presented using the Mode Choice Model.

The model showed relatively high patronages on SERT buses for both routes, Table 7-3 shows the total average hour patronages and Table 7-4 shows the passengers per SERT bus that this would equate to where the model assumed a service frequency of 6 buses per direction. Assuming that SERT buses have a capacity of around 80 the model shows that SERT buses would be well used from the opening year onwards. The model demonstrates that an improved quality bus such as SERT would have high patronages in all time periods throughout the day, as shown in Table 7-3 and Table 7-4.

Time Period	SERT 1 patronage (Total Passengers per hour)		SERT 2 patronage (Total Passengers per hour)	
	2013	2028	2013	2028
AM	737	884	433	470
IP	1106	1390	427	476
PM	983	984	525	547

Table 7-3 SERT patronage figures for SERT 1 and SERT 2

Time Period	SERT 1 passengers per bus per average hour time period		SERT 2 Average passengers per bus in average hour time period	
	2013	2028	2013	2028
AM	62	74	37	40
IP	93	116	36	40
PM	82	82	44	46

Table 7-4 Average SERT patronage figures per bus for SERT 1 and SERT 2

Appendix B shows plots of the average hour flows along the SERT routes and it can be seen that passenger numbers are sustained along the full length of the SERT routes with peaks in numbers towards the centre of the routes.

Appendix B also shows the total bus flows with and without the inclusion of the SERT bus routes and shows that the overall PT network benefits from the introduction of SERT through re-routeing to quicker routes and extra bus flows along the SERT corridors.

7.1.1 Low Cost Alternative

SERT 1 patronage (Total Passengers per average hour)						
Time Period	2013			2028		
	Preferred Route	LCA	% Difference	Preferred Route	LCA	% Difference
AM	687	377	-45%	746	388	-48%
IP	715	387	-46%	836	322	-61%
PM	744	334	-55%	835	332	-60%

Table 7-5 SERT patronage for low cost alternative compared to preferred route for SERT 1

SERT 2 patronage (Total Passengers per average hour)						
Time Period	2013			2028		
	Preferred Route	LCA	% Difference	Preferred Route	LCA	% Difference
AM	400	172	-57%	422	188	-56%
IP	394	109	-72%	426	119	-72%
PM	492	223	-55%	515	250	-51%

Table 7-6 SERT patronage for low cost alternative compared to preferred route for SERT 2

The Low Cost Alternative was tested in the Mode Choice model, and in order to ensure consistency of comparison, the results of the central case, as modelled in the Mode Choice model are presented as a comparison. The Low Cost Alternative as described in 0 has significantly lower patronage than the preferred routes. Table 7-6 and Table 7-5 show that the fall in SERT patronage is generally around 50% with the reduction of priority measures and removal of other quality measures associated with the Low Cost Alternative. The model clearly supports the preferred options having a full set of priority measures and other quality elements associated with the service.

Model Sensitivity

A set of sensitivity tests were carried out in the model in order to check how the scheme would perform if some of the assumptions in the model were varied, and how big the effects of changes to these assumptions would be. The following sensitivity tests were carried out on the Mode Choice model:

- Normal bus speeds were slowed down in forecast years to account for increases in congestion
- The SERT mode constant was varied by +/-1 minute to account for possible variations in mode perception
- The level of developments in the SERT corridors was changed by +/-10% to account for different levels of development
- SERT bus running times were changed by +/-5% in order to account for any changes in the predicted running time of SERT buses

The tests were by no means exhaustive but covered the most important assumptions of the model and those recommended by WebTag.

A summary of the sensitivity tests carried out is presented in this section.

7.1.2 Future bus speeds

Buses run at 2006 timetabled speeds in the 2006 and forecast models. Because predicted traffic and congestion levels increase from 2006 to the opening and design years a sensitivity test was carried out to check for the effect of slowing traffic on the bus timetables.

Where non-SERT buses meet certain quality criteria they would be allowed to use the SERT priority measures. There may also be an unpredicted increase in other priority measures such as bus lanes in the future which would negate any detrimental impact of increasing congestion.

Because it is impossible to predict which non-SERT buses would meet the quality criteria the sensitivity test was designed to check only for the broad impact of the slowing down of highway traffic across the network. Global speed factors were generated for both the opening and design years which represented the average speed reduction factor for car traffic in the TGSE area. The same factors were then applied to the bus timetables in the opening and forecast years to account for the effects of congestion. Table 7-7 shows the congestion factors for both years and Table 7-9 and Table 7-8 show the effect on SERT patronage. Table 7-9and Table 7-8 clearly show that as congestion increases SERT buses benefit from an increase in patronage due to other buses slowing down.

Factor by which average car speeds slow down by in the model by year and time period			
Year	AM	IP	PM
2006	1.00	1.00	1.00
2013	0.97	0.96	0.96
2028	0.82	0.83	0.83

Table 7-7 Highway congestion factors for forecast years

SERT Route 1 Average hour patronage						
Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with 2006 bus speeds	687	715	744	746	836	835
DS Congested Bus Speeds	695	720	749	768	880	887

Table 7-8 SERT 1A & 1B patronages with buses running in congested speeds compared to timetabled speeds

SERT Route 2 Average hour patronage						
Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with 2006 bus speeds	400	394	492	423	427	515
DS Congested Bus Speeds	416	404	514	536	512	645

Table 7-9 SERT 2 patronages with buses running in congested speeds compared to timetabled speeds

7.1.3 New Developments

A sensitivity test was carried out to test the impact of a potential increase or decrease in new developments in the SERT corridor once the routes were introduced. The introduction of SERT may result in increased development in the longer term due to the improved transport links which SERT facilitates, and as a result trip rates to and from zones in the SET corridors were increased by 10% and then reduced by 10% in order to assess the potential impacts. The results in Table 7-11 for Southend and Table 7-10 for T1&B1 show that an increase in developments nearby results in significant increases in SERT patronage and likewise a decrease in developments results in a large decrease. The model is showing that developments within the local corridor will view SERT buses as a significant mode of transport.

SERT Route 1 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with No Change	687	715	744	746	836	835
DS (SERT +10% increase in developments in SERT corridor)	750	774	806	817	903	906
DS (SERT -10% increase in developments in SERT corridor)	627	659	684	681	772	766

Table 7-10 SERT 1 patronages in sensitivity test on increase or reduction in developments in SERT corridor

SERT Route 2 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with No Change	400	394	492	423	427	515
DS (SERT +10% increase in developments in SERT corridor)	455	447	556	480	484	586
DS (SERT -10% increase in developments in SERT corridor)	347	343	430	362	369	450

Table 7-11 SERT 2 patronages in sensitivity test on increase or reduction in developments in SERT corridor

7.1.4 Mode constant

Because the mode constant represents the perception of a mode it is important to test the impact of the mode constant on SERT patronages. The mode constant for SERT was increased by 1 minute and decreased by 1 minute in two tests. The results in Table 7-13 for Southend and Table 7-12 for B1 and T1 show that it is sensitive to changes in mode constant showing that the perception of any new service is a very important factor in future SERT patronages.

SERT Route 1 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with No Change	687	715	744	746	836	835
DS (SERT Mode constant +1 minute)	654	665	690	711	776	774
DS (SERT Mode constant -1 minute)	808	781	796	877	911	892

Table 7-12 SERT 1 patronages when SERT mode constant is increased and decreased by 1 minute

SERT Route 2 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with No Change	400	394	492	423	427	515
DS (SERT Mode constant +1 minute)	343	304	446	359	349	469
DS (SERT Mode constant -1 minute)	493	467	531	508	504	557

Table 7-13 SERT 2 patronages when SERT mode constant is increased and decreased by 1 minute

7.1.5 SERT bus running time

A sensitivity test on the SERT bus running times was carried out where the SERT speeds across the whole route were sped up by 5% and then slowed down by 5% to see how sensitive the model was to SERT speeds. The results shown in Table 7-15 for Southend and Table 7-14 for SERT 1A and 1B show that the model was sufficiently sensitive to SERT bus speeds such that when the speeds are increased by 5% a substantial increase in passengers in observed, and where the speeds are decreased by 5% a fall in patronage is observed.

SERT Route 1 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS	687	715	744	746	836	835
DS (SERT +5 minutes SERT running time)	662	699	733	715	817	826
DS (SERT -5 minutes SERT running time)	720	731	765	777	853	858

Table 7-14 SERT 1 patronages when SERT bus running speeds are varied by +/-5%

SERT Route 2 average hour patronage						
Sensitivity Scenario	2013			2028		
	AM	IP	PM	AM	IP	PM
DS with No Change	400	394	492	423	427	515
DS (SERT running time 5% slower)	391	368	480	406	416	505
DS (SERT running time 5% quicker)	432	403	517	450	437	534

Table 7-15 SERT 2 patronages when SERT bus running speeds are varied by +/-5%

8 Summary and conclusions

This Report describes the forecasting methodology for determining future traffic flows on a rapid transit scheme implemented in South Essex. Forecasts were undertaken for the anticipated opening year of 2013 and a design year of 15 years after opening of 2028.

The Variable Demand Model has provided a set of patronage data which suggests that the SERT scheme would be a well served PT mode. The model clearly shows that the Route 1 in Basildon and Thurrock would provide the largest patronage flows although Route 2 in Southend would seem to have generous patronage in its own right.

A series of realism tests on the model revealed that the model was suitably replicating what one would intuitively expect, although they did reveal that the model may not be sufficiently sensitive to changes in fuel cost, although for the purpose of this PT scheme this would not appear to be a major shortcoming of the model. The Public Transport elasticity with respect to changes in fare of -0.3 was exactly where experience would suggest that it should be.

Using the Mode Choice model sensitivity tests were carried out on the model to check how the modelled schemes would react under a set of differing assumptions about the conditions of the model. These revealed that the modelled schemes performed well under the varying changes to the underlying model assumptions, suggesting it is a robust scheme.

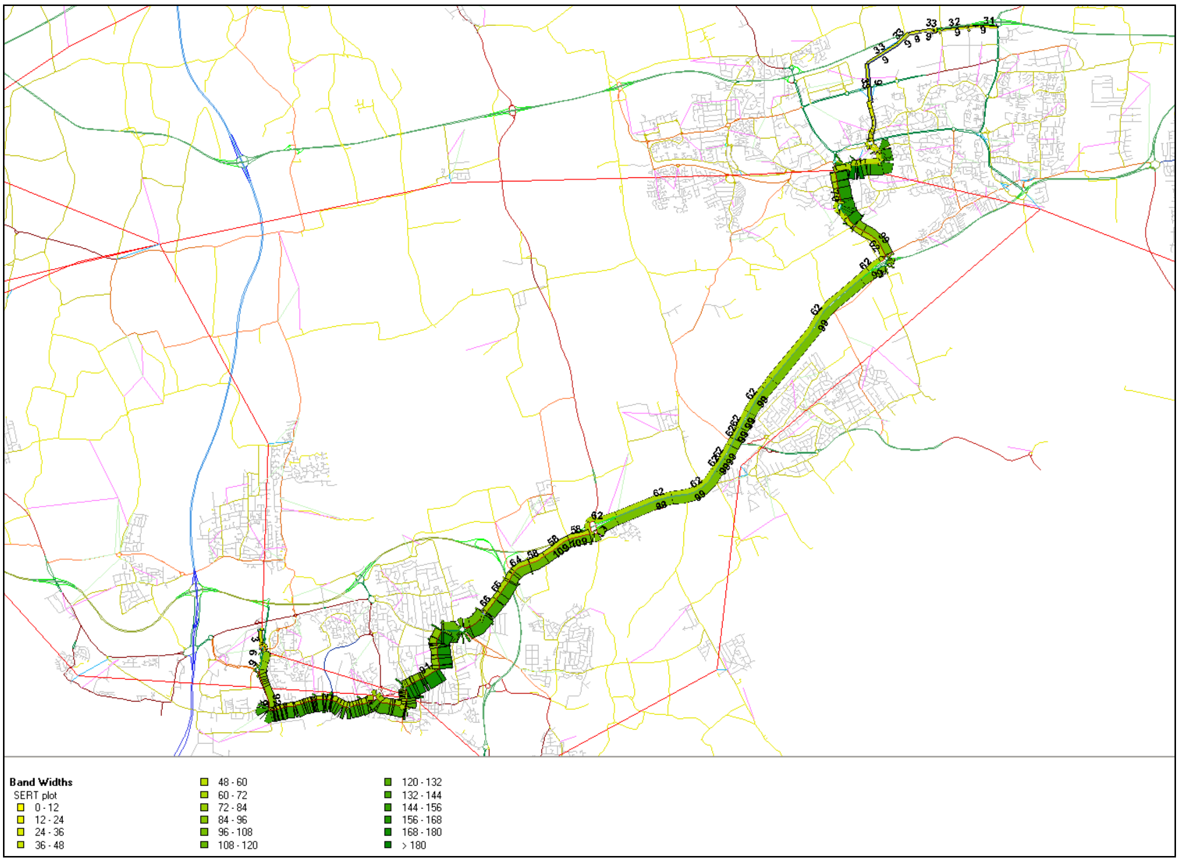
Appendix A – Comparison of SETLUM Adjusted growth rates with TEMPRO growth rates

Comparison of TGSE SETLUM adjusted TEMPRO growth with TEMPRO growth								
Time Period	Mode	Region	2006-2013			2006-2028		
			SETLUM ADJUSTED TEMPRO TGSE AREA	TEMPRO Growth	% Diff	SETLUM ADJUSTED TEMPRO TGSE AREA	TEMPRO Growth	% Diff
AM	Car	GB	1.086	1.087	-0.1%	1.223	1.224	-0.1%
		East of Eng	1.086	1.084	0.2%	1.223	1.248	-2.0%
		Essex	1.086	1.074	1.2%	1.223	1.219	0.3%
	Bus	GB	1.010	1.009	0.2%	1.037	1.031	0.6%
		East of Eng	1.010	1.037	-2.6%	1.037	1.109	-6.6%
		Essex	1.010	1.028	-1.7%	1.037	1.085	-4.4%
	Rail	GB	1.057	1.044	1.2%	1.159	1.116	3.9%
		East of Eng	1.057	1.040	1.6%	1.159	1.122	3.3%
		Essex	1.057	1.033	2.3%	1.159	1.100	5.4%
IP	Car	GB	1.092	1.093	-0.1%	1.244	1.246	-0.2%
		East of Eng	1.092	1.097	-0.5%	1.244	1.279	-2.7%
		Essex	1.092	1.098	-0.5%	1.244	1.280	-2.8%
	Bus	GB	1.027	0.994	3.3%	1.121	1.024	9.4%
		East of Eng	1.027	1.030	-0.3%	1.121	1.110	0.9%
		Essex	1.027	1.028	-0.1%	1.121	1.116	0.4%
	Rail	GB	1.044	1.032	1.1%	1.142	1.102	3.6%
		East of Eng	1.044	1.054	-0.9%	1.142	1.161	-1.7%
		Essex	1.044	1.053	-0.9%	1.142	1.162	-1.7%
PM	Car	GB	1.086	1.087	-0.1%	1.225	1.226	-0.1%
		East of Eng	1.086	1.085	0.1%	1.225	1.254	-2.3%
		Essex	1.086	1.087	-0.1%	1.225	1.258	-2.6%
	Bus	GB	1.009	0.997	1.1%	1.054	1.013	4.0%
		East of Eng	1.009	1.022	-1.3%	1.054	1.085	-2.8%
		Essex	1.009	1.023	-1.4%	1.054	1.093	-3.6%
	Rail	GB	1.047	1.040	0.7%	1.145	1.115	2.7%
		East of Eng	1.047	1.049	-0.2%	1.145	1.152	-0.5%
		Essex	1.047	1.047	0.0%	1.145	1.144	0.1%

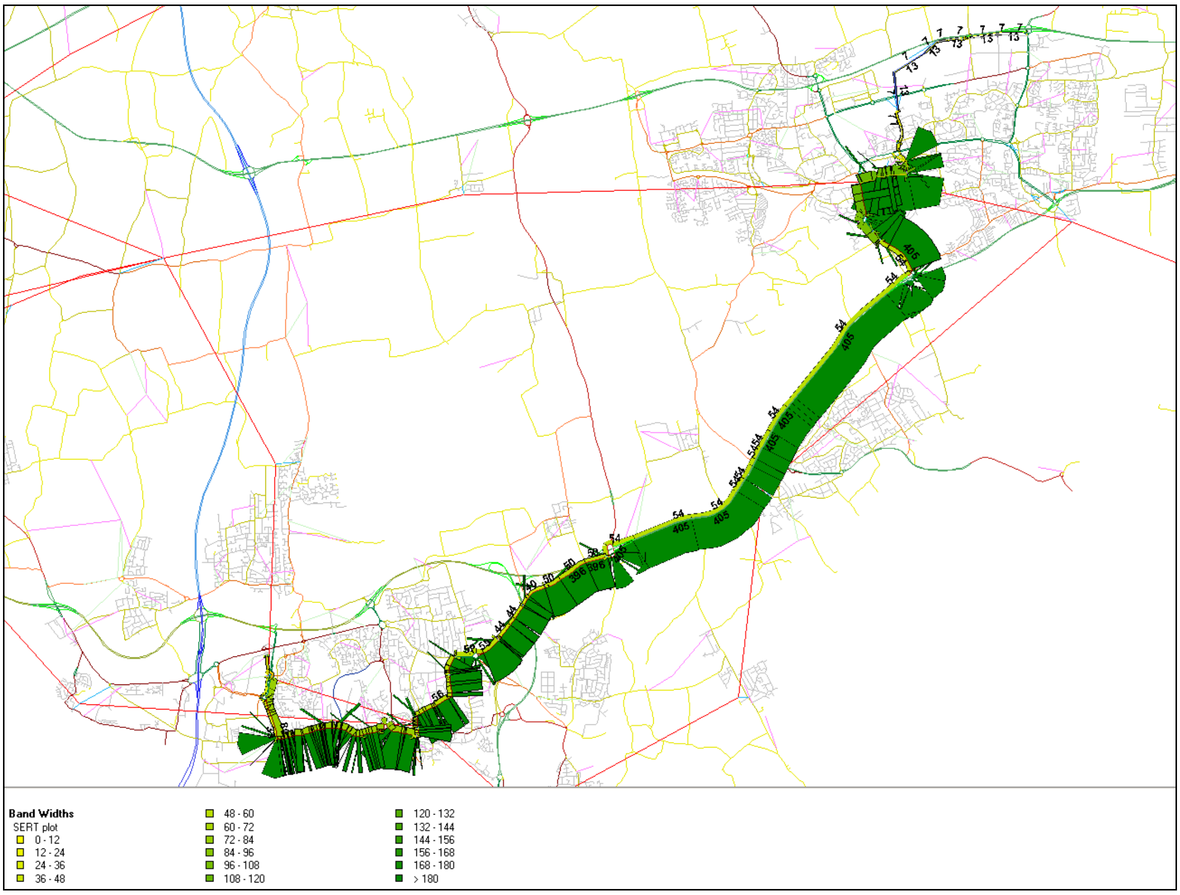
Appendix B – SERT Patronage Plots

This appendix presents plots of each SERT Route, for each time period (AM, IP, PM) and modelled year (2013, 2028)

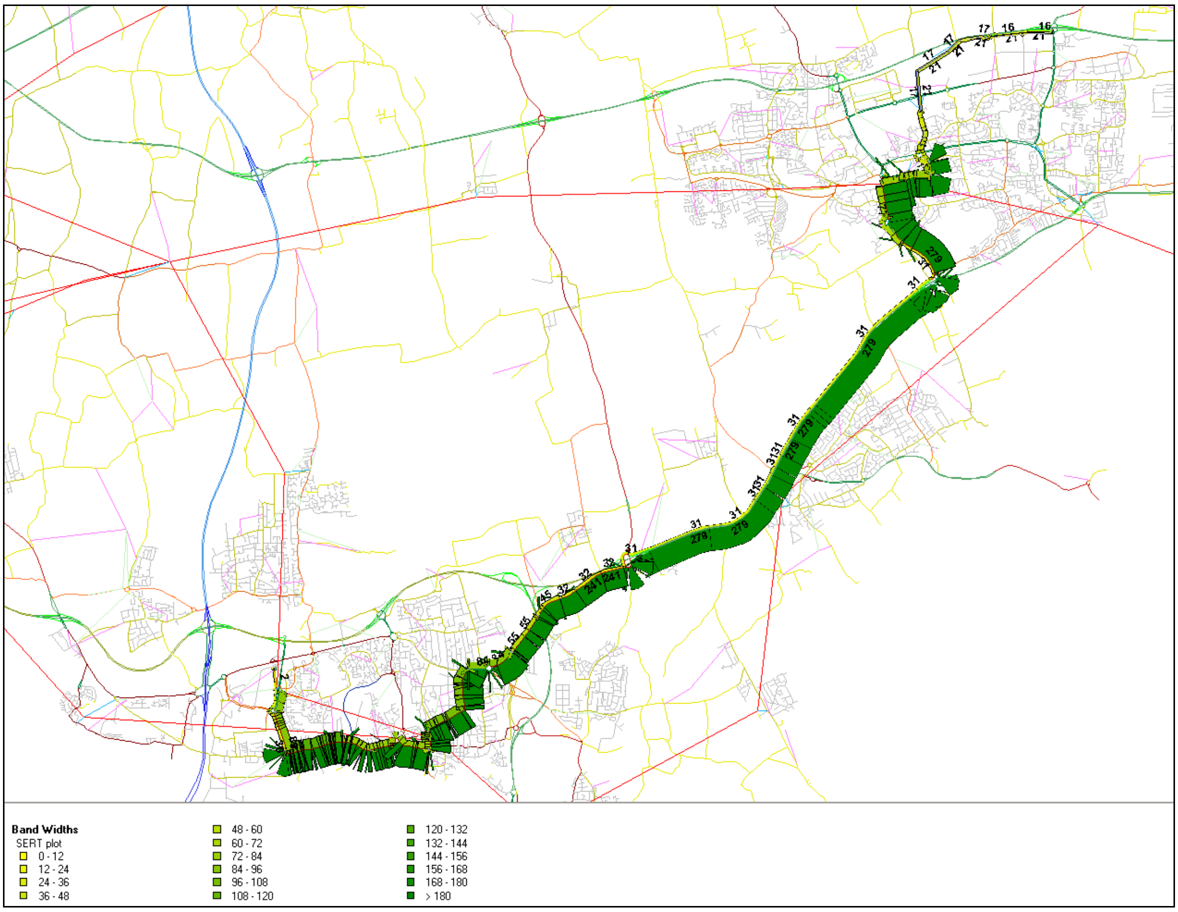
SERT Route 1



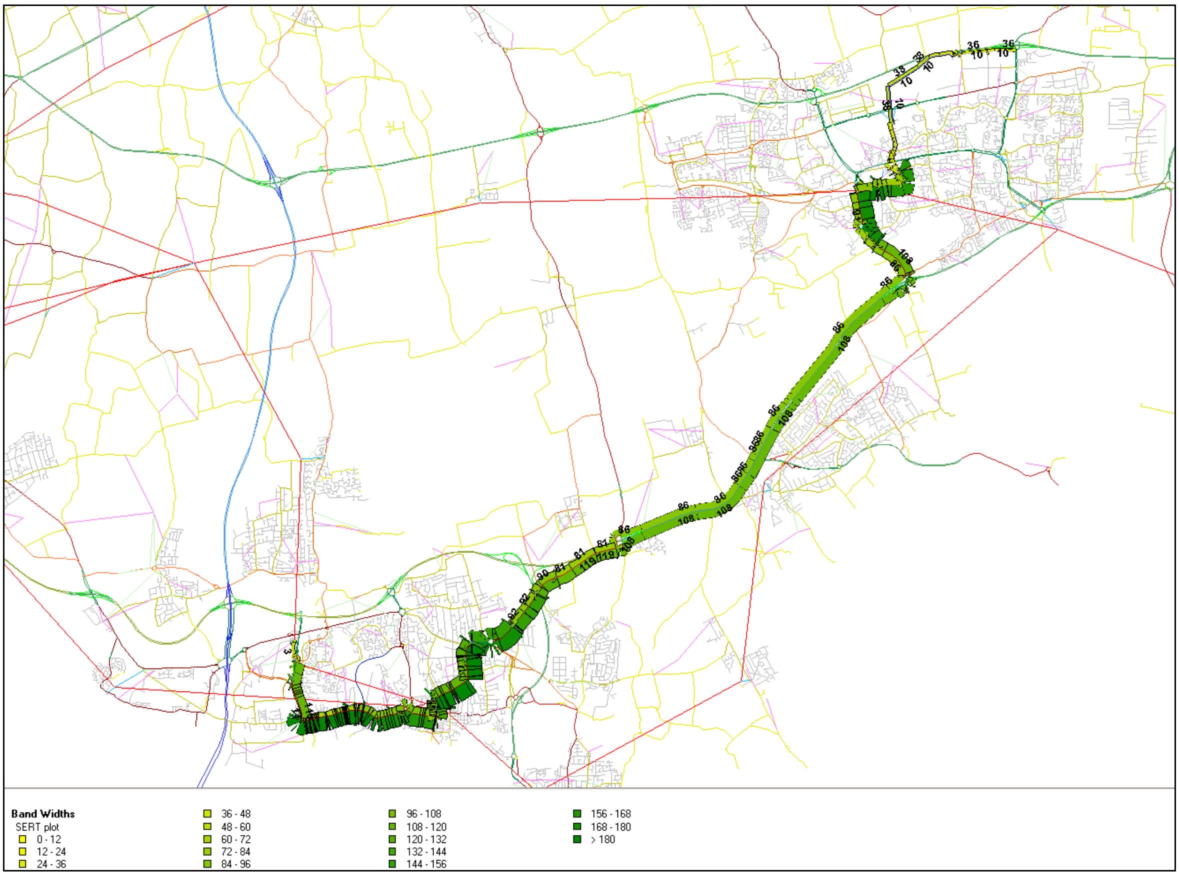
Route 1 SERT flows – 2013 AM



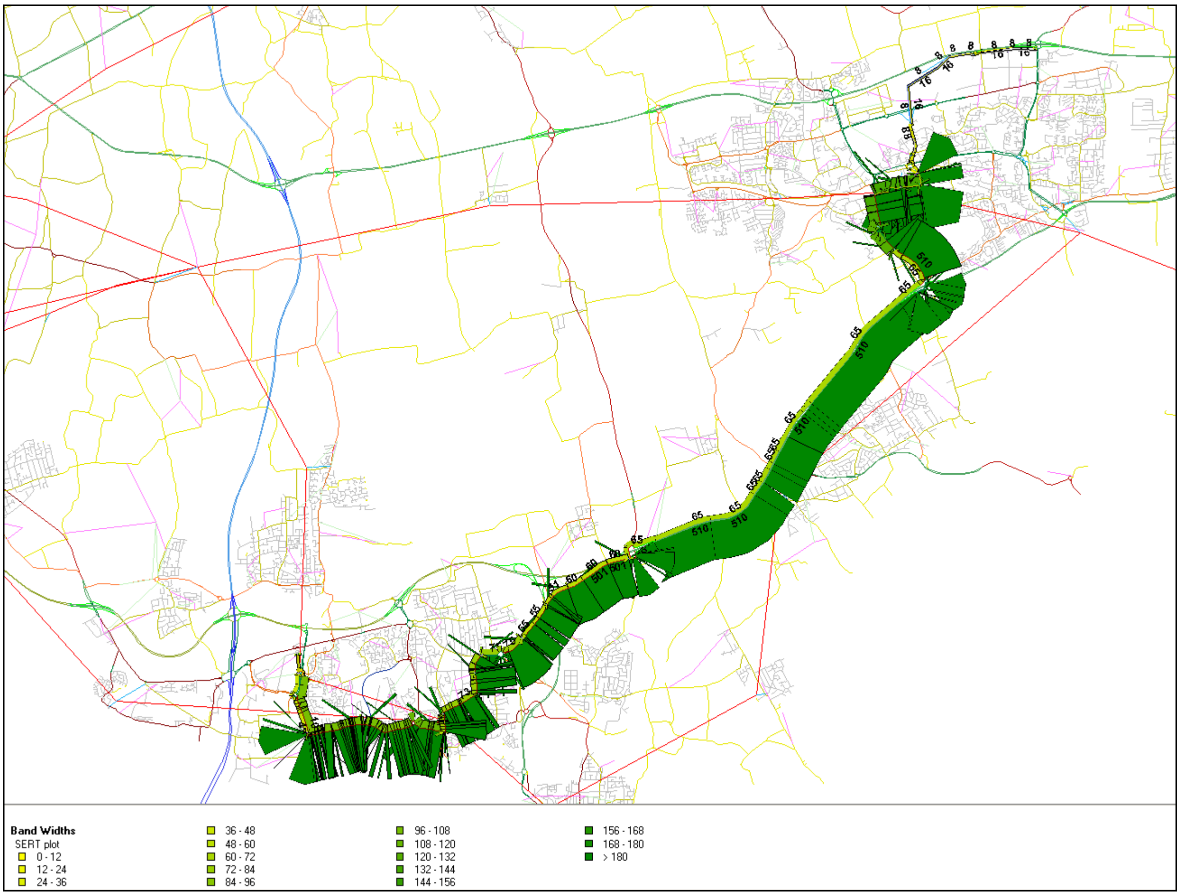
Route 1 SERT flows – 2013 IP



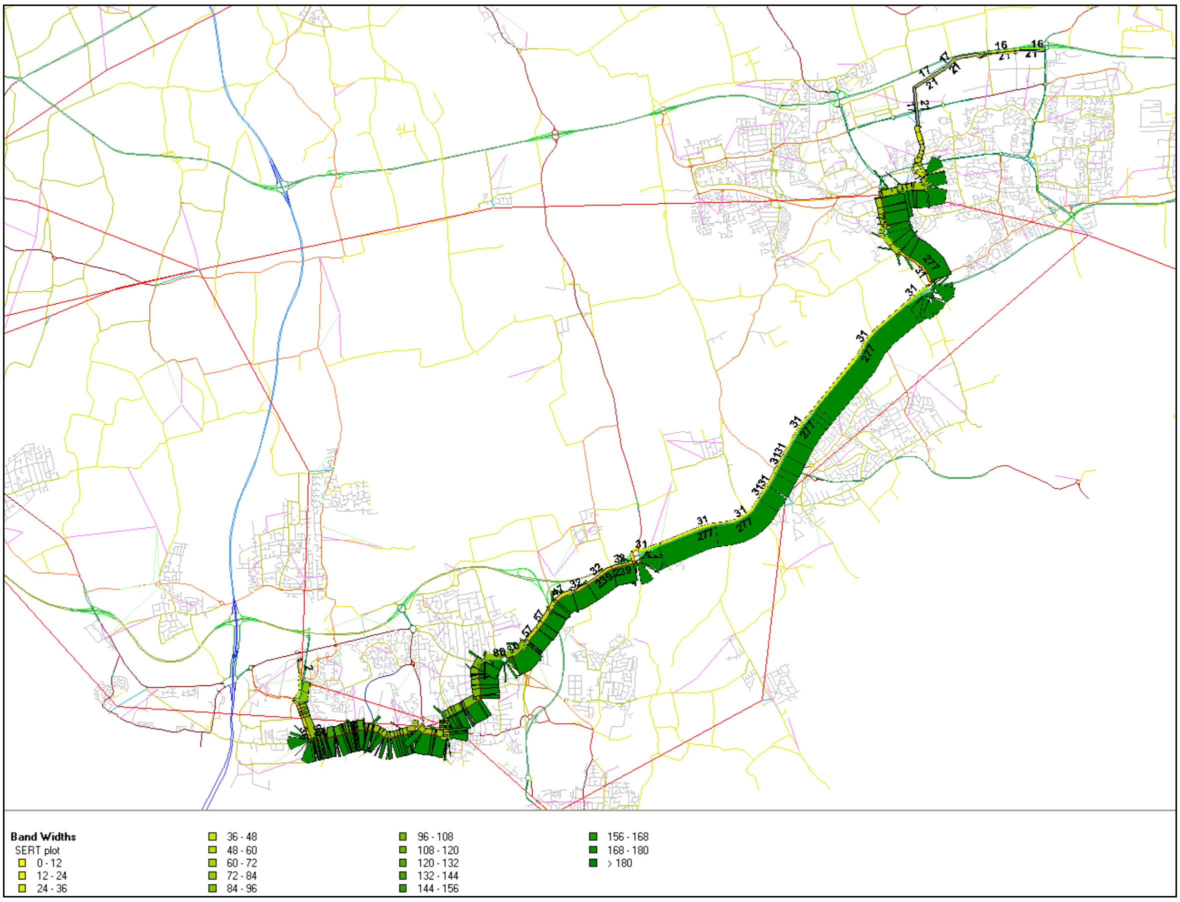
Route 1 SERT flows – 2013 PM



Route 1 SERT flows – 2028 AM

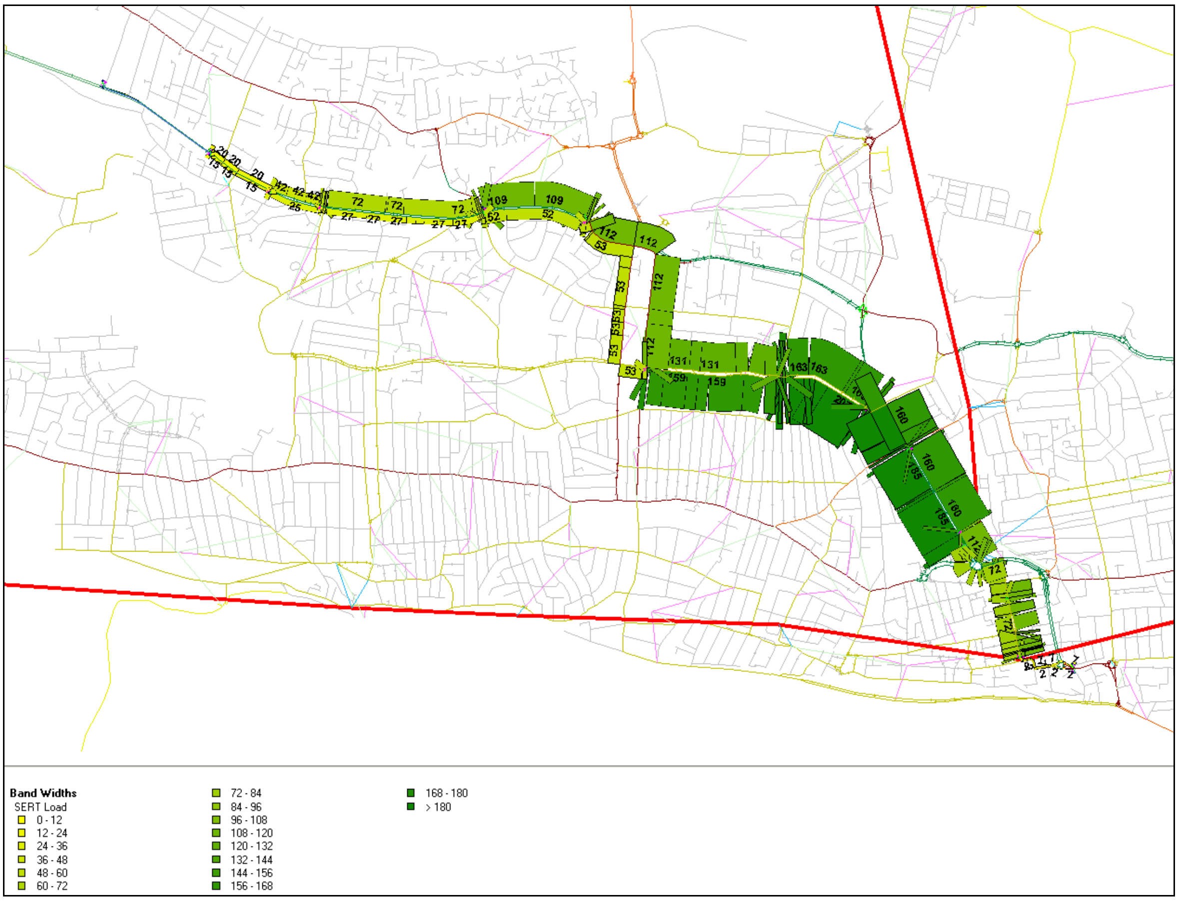


Route 1 SERT flows – 2028 IP

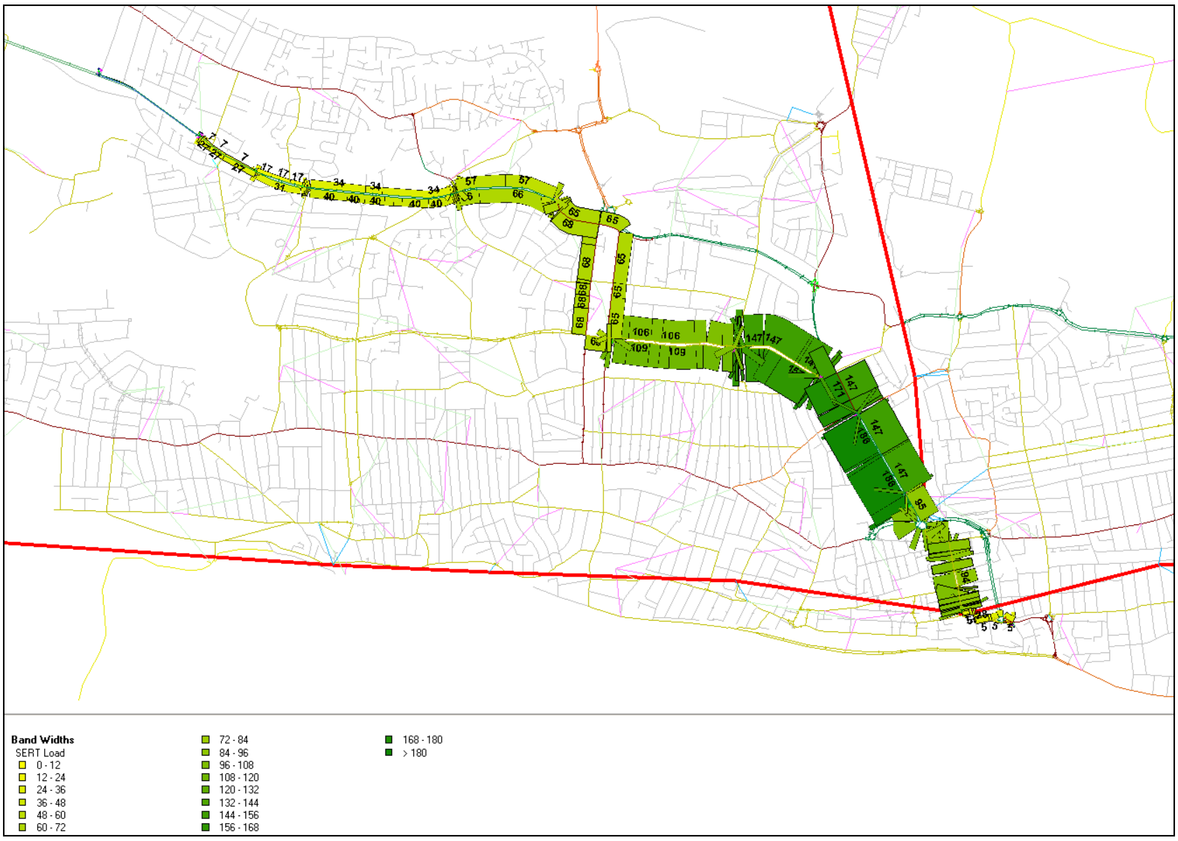


Route 1 SERT flows – 2028 IP

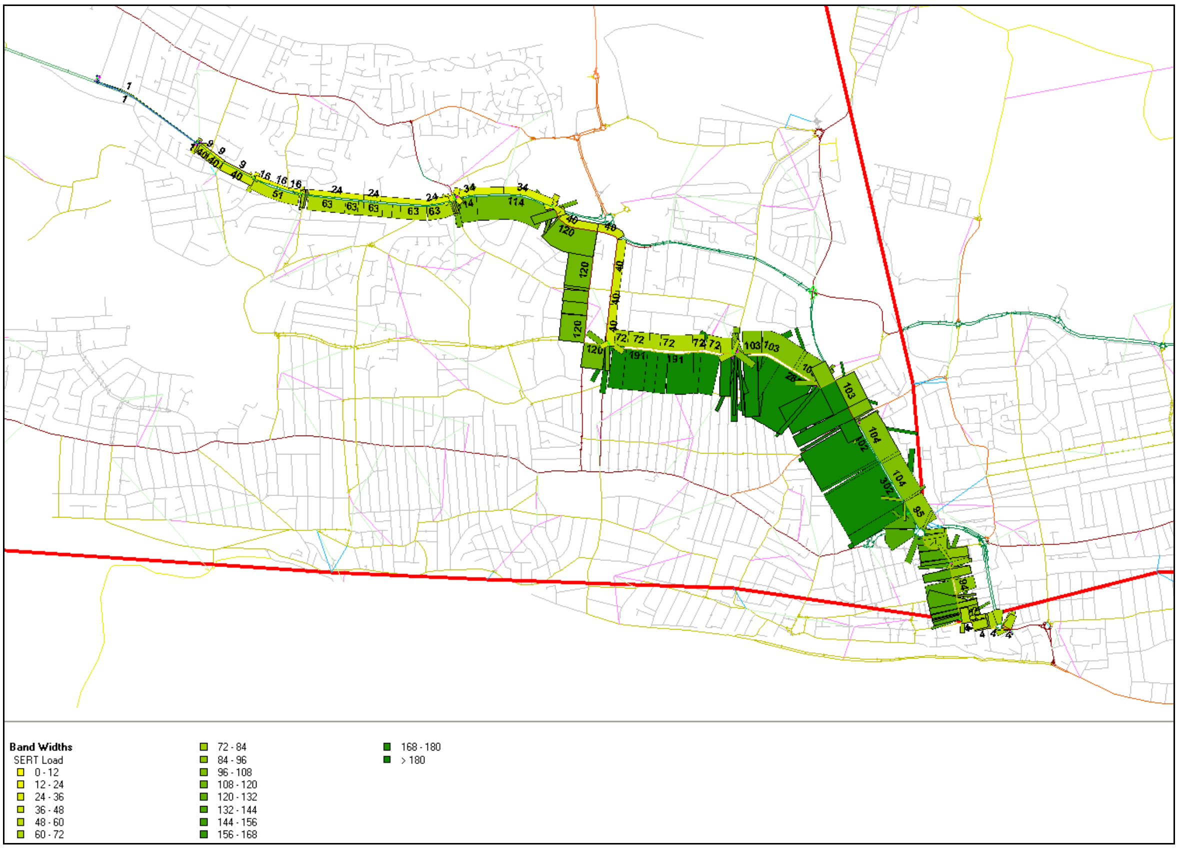
SERT Route 2



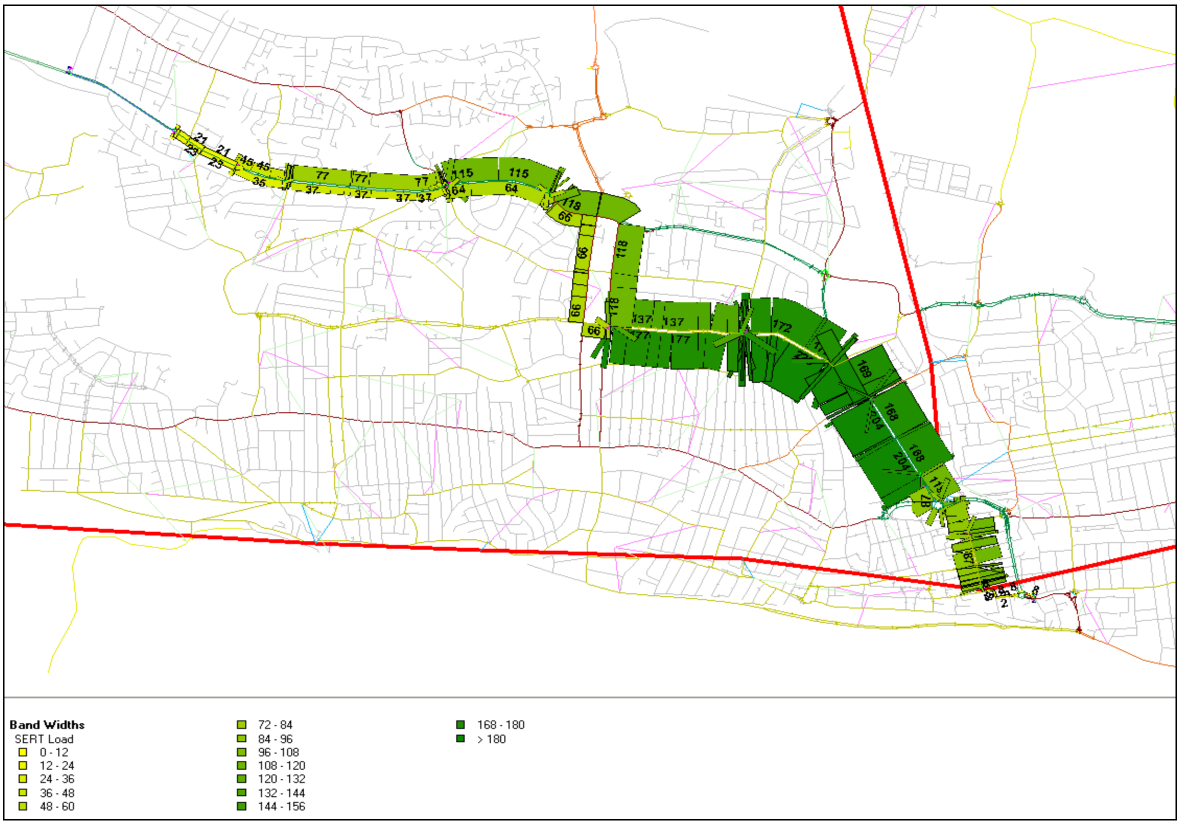
Route 2 SERT flows – 2013 AM



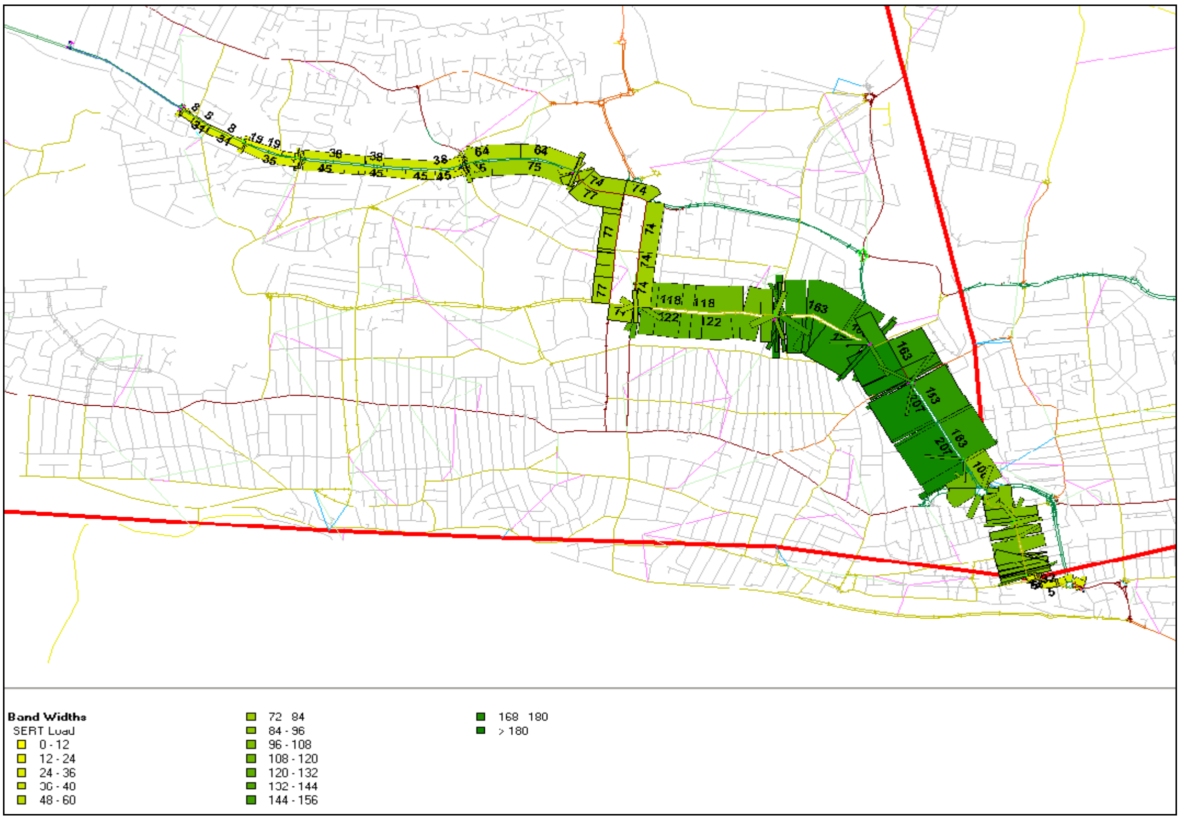
Route 2 SERT flows – 2013 IP



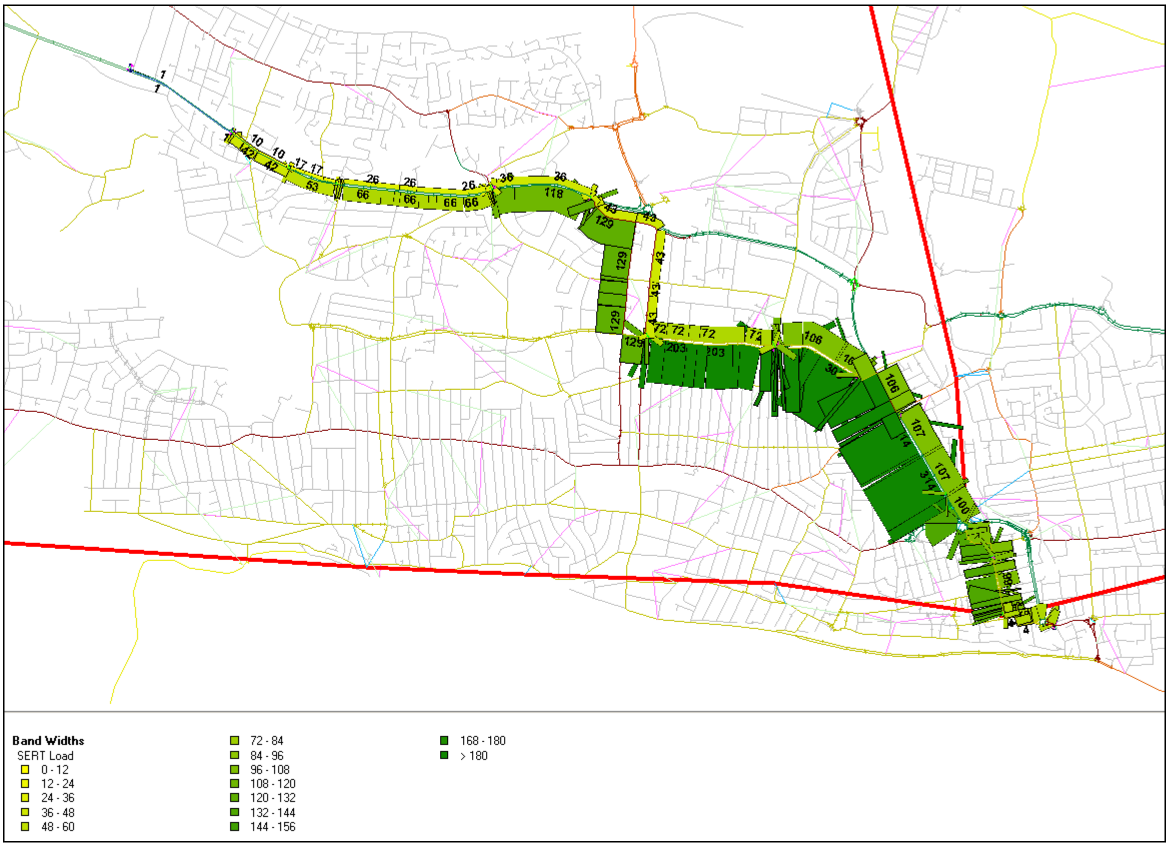
Route 2 SERT flows – 2013 PM



Route 2 SERT flows – 2028 AM



Route 2 SERT flows – 2028 IP



Route 2 SERT flows – 2028 IP